ENVIRONMENTAL SCIENCE
SYLLABUS
M.Sc.
&
M.Phil
(2015-2016)

INDIRA GANDHI ACADEMY OF ENVIRONMENTAL EDUCATION
RESEARCH AND ECROPLANING

JIWAJI UNIVERSITY
GWARLI M.P. 474011
# M.Sc. Environmental Sciences

## Choice Based Credit System

Four Semester Course

Course Structure and Scheme of Examination

2015-2017

### SEMESTER I

<table>
<thead>
<tr>
<th>Code</th>
<th>Course</th>
<th>C/E/S</th>
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<th>Credit</th>
<th>Marks</th>
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**Total Credit Value: #20+4 (virtual credit)**

### SEMESTER II

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**Total Credit Value: #20+4 (virtual credit)**
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**Total Credit Value:** #20 +4 (virtual credit)
### SEMESTER IV

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Total Credit Value: #20+4 (virtual credit)

*Instead of laboratory work, student may perform Project work/Industrial Training of 8 or 12 credits.

NOTE: Lecture (L): 1 hr = 1 Credit  
Tutorial (T): 2 hr = 1 Credit  
Practical (P): 2 hr = 1 Credit

Total Core Course: 68 credits  
Total Elective: 12 credits
Total Virtual Credits: 16
I SEMESTER

Paper 101: FUNDAMENTALS OF ENVIRONMENTAL, CLIMATIC AND SOIL SCIENCE

Unit I
1. Definition, principle and scope of Environmental Science.
2. Structure and composition of atmosphere.
3. Brief account of Hydrosphere, Global water resources and hydrological cycle.
4. Lithosphere: A brief account
5. Biosphere and its components.

Unit II
1. Scale of meteorology: Meteorological parameters pressure, temperature, precipitation, humidity, radiation and wind
3. Climate of India, Monsoons and El nino.
4. Weather and folklores on weather forecast.
5. Climate change

Unit III
1. Environmental ethics.
2. Environmental education
3. Role of people, Professionals and NGO’s in environmental education and Protection.
4. Environmental movements in India.
5. Environment protection faith and religious beliefs.

Unit IV
1. Soil and its organic and inorganic constituents.
2. Physical properties of soil.
3. Electro chemical properties of solid constituents.
4. Gas and liquid phases in soil.
5. Bioremediation of contaminated soils.

Unit V
1. Methods of soil formation
2. Organic farming, microbes and agriculture
3. Soil types of India
4. Soil erosion and conservation
5. Soil pollution and remedial measures.
UNIT I
1. Structure and function of ecosystem
2. Primary productivity
3. Secondary productivity
4. Energy flow and laws of thermodynamics;
5. Energy models and energy relations in ecosystems

UNIT II
1. Characteristics of populations
2. Population growth, Population interactions
3. Population regulation: density dependent and density independent
4. Concept and Characteristics of communities
5. Community Development

UNIT III
1. Concept of Biodiversity.
2. Global and Indian scenario of Biodiversity.
4. Biological Diversity and Agenda-21
5. Hot spots of biodiversity and Key stone species.

UNIT IV
1. Forest Mensuration,
2. Forest Protection and Regeneration of Forest.
3. Agro forestry, Social Forestry. JFM.
4. Forest policies and community participation for sustainable forest management.
5. Ecotourism, Green people and Green organizations of the world.

UNIT V
1. Diversity and distribution of wildlife in India.
2. Wildlife habitat and their management.
3. Red data book and endangered species, CITES.
5. Exploitation, Trade and sustainable utilization of wildlife.
UNIT I
1. Fundamentals and theories of Environmental Economics.
2. Environmental quality as a public good.
3. Natural resources – efficiency and market failure.
4. Environmental issues in developed and developing countries.
5. Environmental issues and five year plan.

UNIT II
1. Concept of cost and benefits in an environmental programme – classification and distribution.
2. Cost benefit and cost effective analysis.
3. Concept of economic growth and development index of economic development.

