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*Credits not included in the CGPA

- Out of 100 Theory marks for each paper, 20 marks for internal assessment and 80 marks for semester-end examinations.
SYLLABUS
M.Sc. Environmental Sciences
First Semester

PAPER – 101: ECOLOGICAL PRINCIPLES AND APPLICATIONS

Course Outcomes (Cos)
CO1: Gain knowledge on the importance of ecological principles
CO2: Understand the biotic and abiotic components of ecosystems and their interrelationships
CO3: Understand the earth’s carrying capacity and factors affecting ecological balance
CO4: Acquire in-depth knowledge on sustainability and importance of ecological applications
CO5: Remember different types of ecosystems and their importance

Course Specific Outcome (CSOs)
CSO1: Able to understand the fundamentals of ecological principles
CSO2: Able to apply ecological principles for the management of natural ecosystems
CSO3: Acquire knowledge to evaluate the environmental impacts of chemical agriculture
CSO4: Able to enumerate and describe ground vegetation composition, structure and function
CSO5: Able to apply ecological principles for sustainable development

Unit I:
Principles of Ecology: Definition, principles and scope of Ecology; Energy flow, ecological pyramids, types and diversity; Food chain and Food Web; Homeostasis – Theories of Limiting Factors; Ecological succession – population and communities; Reproductive strategies - r- and k- factors; Community ecology - structure, species diversity and species interactions

UNIT II
Ecosystem Ecology: Ecosystem structure (abiotic and biotic components) and function; Ecosystem types - terrestrial and aquatic (fresh water and marine) ecosystems; Ecotones - concept of edge effect, ecological niche; Classification of biomes - general relationships, Bio-geographical regions of the World and modern biogeography.

UNIT III
Ecological Imbalances: Human ecology and human settlements - evolution, origin of life and speciation; Population growth and ecological imbalances; Resources shortage; Earth’s carrying capacity; Human engineered ecosystems – agriculture, agro-forestry; Biosphere concept - Man and Biosphere – Future of the Biosphere.

UNIT IV
Ecological Applications: Ecological sustainability; Organic farming, bio-fertilizers, bio-pesticides and Integrated Pest Management (IPM); Biological monitoring of the environment - Indicator species - Ecosystem Development; Theory of human ecology- ecology of space travel; Types of life supporting systems - Exobiology.

UNIT V
Weed ecology: Weed classification, life cycles, reproductive strategies; Ecological strategies of sexual and asexual reproduction in weeds; weed evolution, survival and invasion; Environmental and ecological impacts of control methods; Principles of herbicide chemistry, toxicological issues and environmental fate.
PRACTICALS:
A. Ground Vegetation Analysis (Quadrate Sampling)
   1. Fixation of minimum size of Quadrates
   2. Fixation of minimum number of Quadrates
   3. Determination of Frequency
   4. Determination of Density and Abundance
   5. Determination of Dominance
   6. Importance Value Index (IVI)
B. Aquatic Ecology (Lake and Pond Ecosystems)
      (pH, Temperature and Dissolved Oxygen)
   2. Estimation of Primary Productivity
   3. Identification of Eutrophication Characteristics
C. Field Study / Visits (Visiting different ecosystems)
   a. Rocky and Sandy coast
   b. Hilly terrain
   c. Marshy swamp
   d. Backwaters
   e. Forest Ecosystem
   f. Lake Ecosystem
   g. Riverine Ecosystem
   h. Mangrove Ecosystem.

LEARNING OUTCOMES (LOS)
   1. Students will be able to learn the basics of ecological principles and their applications, reproductive strategies of organisms
   2. Students will be able to understand the structure and function of an ecosystem, ecosystem types, bio-geographic regions of the world
   3. Students will be able to understand how the ecological imbalances contribute to changes in natural ecosystems, resources availability, and what are the different human engineered ecosystems
   4. Students will be able to learn what is ecological sustainability, IPM, indicator species, and exobiology
   5. Students will be knowledgeable of various aspects of weed ecology

Books for References:
PAPER – 102: BIOSTATISTICS AND MODELING IN ENVIRONMENTAL SCIENCES

Course Outcome:
CO1: Acquire the importance of system analysis and its application in the field of environment.
CO2: Understand the importance of mathematical modeling and their properties
CO3: Provides the knowledge on introduction of different systems models in the study of population, pollution and ecosystem with examples.
CO4: Understand the importance and application of biostatistics and gaining the knowledge on different sampling methods.
CO5: Provides the introduction and importance of different attributes and variable in the field of environment system analysis

Course Specific Outcome:
CSO1: Able to understand the Environmental systems analysis
CSO 2: Acquire a sound knowledge on use of mathematical modeling,
CSO 3: Able to get the information on Statistical approaches, biostatistics in deriving
CSO4: Able to understand the environmental models in air, water, soil, floral and faunal analysis etc.
CSO5: Acquire the Knowledge on the Different Probability Distributions.

