### Scheme of Studies & Examinations

**Master of Science in Environmental Science (ES) (SEMESTER - I)**

<table>
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<tr>
<th>S. No.</th>
<th>Course No.</th>
<th>Course Title</th>
<th>Teaching Schedule</th>
<th>Marks</th>
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<td>Ecology And Biodiversity</td>
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<td>Remedial Biology (for Mathematics students)</td>
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<td>8</td>
<td>ES 115</td>
<td>Environmental and Energy Lab I</td>
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### Master of Science in Environmental Science (ES) (SEMESTER - II)

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<td>Analytical Techniques</td>
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* Report based on field visit.
** Four week training in summer vacations
### Master of Science in Environmental Science (ES) (SEMESTER - III)

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### List of Electives (III) Semester

ES 209 Natural hazards and disaster management

ES 211 Energy Policy and Planning
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**NOTE:** In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.

**List of Electives: (IV) Semester**

ES 202 Environmental Geosciences

ES 204 Environmental Microbiology and Biotechnology

ES 206 Water Resources

ES 208 Emerging Technologies for Energy and Environmental applications

ES 210 Nuclear Energy

ES 212 Solar Energy Utilisation
ES -101 ECOLOGY AND BIODIVERSITY

M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (I - Semester)

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<td>: 3 Hours</td>
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UNIT – I
History and scope of ecology, Levels of Organization Hierachy, trophic levels, productivity and energy flow, food chain, food webs, cycling of elements, Concept of carrying capacity, Sustainable development.

UNIT – II

UNIT – III
Ecological succession, primary and secondary processes in successions, models of successions, Ecosystem- its kind, structure and function, Major ecosystem- Pond, Marine, Grassland, Forest and Desert.

UNIT – IV
Biodiversity - definition, hot spots of Biodiversity, strategies for Biodiversity Conservation, National Parks, Sanctuaries and Biosphere reserves, gene pool. IUCN red data book, International conventions, treaties and protocols for Biodiversity Conservation, Biodiversity in the welfare of mankind, Species concept.

Reference Books:
1. Global Biodiversity - W.R. L.IUCN
2. Ecology of natural resource - Ramade
3. Ecology and Environment - P.D. Sharma
4. Fundamentals of Ecology i E. P. Odum
5. Concept of Ecology: Dash

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES-103 ENVIRONMENTAL CHEMISTRY

M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (I - Semester)

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<td>50 Marks</td>
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UNIT I

Fundamental of Environmental chemistry: Stochiometry, Gibbs’ energy, chemical Potential, chemical equilibrium acid base reactions, Solubility product, solubility of gases in water, Unsaturated and saturated hydrocarbons, radio nuclides

UNIT II

Chemical compositions of Air: Classification of elements, chemical speciation, Particles, Ions and radicals in atmosphere, chemical processes for formation of inorganic and organic particulate matter, thermo chemical and photochemical reaction in atmosphere Oxygen and Ozone chemistry, chemistry of air pollutants, photochemical smog

UNIT III

Water Chemistry: Chemistry of water, Concept of DO, BOD, COD, Sedimentation coagulation, filtration, redox potential

UNIT IV

Soil Chemistry: Inorganic and organic components of soil, Nitrogen pathways and NPK in soils

References

1. Environmental Chemistry - G.S. Sodhi
2. Environmental Chemistry - Mannhan

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES -105 FUNDAMENTAL OF ENVIRONMENTAL SCIENCES
M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (I - Semester)

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Class Work : 50 Marks  
Examination (Theory/Practical) : 100 Marks  
Total : 150 Marks  
Duration of Examination : 3 Hours

UNIT – I  

UNIT II  
Mass and Energy transfer across the various interfaces, material balance. First and Second law of thermodynamics, heat transfer processes.

UNIT III  

UNIT IV  
Natural resources, conservation and sustainable development.