UNIT III
1. Forest resources in India and its crisis
2. State subsidies and resource use in dual society
3. Wetlands and woodlands with reference to India.
4. Natural range lands- savanna, steppes and other grasslands
5. The protection of threatened ecosystems, Natural parks and other natural reserves

UNIT IV
1. Water resources of India
2. Ground water provinces in India
3. Origin and composition of sea water, ice sheets and fluctuations of sea levels.
4. Resources of oceans
5. Biological resource management strategies.

UNIT V
1. Minerals essential nutrients of civilization, resources and reserves as a limiting factor
2. Strategies to reduce mineral consumption and conservation
3. Impact of mining on environment
4. Ocean as a new source of exploitation of mineral resources and their cycling
5. World food supply – agriculture, ecosystem and food production
UNIT I
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3. Impact of mining on environment
4. Ocean as a new source of exploitation of mineral resources and their cycling
5. World food supply – agriculture, ecosystem and food production
UNIT I
1. Energy Budget on Earth.
2. Energy cycle and environmental effects.
3. Energy profile in India.
5. Sustainable energy development in India.

UNIT II
2. Traditional fuels in an Urban Society.
4. Electricity.
5. Flow of Energy

UNIT III
1. Sun as a source of energy
2. Solar and its spectral characteristics.
4. Solar photo applications.
5. Green building and their applicability.

UNIT IV
1. Wind energy, conversion, collectors and applications.
2. Hydraulic source of energy-hydroelectricity, ocean energy, ocean thermal electric conversion.
3. Geothermal energy-source applications, advantages and disadvantages.

UNIT V
1. Energy plantations.
2. Energy from biomass, biomass conversion technology.
4. Anaerobic digestion.
5. Biogas technology (Methanogenesis)
Atmosphere

1. Study of Meteorological Parameters: Temperature, Precipitation, Relative Humidity, Wind Velocity, Wind Direction, Atmospheric Pressure, Light Intensity

Energy

1. Field work on Urban Energy usage
2. Field work on Rural Energy use pattern
3. Electricity generation through Photovoltaic Cell (Solar Educational Kit)
4. Installation and working of Solar module
5. Practical implications of solar energy
6. Practical applications of wind energy
7. Biomass conversion technologies
8. Energy auditing and preparation of Audit report

Soil

1. Soil sample collection and sample preparation
2. Study of soil profile, colour, temperature, pH and EC
3. Determination of mechanical composition of soil (Soil Texture) by simple wetting technique
4. Determination of soil density and porosity
5. Estimation of soil moisture content and water holding capacity (WHC)
6. Determination of presence of Carbonate, Bicarbonate and Nitrate
7. Determination of Organic Carbon
8. Determination of Nitrogen, Phosphorus and Potassium level in the soil

Examination Pattern

**S.O.S. in Environmental Science, Jiwaji University, Gwalior**

M.Sc. 1st Semester

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<td>Experiment related to Energy</td>
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<td>3</td>
<td>Determination of physical and chemical composition of given sample(s)</td>
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NOTE: At least 60% of the practical listed to be performed during the semester.
Forestry and Ecology

1. Quadrates
   a. Determination of frequency
   b. Determination of Dominance
   c. Determination of Density
   d. Determination of Basal Area
   e. Determination of Abundance
   f. Determination of IVI
   g. Calculation of Biodiversity Index
2. Canopy Cover
3. Tree Height
4. Profile Diagram
5. Phenology
6. To study the Biotic components of Pond Ecosystem
7. Estimation of Benthos population density

Wildlife

1. Wildlife census through direct evidence by Line Transect, Point Count, Capture-recapture techniques
2. Population estimation through indirect evidences
3. Preparation of pug marks
4. Identification of wild animals and description of their habitats, putting photos, slides or stuffed animals

Examination Pattern

S.O.S. in Environmental Science, Jiwaji University, Gwalior

M.Sc. 1st Semester

Paper 106
M.M. 100

Time 4 hrs.