Unit-I: Introduction to Environmental Systems Analysis
Concepts, Definition and Scope – Formal basis of Systems Analysis – Types of problems and types of systems – Systems diagrams and concepts – Systems Classification: Weaver’s, Chorley and Kennedy’s, Miller’s classifications

Unit – II: Mathematical Modeling:

Unit-III: System Models with Applications
Weather forecasting models, Models of population growth & Interactions, Lotka-Voltera Model, Box Model, Gaussian Plume Model, Leslie’s Matrix Model, System analysis of Moorland ecosystem, Spatial interaction model – Future developments in urban modeling. Bayes theorem

Unit-IV: Biostatistics:
Basic elements and tools of statistical analysis: Measures of central value, Measures of Dispersion, Arithmetic, Geometric and Harmonic means. Distribution – Normal t and $\chi^2$ Poisson and Binomial, Correlation and Regression Analysis. Tests of hypothesis and significance-
Sampling types: Selective sampling, Random sampling and stratified random sampling. Sampling design, Sample size determination and limitation of sampling, Descriptive statistics
Unit – V: - Attributes and Variables: -

Types of variables, Scales of measurement, Measurement of Central tendency and Dispersion, Standard error, Moments – measure of Skewness and Kurtosis, Basic concept of probability theory, Probability Distributions (Normal, log-normal, Binomial, Poisson, t, 2 and F-distribution), Significance and confidence limits.

PRACTICALS:
1. Site Mapping: Determination of points and objects – area and area classification
2. Water courses Mapping
3. Graphic Models for Niche breadth and overlaps
4. Evaluation of Ecological variables: Correlation and regression analysis
5. Population Models: Determination of growth rate and doubling time
6. Population Model: Leslie’s Matrix Model
7. Air Pollution: Box Model
8. Air Pollution: Statistical Model
9. Water Pollution: Point Source Pollution in stream- QC Model
10. Compartment Model
11. Urban Transport: Disorganized complexity and Entropy Maximization Model

Learning Outcome:
1. Students will be able to learn the importance of system analysis and its application in the field of environment.
2. Students will be able to learn the different mathematical modeling and their properties
3. The student gains the knowledge on introduction of different systems models in the study of population, pollution and ecosystem with examples.
4. Students will be able to learn what biostatistics is and know the different sampling types.
5. Students will be able to learn the basics of attributes and variable in the field of environment.

Books for References:
PAPER – 103: ENVIRONMENTAL MICROBIOLOGY AND SANITATION

Course Outcome:
CO1: This unit provides the importance of microbial groups, culturing and factors affecting their growth
CO2: The different inter and extra microbial relationships in the environment
CO3: This unit deals with the role of microbes in the field environment
CO4: Knowledge on different microbial diseases including bacteria, fungal and viral diseases
CO5: This unit provides the knowledge on different toxic agents from microbial world

Course Specific Outcome:
CSO1: Obtaining information on microbial groups and their role in biotechnology, ecofriendly applications, public health and sanitation.
CSO2: Practical analysis on culturing of microorganisms in air, water and soil samples.
CSO3: Evaluate the potential of microbial roles in the field environment
CSO4: Acquire knowledge on the different microbial diseases.
CSO5: Able to understand the distribution and excretion of toxic agents and disease control cycles.

Unit-I: Introduction to Environmental Microbiology:
Microbial groups: Bacteria, Fungi, Algae, Viruses, and Protozoa; their place in the classification of living world; their biology, nutrition, metabolism and reproduction
Culturing of Microorganisms: Types and composition of culture media and sterilization techniques
Environmental Selecting factors for Microbial growth: Physical factors (Temperature and light, Osmotic pressure, Hydrostatic pressure), Chemical factors (pH, O₂ and CO₂).

Unit-II: Microbial Interactions:
Intermicrobial relationships – symbiotic relationships (mutualism, commensalisms and parasitism), Lichens, Lysogeny, Paramecium-Chlorella association, Bacteria-Bdellovibrio-Virus association, Myco-Viruses, Cyanophages,
Extramicrobial relationships – Microbial – ruminant association, Microbial-Insect associations, Microbial-Higher plant associations’ (Mycorrhiza, Rhizobium-Legume association), Microbial (bacterial, fungal and algal) toxins and their role in environment.

Unit-III: Importance of Microbes:
Role of microbes in: Nitrogen, Sulphur, Phosphorus and Iron cycles – Microbes in the recovery of minerals (bioleaching of minerals) - In energy production: (Methane); Microbial biomass or single cell protein, Waste water Treatment.