Recommended Books

2. J.B.Jones and R.E.Dugan, Engineering Thermodynamics, PHI, New Delhi, 1996  
6. Ecology of natural resource í Ramade  
7. Ecology and Environment - P.D. Sharma

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES 107 ENVIRONMENTAL EDUCATION
M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (II - Semester)

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<td>Duration of Examination</td>
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UNIT I
Environmental ethics- Global imperatives, Global environmental problems-Ozone depletion, global warming and climatic change.
Current environmental issues in India: Context: Narmada Dam, Tehri Dam, Almethi Dam, Soil erosion, Formation and reclamation of Usra, Alkaline and Saline Soil

UNIT II
Waste lands and their reclamation, Desertification and its control, Vehicular pollution and urban air quality, Depletion of Natural Resources,

UNIT III
Waste disposal, recycling and power generation, Fly ash utilization, Water Crises- conservation of water

UNIT IV
Environmental Hazards, Eutrophication and restoration of Indian lakes, Rain water harvesting, Wetlands conservation, Epidemiological issues (i.e Goitre, Fluorosis, Arsenic)

Reference:
1. Environmental Management of Mining operations, ENVIS. N L Ramanathan and R Mehta.
2. Environment and management: An Indian Scenerio A B Chaudhary.
3. Assessment of water Pollution, S R Mishra.

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks
UNIT I
Sun as source of energy, solar radiation and its spectral characteristics.

UNIT II
Fossils fuels-classification, compositions, Physico-chemical characteristics and energy content of coal, Petroleum and natural gas, Principles of generation of hydroelectric power, tidal, Ocean thermal energy conversion,

UNIT III
Wind Energy, Geothermal energy, Solar collector, Photovoltaic, solar pond, nuclear energy-Fission and fusion, magneto hydrodynamic power, Bio energy-energy from biomass and biogas, Anaerobic digestion, energy use pattern in different parts of the World.

UNIT IV
Environmental implication of energy uses, CO₂ emissions, global warming, air and thermal palliation, radioactive waste and radioactivity form nuclear reactors, Impacts of large scale exploitation of Solar, Wind, Hydro and Ocean energy.

Reference Books::

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES 111 Remedial Biology

M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (I - Semester)

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Class Work : 00 Marks
Examination (Theory/Practical) : 100 Marks
Total : 100 Marks
Duration of Examination : 3 Hours

Unit-I

Evolution of biosphere, Diversity of life forms. Biological communities, species interaction, Communities properties, Plant diversity and nomenclature with major classes of plants; Phytogeographical regions; Rare and threatened plants and exploration of plant wealth.

Unit-II

Animal diversity and categories of animals; Rare and threatened species of mammals, aves, reptiles, pisces etc.; Exploration and conservation of faunal wealth. Microbial diversity, bacteria, fungi, actinomycetes; Microbial diversity in man-made ecosystems and natural ecosystems. Importance of flora and fauna in nutrient cycling, its effect, degradation and metabolism.

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES 113 Remedial mathematics

M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (I - Semester)

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Class Work : 00 Marks
Examination (Theory/Practical) : 100 Marks
Total : 100 Marks
Duration of Examination : 3 Hours


**NOTE:** In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES 115 ENVIRONMENT AND ENERGY LAB- I

M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (I - Semester)

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Class Work : 50 Marks
Examination (Theory/Practical) : 50 Marks
Total : 100 Marks
Duration of Examination : 3 Hours

1. To determine the pH value of soil, water and waste water sample.
2. To determine the turbidity of water and waste water sample.
3. To determine the conductivity of soil, water and waste water sample.
4. To determine the total alkalinity of the water sample.
5. To determine the total hardness of the water sample.
6. To determine the normality and morality of a given solution.
7. Determination of Thermal Efficiency of Flat Plate Collector.
10. Measurement of Intensity of solar radiation
11. Study of solar collector.
12. Characteristics of SPV system.

NOTE: Any five experiments from environment and five from energy will be conducted.
ES 102 ENVIRONMENTAL IMPACT ASSESSMENT

M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (II - Semester)

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Class Work : 50 Marks
Examination (Theory/Practical) : 100 Marks
Total : 150 Marks
Duration of Examination : 3 Hours

UNIT I
Introduction to environmental impact analysis, environmental impact assessment and environmental Management Plan.