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<td>2</td>
<td>Experiments related to Ecology</td>
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<tr>
<td>3</td>
<td>Experiments related to Wildlife</td>
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<tr>
<td>4</td>
<td>Identify and Comment upon the spots 1 to 5</td>
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</table>

NOTE: At least 60% of the practical listed to be performed during the semester.
II SEMESTER

Paper 201: AIR, NOISE POLLUTION AND CONTROL

Unit I
1. Air pollution, sources and types.
2. Pollution dispersion models.
3. Pollutant behavior in the atmosphere.
4. Smog, Acid rain, cause consequences and control
5. Green house effect and ozone depletion.

Unit II
1. Indoor air pollution.
2. Effects of air pollutants on ecosystem.
3. Monitoring of air pollutants: Sox, NOx, Co.
4. Air quality standards and management.
5. Control of air pollution.

Unit III
1. Introduction to automobile pollution.
2. Exhaust emission and their measurement.
4. Environmental effects of automobile pollution.
5. Emission control technology and Compressed Natural Gas

Unit IV
1. Noise pollution Definition and classification
2. Causes of noise pollution
3. Measurement of noise and sound pressure level
4. Impact of noise on human health
5. Noise control and abatement measures

Unit V.
1. Atmospheric reactions and secondary pollutants.
2. Effects of meteorological parameters on transport and diffusion of air pollutants.
3. Wind effects (planter wind motion, synoptic wind motions, land sea breeze, Micro scale wind motions)
4. Atmospheric stability (temperature lapse rates, inversion plume types.
5. Air quality impact assessment.
Unit I
1. Sources and types of water pollution.
2. Chemistry and Biology of water.
3. Water quality parameters; criteria and standards.
4. Chemical and bacteriological sampling and analysis.
5. Toxicity of drinking water.

Unit II
1. Lake optics, thermal stratification in lakes and streams.
2. Water borne diseases.
3. Wet land, conservation and RAMSAR.
4. Role of aquatic plants in pollution abatement.

Unit III
1. Principle of ground water flow
2. Ground water contamination
3. Control of ground water pollution
4. Water shed management
5. Rain water harvesting.

Unit IV
1. Water and sanitation assessment
2. Strategies, issues in water environment and sanitation
3. Human rights and sanitation assessment
4. Ecosystem approach in low cost sanitation assessment in India.
5. Land treatment system and advance waste water treatment system.

Unit V
1. Thermal pollution, causes control and consequences
2. Radioactive pollution, causes control and consequences
3. Marine pollution, causes, control and consequences
4. E-waste, causes and consequences.
5. Desertification causes and control.
UNIT I

1. Major industrial wastes
2. The apparel industries: Textiles, Tannery, and Laundry.
3. Food industries: Cannery waste, Diary, Poultry and Distillery wastes.
4. Material industries: wood, metals, etc.
5. Chemical Industries.

UNIT II

1. Introduction: Handling & storage to Hazardous materials.
2. Hazardous waste: sources, effects, characterization, sampling and analysis
3. Risk assessment and hazardous waste management, treatment, storage and disposal.
4. Guidelines for owner/operator/transporter of hazardous waste, storage, treatment and disposal.
5. Responsibilities of the occupiers, generators of hazardous waste and its management.

UNIT III

1. Solid waste characteristics, collection and Transportation.
2. Waste separation, storage and disposal.
4. Integrated municipal solid waste management.
5. Biomedical waste management.

UNIT IV

1. Energy recovery from solid waste
2. Municipal waste water treatment and energy recovery.
3. Integrated solid waste management
4. Environmental and health impact assessment of waste management
5. Wealth from wastes.

UNIT V

1. The people issue in construction, safety and health.
2. Construction, safety and health programme of UN with special reference to India.
3. Industrial hygiene activations in construction.
4. Personal protections equipment.
5. Safety Management.
UNIT I

1. EIA: Introduction, Legislative frame work.
2. NEPA'S concept of Environmental Impact Analysis.
3. Elements of EIA
4. EIA Methodologies.
5. Guidelines for conducting EIA.