Unit-IV: Microbial Diseases:
Bacterial:– Boils and Carbuncles, ‘Strep’ sore throat, Pneumonia, Tuberculosis, Cholera, Salmonellosis, Typhoid fever, Anthrax, Brucellosis, Plague, Gonorrhea, Syphilis -
Viral: - Smallpox, Poliomyelitis, Measles, Hepatitis, Encephalitis, Rabies
Fungal: - Dermatomycoses, Systemic mycosis and Protozoa: - Amoebiasis, Malaria
Epidemiological Diseases: Fluorosis, Arsenocosis, Goitre, Dengue
Unit – V: - Toxicology and Microbiology:-
Absorption, distribution and excretion of toxic agents, acute and chronic toxicity, concept of bioassay, threshold limit value, margin of safety, therapeutic index, and biotransformation. Major water borne diseases and air borne microbes, Environmental Sanitation and Disease Control.

PRACTICALS:
1. Demonstration of air samplers used in microbial studies
2. Preparation of media for microbial growth
3. Techniques in culturing microbes
4. Microbial examination of potable waters:
   (a). Detection of fecal pollution (E.coli)     (b). Standard Plate Count
   (c). Most Probable Number (MPN) of coliforms.
5. Gram staining
6. Identification of common pathogenic microbes:
7. Total Plate count of soil microorganisms
8. Isolation of Rhizobium sps. Form root nodules
9. Microbial growth curves
10. Detection of microorganisms in spoiled foods (bread, rotten meat, fish, fruits etc..)

LEARNING OUTCOMES (LOS)
1. Students will be able to learn the basics of Environmental Microbiology and different Environmental factors affecting the microbial growth with Practical Approaches.
2. Students will be able to understand the different microbial interactions in the Environment.
3. Students will be able to understand how the microbes will be useful in different fields.
4. Students will be able to learn the different Bacterial, Viral and fungal diseases.
5. Students will be knowledgeable of various aspects of Toxicology and Microbiology.

Books for References:
PAPER – 104: ENVIRONMENTAL POLLUTION AND INSTRUMENTATION

Course Outcome:
CO1: Provides the knowledge on classification of elements and fundamentals of environmental chemistry
CO2: Understand the knowledge on the sources, impacts of air pollution and controlling methods
CO3: Acquire the knowledge on the sources, impacts of water pollution and different controlling methods
CO4: Understand the knowledge on the sources, impacts of soil pollution and different controlling methods
CO5: Provides the information on instruments used in pollution analysis studies (Air, Water and Soil)

Course Specific Outcome:
CSO1: Acquire the Knowledge on classification of elements and fundamentals of environmental chemistry
CSO2: Able to understand the concept of Air Pollution, impacts and controlling devices.
CSO3: Able to understand the concept of Water Pollution, impacts and different treatment methods.
CSO4: Able to understand the concept of Soil Pollution, impacts and Soil erosion.
CSO5: Evaluate the use of different types of instruments and principles in analyzing physico-hemical and heavy metal analysis.

Unit-I: Fundamental of Environmental Chemistry

Unit-II: Air Pollution:
Structure of Atmosphere: Temperature Profile – Influence of Meteorological factors on Air Pollution
Air Pollutants: Oxides of Sulphur – Oxides of Nitrogen – Carbon monoxide – Particulate matter; Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions, Lapse Rate, Carbon sequestration and carbon credits.
Impacts of Air Pollution: - Impacts (Photochemical smog – Green house effect – Ozone depletion – Acid Rains), Impacts of Air Pollution on human health and structures.
Control devices for particulate matter: - Principle and working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator.
Control of gaseous pollutants: - through adsorption, absorption, condensation and combustion including catalytic combustion. Vehicular emission norms in India.

Unit-III: Water Pollution:
Types and sources of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN.
Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant
Unit – IV: - Soil Pollution


Unit-V: Pollution Analysis and Instrumentation

**Analysis of Pollutants:** Titrimetry – Gravimetry – Spectrophotometer – Chromatography and Flame techniques.


PRACTICALS:

1. **Soil Analysis:** Determination of soil types and texture, pH, Hydraulic conductivity. Soil Moisture, Nitrogen, Potassium, Phosphorus and Organic matter.

2. **Water Analysis:**
   
   (a). Determination of pH, Dissolved solids and Suspended solids, Dissolved Oxygen, COD, BOD, Alkalinity / Acidity, Nitrogen, Phosphorus and Potassium.
   
   (b). Determination of Chromium and Zinc by Spectrophotometer.

3. **Solid Waste Analysis:** Characteristics of Waste.

4. **Liquid Wastes:** Characterization and suggesting Treatment Plan.