UNIT II

UNIT III
Introduction to environmental Planning, Base line information and prediction (land, water, atmosphere, energy etc), restoration and rehabilitation technologies, Land use policy for India

UNIT IV
Urban planning for India. Rural planning and Land use pattern, Concept and strategies of sustainable development, Cost-Benefit analysis, Environmental priorities in India and Sustainable development

Reference Books:
4. Chemical principles of Environmental pollution - Lalloway and Ayers.
5. Industrial Environment - Assessment and strategy - S.K. Aggarwal

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES 104 SOLAR ENERGY AND BASICS OF PHOTOVOLTAICS

M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (II - Semester)

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<td>Duration of Examination : 3 Hours</td>
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UNIT I
P-N junction Solar Cells: P-N diode structure, band diagram, the contact potential, junction analysis at equilibrium, p-n junction under reverse & forward bias, linear graded junction asymmetrical doped junction. Computation of parameters of depletion region, signal, breakdown voltage, dynamic resistance, diffusion capacitance & recombination current, Quantitative analysis of heterojunctions.

UNIT II
Photo voltaic effect, current generation in illuminated p-n junction, solar cell, characteristics & parameters, back surface field solar cells, photovoltaic module & arrays, energy storage.

UNIT III

UNIT IV

Reference Books:


NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
UNIT –I

UNIT –II

UNIT –III

UNIT –IV

Reference Books:
1. Economics and Environment: Good Steie
2. Environmental Planning, Policies and Programmes in India: K D Saxena
3. Land Use and Environment: S M Mujtava
5. Environmental Laws: V K Garg

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES 108 ENVIRONMENTAL POLLUTION

M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (II - Semester)

L T P/D Credits

| 4 | -- | -- | 4 |

Class Work : 50 Marks
Examination (Theory/Practical) : 100 Marks
Total : 150 Marks
Duration of Examination : 3 Hours

UNIT I
Air: Natural and anthropogenic source of pollution, Primary and Secondary pollutants, Transport and diffusion of pollutants, gas laws governing the behaviour of pollutants in the atmosphere, Acid rain, Air Quality standards

UNIT II
Water: types, Sources and consequences of water pollution, Water Crises-Conservation of water.

UNIT III
Soil: Physio-chemical and soil quality, heavy metals their interaction with soil components,

UNIT IV
Noise: Sources of noise pollution Measurements of noise and indices, effect of metrological parameters on noise propagation, Noise exposure levels and Standards.

Marine: Sources of Marine pollution

References:
1. Environmental Pollution ï Peavy and Rowe.
2. Environmental Pollution and Solution ï Asthana and Asthana.
4. Environmental Science ï A study of Inter relationships ï E D Enger and B E Smith.

NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES 110 ANALYTICAL TECHNIQUES
M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (II - Semester)

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UNIT I
Titrimetry, Gravimetry, Colourimetry, Chromatography, Gas Chromatography.

UNIT II
Spectrophotometry, Atomic Absorption Spectrophotometry, GLC, HPLC.

UNIT III
Electrophoresis, X-ray fluorescence, X-ray diffraction, Flame photometry.

UNIT IV
Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Raman spectroscopy, Atomic force microscopy (AFM).

Reference books:


NOTE: In the semester examination, the examiner will set eight questions in all, selecting two from each unit. The candidates will be required to attempt five questions in all selecting at least one from each unit. All questions will carry equal marks.
ES 112 ENVIRONMENT AND LAB - II

M. Sc. - ES (ENVIRONMENTAL SCIENCE) 1st Year (II - Semester)

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<th>Class Work</th>
<th>Examination (Theory/Practical)</th>
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1. To determine residuals chlorine of given sample.
2. To determine the hydroxyl carbonate and bicarbonate ions in a given sample.
3. To remove both types of hardness from the given water sample.
4. To determine the Calcium and Magnesium ions from the given water sample.
5. To determine the organic carbon in given sample.
6. To determine the total nitrogen in soil sample.
7. Determine the I-V and P-V characteristics of PV module with varying radiation and temperature level.
10. Study of solar hot air collector/ solar dryer.
11. Performance evaluation of box type and concentrating type solar cooker.
12. Charging and discharging characteristics of battery.

NOTE: Any five experiments from environment and five from energy will be conducted.