UNIT II

1. EIS: Introduction and legal basis for EIS.
3. Environmental audit: Introduction, definition, benefits and objective of Environmental Audit.
4. Procedure and guidelines for EA
5. Draw backs of EIA

UNIT III

2. The integrated approach to Environmental Management. 12 steps to heaven.
3. EMS Audit, Management reviews and preparing environmental optional procedures.
4. Documentation assistance, manual, folders and assistance.
5. EIA notification 2006

UNIT IV

2. ISO 14000: Introduction, Certification and standards.
5. OHSAS 18000 health and safety.

UNIT V

1. Sitting of Industries – Introduction, Environmental site clearance, classification of Industries.
2. Site selection, Resource Analysis and Baseline information.
4. Industrial Scenario-Locational Policies
5. Industrial Policy of Indian and fiscal incentives for environmental protection
Practical Paper: 205

Water and Waste Water analysis

1. Water sampling for Chemical, Bacteriological and Benthos analysis.
2. Study of Physical characteristics of water: Colour, Odour, Turbidity and Temperature
3. Determination of solids: Total Solids, Total Suspended Solid, Total Dissolved Solid, Total Setttable Solid
4. Determination of pH, Conductivity
5. Determination of Dissolve Oxygen
6. Determination of Acidity, Alkalinity, Hardness, Free CO₂
7. Determination of Chloride, Sulphate
8. Determination of Nitrate, Ammonical Nitrogen, Phosphate
9. Determination of Fluoride
10. Determination of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand

Solid Waste and Hazardous Waste Management

1. Solid waste characterization
2. Solid waste segregation techniques
3. Survey of solid waste dumping sites
4. Hazardous waste characterization
5. Techniques of hazardous waste treatment
6. Occupational Safety Assessment

Examination Pattern

S.O.S. in Environmental Science, Jiwaji University, Gwalior

M.Sc. 2nd Semester

Paper 205
M.M 100

Time 4 hrs.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Topics</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Determination of physic-chemical composition of given sample(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Physical Parameter (2)</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>· Chemical Parameter (2)</td>
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<tr>
<td>2</td>
<td>Experiments related to solid waste management</td>
<td>16</td>
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<tr>
<td>3</td>
<td>Experiments related to hazardous waste management</td>
<td>16</td>
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<tr>
<td>4</td>
<td>Identify and Comment upon the spots 1 to 5</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Practical Record</td>
<td>20</td>
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<tr>
<td>6</td>
<td>Viva-voice</td>
<td>10</td>
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<td></td>
<td>Total</td>
<td>100</td>
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</tbody>
</table>

NOTE : At least 60% of the practical listed to be performed during the semester.
Practical Paper: 206

EIA/EMS/EA and Sitting of Industries

Case studies/Field works
1. Preparation of Environmental Impact Assessment report of a given area/scenario
2. Preparation of Environmental Impact Statement report of a given area/scenario
3. Preparation of Environmental Management System for a given institution/industry
4. Preparation of Environmental Audit report of a given institution/industry /scenario
5. Implementation of ISO 9000 (Total Quality Management) for a given institution/industry /scenario
6. Implementation of ISO 14000 and 14001 (Environmental Management System) for a given institution/industry /scenario
7. Plan for how to site an Industry
8. Ecolanning of an urban area
9. Ecolanning of rural area

Air
1. Air sampling for gaseous pollutants and Suspended Particulate Matter (SPM)
2. Analysis of SO$_2$ in ambient air
3. Analysis of H$_2$S
4. Analysis of NO$_x$
   a. In ambient air
   b. In petrol vehicle exhaust
5. Analysis of CO-CO$_2$
   a. In ambient air
   b. In petrol vehicle exhaust
6. Determination of Smoke level from diesel vehicle exhaust
7. Analysis of Aerosols