5. **Visits** to Industrial establishments to know more about pollution devices and pollution management.

Learning Outcome:

1. Students will Able to gain knowledge on basics and fundamentals of environmental chemistry

2. Students will be knowledgeable on the sources, impacts of air pollution and practical knowledge on PM 2.5 & PM 10 Equipments’.

3. Students will be skilled in practicing of different Water quality parameters.

4. Students will understand the sources, impacts of soil pollution and different controlling methods

5. Students will be knowledgeable on instruments used in pollution analysis studies (Air, Water and Soil).

Books for References:

1. Laurent Hodges – *Environmental Pollution*

2. C.S. Rao – *Environmental Science and Engineering*

3. Moore and Moore – *Environmental Chemistry*

4. H.C. Perkins – *Air Pollution*


7. Willard, Merritt and Dean – *Instrumental Analysis*

8. APHA – *Analysis of Water and Waste Water*
9. JOM Bockins – *Environmental Chemistry*
10. H.C. Stern – *Air Pollution (Volumes I – IV)*
Second Semester

**PAPER-201: ENVIRONMENTAL PROBLEMS AND ECOFRIENDLY SOLUTIONS**

**Course Outcome:**
Unit-1: Need of Creating awareness on environmental education and ethics of environment.
Unit-2: Understand the problems affecting global warming by focusing on ozone depletion, GHG effect, acid rains and Atmospheric turbidity
Unit-3: Acquire the knowledge on environmental problems and specifying possible ecofriendly solutions for their mitigation.
Unit-4: Understand the Aspects on current environmental problems associated in India.
Unit-5: Providing information on environmental conventions at global level and their objectives, targets and achievements

**Course Specific Outcome:**
CSO1:- Acquire the knowledgeable on environmental education and ethics in India
CSO2:- Acquiring knowledge towards understanding complex environmental issues like global warming and their economic-social challenges in solving.
CSO3:- Understand and evaluate the global scale of environmental problems like over population, food, health & energy security etc
CSO4:- Analyze and evaluate the overview on current environmental issues and movements in India
CSO5:- Able to understand the Environmental conventions and agreements

**UNIT – I: Environmental Education and Awareness**
Environmental education and awareness; Need of Environmental Education in India, The Environmental Paradox; Environmental Ethics;
- **Outdated ethics** – The purpose ethic. The myth of super abundance, Dilution is not the solution. The idea of progress;
- **Updated ethics** – Attitude for survival, Reverence for all life, the right of existence for all environments, according the highest priority to environmental quality.

**UNIT – II: Global Environmental Problems**
- **The Ozone layer Depletion**– Ozone, Importance of Ozone, Causes of Ozone layer depletion, Antarctica ozone Hole, Effects of Ozone layer depletion & Controlling measures, The Montreal Protocol
- **Atmospheric turbidity (atmosphere aerosols)** – Aerosol types, production and distribution, Aerosols and radiation, volcanic eruptions and atmospheric turbidity,. The human contribution to atmospheric turbidity. The atmospheric turbidity and related environmental problems, Eco friendly solutions and technologies.
- **Acid rain** – The nature and development of acid rain, the pH scale, the geography of acid rain, Effects of Acid Rains, Eco friendly solutions and technologies.

**UNIT – III: Environmental Problems and Ecofriendly Solutions:**
Over population, Food security, Health security, Energy security, Environmental security, Green revolution, Desertification, Deforestation.
Unit – IV:- Current Environmental Issues in India


Unit – V:- Environmental Conventions and Agreements:


Practical's:-

1. Need of Environmental education and awareness programmes
2. Concept of Environmental Ethics
3. Concept of Global Warming
4. Concept of Ozone Layer Depletion
5. Concept of Acid Rains
6. Namami Ganga Action Plan
8. Clean Development Mechanism (CDM),
9. Earth Summit at Johannesburg, 2002,

LEARNING OUTCOMES (LOS)

1. Students will be able to understand the concept of environmental education and creating awareness among others and encouraging values of environmental ethics
2. Students will be able to realize the problems associated with environmental issues and their role in finding solution
3. Students will be capable to find out ecofriendly solutions to the global environmental problems like desertification, deforestation etc
4. Students will obtain knowledge on current environmental issues in India related to water resource projects like hydel power and dams construction
5. Students will be able to learn the global environmental conventions and agreements in combating the climate change

BOOKS RECOMMENDED:

PAPER – 202: ENERGY RESOURCES AND ENVIRONMENT

Course Outcomes (Cos)
CO1: Understand the importance of energy resources, consumption pattern and solar spectral characteristics
CO2: Describe non-renewable energy resources and environmental impacts of each energy resource
CO3: Describe non-biological renewable energy resources, their limitations and environmental problems
CO4: Describe biological renewable energy resources, their limitations and environmental problems
CO5: Understand energy use pattern, energy demand and green energy auditing concept