Noise
1. Noise measurement
2. Noise pollution during festivals

Examination Pattern

S.O.S. in Environmental Science, Jiwaji University, Gwalior

M.Sc. 2nd Semester

Paper 206

M.M 100

Time 4 hrs.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Topics</th>
<th>Marks</th>
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<tbody>
<tr>
<td>1</td>
<td>Report writing of EIA /EMS/EA according to a given scenario</td>
<td>16</td>
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<tr>
<td>2</td>
<td>Experiments related to EMS</td>
<td>16</td>
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<tr>
<td>3</td>
<td>Determination of physical and chemical composition of given sample(s)</td>
<td></td>
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<tr>
<td></td>
<td>• Particulate and smoke (1)</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>• Chemical Parameter of ambient air or vehicular pollutant (2)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Identify and Comment upon the spots 1 to 5</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
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<td>6</td>
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<td><strong>Total</strong></td>
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NOTE: At least 60% of the practical listed to be performed during the semester.
III SEMESTER

Paper 301: EARTH PROCESSES, HAZARDS AND RISK ASSESSMENT

UNIT-I

1. Fundamental Concepts of earth.
2. Earth material and processes.
3. Resources from the earth
4. Land use pattern in India.
5. Land use management and practices.

UNIT-II

1. Hazards in the environment Dimension of Disaster.
2. Tectonic hazards
3. Atmospheric hazards
4. Hydrological hazards
5. Biophysical hazards

Unit III

1. Introduction to risk assessment.
2. The elements of human health and risk assessment.
3. Risk Characterization.
5. Future directions in risk assessment.

Unit IV

1. The concept of disaster as a product of hazard and vulnerability.
2. Disaster risk management concept areas for action and components.
3. Risk analysis concepts goals and products.
4. Bhopal disaster analysis.
5. Nuclear power plant disaster and its safety management.

Unit V

1. The chemistry of hazardous material.
2. Safety management practices for laboratory.
3. RCRA act and waste analysis plan.
4. Hazard communication.
5. Process technology and hazard analysis.
UNIT I
1. Role of Biotechnology in environmental protection.
3. Genetic engineering
5. Genetically engineered microbes in Bio treatment of waste and environment.

UNIT II
1. Bioabsorption of metals.
2. Biopolymers and Bioplastics
3. Biofuels and Biodiesel.
4. Biofertilizers and Biopesticides
5. Bioleaching

UNIT III
2. Fermentation Technology.
4. Mushroom culture technology.
5. Hydroponics and their role in waste water management.

UNIT IV
1. Definition, scope, goals and divisions of environmental toxicology
2. Factors affecting environmental concentration of toxicants
3. Toxicity of chemical mixtures
4. Dose, effect, response and dose response relationship
5. Environmental impact of nanotechnology.

UNIT V
1. Membrane permeability & mechanism of chemical transfer
2. Xenobiotic compounds in the Environment
3. Degradation of Xenobiotic compounds
4. Toxicity testing methods (single and multi - species, acute, sub-acute and chronic toxicity tests)
5. Environmental diseases.
PAPER-303: SURVEYING, PHOTOINTERPRETATION AND REMOTE SENSING.

UNIT I

1. Types of maps-survey of India maps, toposheets, map reading.
2. Symbols signs used in maps.
3. Primary Division and Classification of Surveying.
5. Basic concepts of cartography and Digital cartography.

UNIT II

1. Introduction to aerial photography, Basic information and specifications of aerial photography.
2. Scale, vertical exaggeration and types of aerial photographs.
4. Principals of photo interpretation.
5. Application of aerial photo interpretation in environmental science.

UNIT III

1. Basic concepts and principles of remote sensing, ground truth Collection and spectral Signatures.
2. (a) Platforms: Balloon, Rocket, Aircraft, Spacecraft.
   (b) Satellites: Land sat, SPOT, IRS-IKONOS
4. Thermal infrared imaging system and its applications.
5. Radar Imaging system and its application.

UNIT IV

1. Fundamental of digital image processing.
2. Introduction to image enhancement technique – the image histogram, contrast stretching and band rationing and Edge Enhancement.
4. Basic concepts of Geographical Information System (GIS) and GIS Applications.