Course Specific Outcome (CSOs)
CSO1: Able to understand Energy forms, green energy and solar spectral characteristics
CSO2: Able to understand the environmental problems linked to non-renewable energy resources
CSO3: Evaluate the potential of non-biological energy resources and their limitations
CSO4: Evaluate the potential of biological energy resources to meet energy demand
CSO5: Acquire knowledge on energy use, demand and options, and socio-economic impacts of energy crisis

UNIT – I:

UNIT – II:
Non-Renewable Energy Resources: Fossil fuels (Coal, Petroleum, Natural gas, Tar sand, Shale Oil and Gas Hydrates) and environmental problems, Nuclear energy (Nuclear fission and fusion) and environmental problems, nuclear fuel cycle and nuclear accidents.

UNIT – III:
Renewable Energy Resources (Non-biological): Hydropower, its limitations and environmental problems, Tidal energy, its limitations and environmental problems, Wind energy and its limitations, Geothermal energy, its limitations and environmental problems, Solar energy (Solar collectors, Solar cells and Solar ponds), its limitations and prospects.

UNIT – IV:
Renewable Energy Resources (Biological): Fuel wood energy and its limitations; Energy plantations; Biogas and Biodiesel; Organic solid waste energy; Bio-energy advantages and disadvantages; Environmental impacts of biofuel production.

UNIT – V:
Energy use pattern, environmental implications of energy use and energy options: India and Global energy use pattern; Present and future energy demands, and energy options in India; Energy crisis and its socio-economic impacts; Environmental implications of energy use in urban and rural sector; Green energy auditing.
PRACTICALS:
1. Enumeration of fuel wood species in a locality
2. Listing of Fossil fuels and related pollution problems
3. Listing of hydrocarbon plant species
4. Conversion of sea water into fresh water by using sunlight
5. Examination of biogas plant designs
6. Field visits to biogas plants
7. Electricity Diary
8. Energy Bill
9. Energy Audit
10. Fuel consumption pattern in different classes of an urban society

LEARNING OUTCOMES (LOS)
1. Students will be able to learn energy forms and types, energy utilization pattern and characteristics of solar spectrum
2. Students will be able to understand the utilization of energy resources and their impacts on the environment and society
3. Students will be able to acquire complete understanding about the potentiality of non-renewable and renewable energy resources in India and in the world
4. Students will be knowledgeable of the potential future sources of renewable energy and intelligently analyze reported aspects of the energy
5. Students will be able to evaluate and interpret the energy crisis, issues and rational utilization of energy resources

BOOKS RECOMMENDED:
PAPER – 203: BIODIVERSITY CONSERVATION AND MANAGEMENT

Course Outcome:
CO1: Understand the Concept of biodiversity and biological regions of the world
CO2: Provide the knowledge on different Methodologies in measuring the biodiversity using statistical indices of biodiversities.
CO3: Acquire the knowledge on Biodiversity and wildlife conservation practices in India.
CO4: Understand the Conservation and management of biodiversity and statutory practices involved.
CO5: Provides the knowledge on different Environmental movements in India in 19th & 20th century.

Course Specific Outcome:
CSO1: Able to understand the conceptual understanding of biodiversity and its significance with information on Biogeographical regions of the world.
CSO2: Critically examining and measuring flora and fauna using statistical indices
CSO3: Provides knowledge on wildlife and its conservation and management practices
CSO4: Able to identify the reasons for biodiversity loss and evaluate the status of biodiversity in a particular region
CSO5: Able to have a brief history on environmental issues and movements in India

UNIT – I: Introduction to Biodiversity
Introduction: Definition and concepts. Significance of Biodiversity: Ecological, Economical and Aesthetic importance. Types of Biodiversity as per IUCN.
Biogeographical regions of the World, Distribution of world climatic regions and Vegetation types, distribution pattern of flora and fauna at Latitudes and Altitudinal; Patterns of species diversity, species importance, species area relationships, theories of species diversity, Equilibrium theory, Biodiversities of Tropical and Temperate regions.

UNIT – II: Measures of Biodiversity
Indices of diversity; Evenness Index, Shannon Wiener’s Index of Diversity, The Simpson Index, Estimating the diversity of large community: Margalef's Index diversity, Similarity Index, Bray- Curtis measures (B), Morisita’s Index of similarity. Hierarchical diversity. Diversity on Environmental gradients- Alfa Beta and Gamma diversities.

UNIT – III: Biodiversity in India:-
India is Mega biodiversity. Why?, Biodiversity Hotspots in India, Present status of Biodiversity in India – Extinct, Rare, Endangered and Threatened for a & Fauna in India, Man and Biosphere program, Future of Biosphere, National Biodiversity Strategy and Action Plan.

UNIT- IV: Biodiversity Conservation and Management:
Biodiversity. Introduction to Gene pools in forestry - Biodiversity Act, 2002 – Biodiversity Trade – Biopiracy issues.

UNIT – V: - Environmental Movements:-

PRACTICALS:
1. Vegetation Analysis:
   a) Frequency
   b) Abundance and Density
   c) Cover and Basal area
   d) Importance Value Index
2. Vegetation Sampling
   a) Transects
   b) Plot less Methods
3. Degree of Maturity of a plant community
4. Community Coefficients
5. Study of communities (Based of percentage, Density, Frequency, Basal area and size classes).
6. Diversity Measure: Shannon Wiener, Simpson and Brillion’s Index.
7. Listing of indicator species in a Forest, Ecosystem (Based on Field trip).
8. Identification Techniques for wild fauna:
   a) Pug Marks
   b) Hair sample
   c) Faecal analysis
9. Diversity Measure of Birds fauna in different habitat conditions.
10. Listing of Threatened and Endangered Fauna in a Forest Ecosystem (Based on field trip)

LEARNING OUTCOMES (LOS)
1. Students will be able to understand biodiversity and its vital role in ecosystem function
2. Students will realize the need of biodiversity conservation in the context of various developmental pathways and policy framework
3. Student will obtain knowledge and understanding of: Ecological and evolutionary processes that are important for conservation of biodiversity - Important approaches and practices in biodiversity conservation and management
4. Students will be skilled in planning management of biodiversity and biological resources in the light of ecological and evolutionary dynamics
5. Students will be knowledgeable in critically examine biodiversity and human linkages, and help policy formulating for conservation and develop appropriate policy options for conserving biodiversity
BOOKS FOR REFERENCE:
**204: REMOTE SENSING AND GIS APPLICATIONS**

Course Outcome:
CO1: Understand the Importance of Remote sensing and Geographic Information systems in the field of environment.
CO2: It helps to know the different Satellite systems and applications in environment
CO3: Acquire the knowledge on Image classification and applications
CO4: Understand the knowledge on Preparation of management plan for forest fire risk zoning, large scale mapping with case studies.
CO5: Provides the information of different Data interpretation techniques.

Course Specific Outcome:
CSO1: Able to have a foundation about remote sensing and GIS as a powerful tool for geo spatial analysis in the field of environment.
CSO2: Understand working principles of remote sensing and history of satellite development in India and globally.
CSO3: Analyze and evaluate the Mapping of large scale areas by using remote sensing techniques.
CSO4: Able to understand the Applications of GIS software to know the impact of natural calamities by developmental activities.
CSO5: Obtain Basic competence in skills with functional knowledge of the fundamentals to carry out GIS (RS-GIS) based project

UNIT – I: introduction to Remote Sensing & GIS:-

UNIT – II: Satellite systems & Applications
 Earth Observation Satellites (LANDSAT, SPOT, IRS, RADARSAT etc) and their characteristics Remote Sensing Systems, Indian Meteorological Satellites, Navigation satellites
 Application of remote sensing and GIS in land cover/land use planning and management (urban sprawling, vegetation study, forestry, natural resource), waste management and climate change.

UNIT – III: Image classification:-

UNIT – IV: Forest Inventory:-
 Principles of inventory; sampling techniques - Preparation of Management Plan - Site suitability analysis - Sustainable management - Fire risk zoning – Vegetation change detection and monitoring - Microwave remote sensing - Wildlife habitat evaluation - Forest ecosystem analysis - Large scale mapping with GPS
Unit – V:- Nature of Qualitative Information and Sequence in Interpretation;
   Elements of Image Patterns-Landforms, Drainage, Erosion Details; Remote Sensing
   Applications in Environmental Studies; Digital Image enhancement and classification methods;
   Principles of Microwave Remote Sensing; Characteristics of Microwave remote sensing Data; Radar
   and Lidar: Applications of Microwave Remote Sensing Data, Spectral Characteristics of Common
   Natural Objects; Atmospheric Effects on Remote Sensing Data;

PRACTIALS:
1. Study of Satellite Image Annotation (information) LANDSAT, SPOT and IRS
2. Study of Satellite data, identification and mapping of different surface features
3. Study of Ground Data collection instruments, Radiometers, Spectrometers etc.
4. Study of Satellite imagery (Black/White) in different bands and visual interpretation
5. Loading image data and display, identification of objects on video display, display of Histograms
6. Image enhancement techniques Contrast Enhancement, Band Rationing, Edge
7. Image Registration – Image to map, Image to Image, Image to user coordinates
8. Image classification techniques – supervised and unsupervised
9. Forest vegetation analysis & mapping using satellite images
10. Forest change detection
11. Site suitability analysis
12. GIS database creation