UNIT V

1. Application of remote sensing in the assessment of environmental degradation.
2. Application of remote sensing in natural hazard detection.
3. Remote sensing in solid waste management studies.
4. Role of remote sensing and GIS in water quality mapping and monitoring.
5. Future prospect of remote sensing with special reference to environmental Sciences.
UNIT I

1. Environmental protection: issues and problems.
2. International and National efforts for environmental protection.
4. Public policies strategies in Pollution control
5. Environmental legislation

UNIT II

2. The merchant shipping (amendment) act, 1970.
4. Judiciary approach and water pollution.

UNIT III


UNIT IV

2. Wildlife Protection Act, 1972 with recent amendments.

UNIT V

3. Environmental law and Public Interest Litigation.
4. Environmental law in the curriculum of legal education.
Practical Paper: 305

Hazards Risk Assessment, Environmental Biotechnology and Toxicology Hazard and Risk Assessment

1. Risk assessment study of the following Commercial sites:
   - Shopping malls, Petrol Pumps, Offices, Welding shops, Cracker shop
2. Risk assessment study of the following Industrial sites:
   - Heavy Industries, Chemical Industries, Mining area, Stone Crusher, Construction sites
3. Risk assessment study of Hospitals/Nursing homes
4. Safety practices in Laboratories

Environmental Biotechnology and Toxicology

1. Tissue Culture technologies, effect of environmental agents on tissue culture
2. Hydroponics
3. Vermiculture Technology and analysis of the following parameters
   - pH
   - Electrical Conductivity
   - Humus
   - Total Phosphorus
   - Total Nitrogen
   - Organic Carbon
4. Study of microbes in the Water, Air and Soil
5. LD₅₀ and LC₅₀ values of toxicants
6. Determination of Heavy metals in water

Examination Pattern

S.O.S. in Environmental Science, Jiwaji University, Gwalior

M.Sc. 3rd Semester

M.M 100

Time 4 hrs.

<table>
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<th>S. No.</th>
<th>Topics</th>
<th>Marks</th>
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<tbody>
<tr>
<td>1</td>
<td>Report writing of Risk Assessment study for a given location</td>
<td>12</td>
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<tr>
<td>2</td>
<td>Experiments related to Tissue Culture/Hydroponics/Determination of physical and chemical composition of given vermicompost sample(s)</td>
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<tr>
<td></td>
<td>• Physical parameter (1)</td>
<td>24</td>
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<tr>
<td></td>
<td>• Chemical Parameter (2)</td>
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</tr>
<tr>
<td>3</td>
<td>Experiment related to Microbial Study/ Lethal values/Heavy metals</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Identify and Comment upon the spots 1 to 5</td>
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NOTE: At least 60% of the practical listed to be performed during the semester.
Practical Paper: 306

Surveying and Remote Sensing

1. Calculation of SOI Map lay out number
2. Interpretation of SOI Topographic sheet
3. Map Reading
4. Study of the border information of Aerial photograph
5. Determination of Scale
6. Stereo-test and orientation of Aerial photographs
7. Identification of features from single vertical aerial photograph
8. Study of Topography through stereographs and aerial photographs
9. Preparation of land use map
10. Visual Interpretation of stereo-pair for environmental studies

Environmental Laws and Judicial Attitude

7. U.P. Pollution Control Board V.M.P. Modi Distillery and other, AIR 1988 SC 1128.
10. Satyavan V. AP Pollution Board, AIR 1993 AP 257.

Examination Pattern

S.O.S. in Environmental Science, Jiwaji University, Gwalior

M.Sc. 3rd Semester

Paper 306
M.M 100

Time 4 hrs.

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<tr>
<td>1</td>
<td>Experiment related to Survey procedures/Map reading/Aerial photography</td>
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</tr>
<tr>
<td>2</td>
<td>Experiments related to Base map preparation/Interpretation of Remote Sensing data</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Comment upon a given Environmental Case Study</td>
<td>20</td>
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<tr>
<td>4</td>
<td>Identify and Comment upon the spots 1 to 5</td>
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</table>

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IV SEMESTER
PAPER-401 GLOBAL PROSPECTS TOWARDS ENVIRONMENTAL ETHICS AND SUSTAINABLE DEVELOPMENT

UNIT I
1. Totality of environment-Holistic view and ecology to environmental Science
2. Environmental Science on the move.
3. Ecosystem Management and Environmental ethics
4. From Stockholm to Rio and Beyond

UNIT II
1. Global issues and strategies.
2. World Trade and environment.
3. The vital issues process: Managing critical infrastructures in the global areas.
4. Issues calling for immediate attention.