LEARNING OUTCOMES (LOS)
1. Students will be able to understand the basic concept of remote sensing and GIS and its applications,
   know different types of data representation in GIS
2. Students will be able to build the foundation of understating of cartography, digital image, spatial and
   non-spatial data and geospatial terminology
3. Students will be able to illustrate spatial and non spatial data features in GIS and understand the map
   projections and coordinates systems and application in GIS based software and different platforms
4. Students will be able to identify specific data and methodologies for effective mapping and
   evaluation of natural resources, flood management, watershed management, LULC classification,
   forest resource management etc for decision making
5. Student will be able to pursue lifelong learning for professional advancement

BOOKS RECOMMENDED:
  Jersey: Pretince Hall).
  York:John Wiley&Sons).

Champion, H.G. 1968 Revised forest types of India

Roy, PS, Ranganath, BK, Diwakar, PG, Bhan TPS, Singh, SK, 1991,
Tropical forest type mapping and monitoring using remote sensing. Int. J. Remote Sensing, 12(11) 2205

Chacko, VJ. 1965. A manual on sampling techniques for forest surveys. (Govt. of India publications)


Food and agriculture Organization. 1984. Land evaluation for forestry, FAO, Rome

Sing, IJ & Roy, PS 1990. Growing stock estimation through stratified random sampling, Photonirvachak, 18,29.

WEBSITES:
http://www.ciesin.org
http://edcwww.cr.usgs.gov/landdace
http://daac.gsfc.nasa.gov
http://eosweb.larc.nasa.gov
http://ghx.insfa.nasa.gov
Third Semester

PAPER-301: ECOTOURISM, ECORESTORATION AND SUSTAINABLE DEVELOPMENT

Course Outcomes (Cos)

CO1: Understand tourism types and the concept of ecotourism and its benefits
CO2: Understand ecotourism types, ecotourism promotion and development
CO3: Acquire knowledge on eco-restoration, its process and limitations
CO4: Understand restoration process in different ecological settings
CO5: Understand the concept of sustainable development and the ways to achieve sustainability

Course Specific Outcome (CSOs)

CSO1: Able to evaluate the advantages and disadvantages of tourism versus ecotourism
CSO2: Able to understand the potential of different ecosystems for ecotourism
CSO3: Analyze and evaluate the steps in eco-restoration process and the importance of phyto-remediation
CSO4: Able to understand the fundamentals of restoration activity in different ecosystems
CSO5: Acquire knowledge on sustainable development in different eco-sectors green growth and economy

UNIT – I:

Fundamentals and importance of ecotourism: Tourism definition, historical background, conventional tourism, mass tourism, nature-based tourism; Eco-tourism definition and its principles and guidelines; Importance of parks and gardens in ecotourism; Role of photography and electronic media in ecotourism, Potential sites for ecotourism promotion in India. Environmental impacts of ecotourism; Trends and future of ecotourism.

UNIT – II:

Ecotourism promotion and development: Ecotourism benefits – environmental awareness, environmental education, recreation, conservation and economic development; Wetland ecotourism, coastal ecotourism; bird ecotourism, butterfly ecotourism; Role of butterfly parks and gardens in ecotourism promotion, environment conservation and management; Communities involvement in ecotourism development.

UNIT – III:

Introduction and need for eco-restoration: Eco-restoration - definition, introduction, historical development; Restoration process – steps in the process and understanding biological, physical and chemical limitations, and overcoming limitations; Phyto-remediation for re-vegetation; philosophical and ethical context for good restoration and significance of community involvement.

UNIT – IV:

Eco-restoration in different ecological settings: Restoration of degraded waste lands, forests and agricultural soil fertility; Ground water restoration; Restoration of inland and coastal wetlands; Restoration of ecology in urban and industrial centers – Indicators for restoration and reclamation.
UNIT – V:
Sustainable Development: Concept of sustainability and sustainable Development; Brundtland Commission and its contribution to sustainable development; Sustainable agriculture; Sustainable forest management, sustainable forestry; Sustainable fisheries; Green growth and economy; Sustainable economic growth, environmental worldviews and ethics.