UNIT III
1. Terrorism and its impact on human ecosystem.
2. Effects of Nuclear Explosions and Threat of Nuclear Terrorism.
3. Genesis of Biological warfare and current threat.
4. Chemical warfare.
5. The chemical weapons convention.

UNIT IV
1. The global environment debate.
2. Managing global commons.
3. Poverty, Trade, DEBT, and Environment.

UNIT V
1. Sustainable Development: brief history and interpretation.
2. Sustainable development in India.
3. Rural development, industrialization and self employment.
4. Strategies and appropriate Technologies for Sustainable Development.
5. Environmental Accounting.
UNIT I
1. Introduction.
2. Collection, Tabulation and classification of data.
3. Measure of Central values, mean, mode and median.
4. Geometric mean and Harmonic mean.

UNIT II
1. Calculation of coefficient of correlation in simple series.
2. Linear regression.
3. Curve fitting up to second order.
5. Binomial, poison and normal distribution.

UNIT III
1. Large samples: relating to attributes, relating to variable differences of means.
2. Small samples: 't' test.
3. ANOVA – 1 way classification.
4. ANOVA – 2 way classification.
5. Chi Square test.

UNIT IV
1. Concept and method of Research
2. Sources of information on research and relation of research topic.
4. Use of Sampling and Questionnaires construction for Research.
5. Processing of Research data and preparation of research report.

UNIT V
1. Approaches to development of models.
2. Linear, simple and multiple regression models.
3. Lotka-volterra Model and Leslie’s matrix model.
4. Point source stream pollution model.
5. Box model and Gaussian plume model.

(Note: Mathematical aspects of statistics and derivations are not’ included in this syllabus.)
UNIT I
1. Introduction.
2. Collection, Tabulation and classification of data.
3. Measure of Central values, mean, mode and median.
4. Geometric mean and Harmonic mean.

UNIT II
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2. Linear regression.
3. Curve fitting up to second order.
5. Binomial, poison and normal distribution.

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4. Point source stream pollution model.
5. Box model and Gaussian plume model.

(Note: Mathematical aspects of statistics and derivations are not included in this syllabus.)
Practical Paper: 403

Practical / Field Work / Case Studies:

Global Prospects towards Environmental Ethics and Sustainable Development.

1. Impact of terrorism on the natural environment - Case study
2. Impact of terrorism on the human ecosystem – Case Study
3. Impact of the human activities on the natural environment – Case Study
4. Environment accounting in different areas
5. Study of level of industrialization
6. Study of physical setting of an area
7. Study of social setting of an area
8. Study of technologies for sustainable development adopted in your area
9. Study of impact of industrialization on local environment
10. Local issues calling for immediate attention

Statistics, Biometry and Research Process as applied to Environment

1. Methods and techniques of research
2. Level of research project
3. Problem, selection and research design
4. Questionnaires construction for research
5. Study of collection of data and tabulation
6. Application of standard deviation and standard error
7. Application of Test of Significant
8. Application of ANOVA
9. Application of Chi Square Test

Examination Pattern

S.O.S. in Environmental Science, Jiwaji University, Gwalior

M.Sc. 4th Semester

Time 4 hrs.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Topics</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Write comment upon environmental and social impact of Anthropogenic</td>
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<tr>
<td></td>
<td>activities/Industrialization/terrorism of a given case study</td>
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<tr>
<td>2</td>
<td>Experiments related to data interpretation</td>
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<tr>
<td>3</td>
<td>Experiments related to Standard deviation/Chi square/ANOVA</td>
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<tr>
<td>4</td>
<td>Experimental design on a given scenario</td>
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<td>5</td>
<td>Practical Record</td>
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