PRACTICALS
1. Collection and identification of insect fauna
2. Bird watching and identification
3. Field study of a local park/wild habitat
4. Examination of host plants of butterflies
5. Examination of life cycle of butterflies
6. Nesting habits of bees
7. Development of an eco-restoration strategy for denuded hills
8. Development of an eco-restoration strategy for aesthetic enhancement of beaches

LEARNING OUTCOMES (LOS)
1. Students will be able to differentiate between ecotourism and other forms of tourism and their impacts on environment and society
2. Students will be able to understand the role of media, parks, gardens, birds and butterflies in promoting ecotourism
3. Students will be able to learn what is eco-restoration, its process and its importance in restoring the ecology of natural areas, urban and industrial centers
4. Students will be able to learn the criteria as indicators for restoration and reclamation
5. Students will be knowledgeable of the environmental, social and economic dimensions of sustainable development and environmental ethics

BOOKS FOR REFERENCE:
PAPER-302: RISK ASSESSMENT AND DISASTER MANAGEMENT

Course Outcome:
CO1: Provides the knowledge on the concept of risk, hazard and the purpose of contingency plans.
CO2: Gain knowledge on process of risk assessment and hazard identification in environmental management.
CO3: Describe the Overview of disasters caused by natural, climatic and edaphic factors.
CO4: Gives information on manmade disasters and their involvement in the destruction of environment with case studies.
CO5: Acquire the knowledge on Disaster management, mitigations and control measures with statutory acts and guidelines.

Course Specific Outcome:
CSO1: Able to provides sound knowledge on concept of risk and hazard in environmental management and specifying contingency plans.
CSO2: Acquire information on natural and anthropogenic disasters and their mitigation methods with case studies.
CSO3: Understanding foundations of hazards, disasters and associated natural/social phenomena.
CSO4: Evaluate the potential of Disaster management, mitigations and control measures in India.
CSO5: Knowledge about existing global frameworks and agreements on pre and post Disaster management.

UNIT – I: Concepts of Environmental Risks

UNIT – II: Environmental Risk Assessment

UNIT – III: Natural Disasters
Disasters – Natural, understanding the causative factors vulnerability, their analysis and evaluation. Environmental implications of Earthquakes, Avalanches, Volcanic eruptions, Landslides, Floods (Riverine Floods) and tsunamis, cyclones (Diviseema Uppena, Hud-Hud & Titli), hurricanes, typhoons, tornadoes, cloud bursts.

Unit: - IV: - Human Influenced Disasters:-
Disasters due to nuclear chemical and biological weapons, Earthquakes in the areas of larger dams, forest fires and wild life destruction, Minamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011 LG Polymers accident in Vizag, Major Train accidents in India.

UNIT – V: Disasters Mitigation and Management
Identification of Disaster prone areas and high risk groups - Disaster warning programmes, Disaster preparedness and prevention of loss to life, livestock, property, natural resources and ecology – Development of Disaster Mitigation Plans – Awareness programmes and capacity building among the Risk Groups - Post disaster environmental problems and their management.
PRACTICALS:
1. Global Climate Change
2. Global warming
3. Green House Effect
4. Cyclone and three case studies
5. Major Forest Fires with Case studies
6. Floods with case study
7. Major train accidents in India
8. Nuclear Disasters with two examples
9. Biowarfares
10. Disaster management in India

LEARNING OUTCOMES (LOS):
1. Students will be capable in understanding the fundamentals of the environmental risk assessment and management procedures
2. Students will have better knowledge in identifying and classifying environmental hazards and risks and evaluating the significance and likelihood of harm
3. Students will have basic conceptual understanding of disasters and its impacts, mitigation, control measures etc
4. Students will be aware of major disasters occurred world-wide and their impacts and management
5. Students will be acquiring the skills in assessing, planning, mitigating, responding to and recovery from disaster from local through global levels

REFERENCES:
PAPER-303: POLLUTION CONTROL, MONITORING AND MANAGEMENT

Course Outcome:
CO1: Provides information on different sources, impacts of noise pollution and controlling methods
CO2: Understand the pollution sources from thermal pollution, marine pollution and radioactive pollution and their controlling measures
CO3: Able to evaluate the impacts of solid waste and their role in waste management
CO4: Understand the disposal, reuse & recycling and management of e-waste, hazardous waste, fly ash and plastic waste
CO5: Acquire knowledge on goals on national action plan of climate change by the Government of India by implementing different missions for mitigating climate change.

Course Specific Outcome:
CSO1:- Ability to identify noise pollution problems and interpret criteria of noise quality
CSO2:- Acquire knowledge on pollution caused from specific industries such as thermal, nuclear etc are explained in detailed.
CSO3:- Ability to identify solid/hazardous wastes, waste minimization, source reduction and elucidate the management, treatment and disposal of wastes.
CSO4:- To enrich knowledge about characteristics of hazardous, e-waste, fly ash and plastic wastes and their management
CSO5:- Able to understand the different missions in national action plan for combating climate change

Unit-I: Noise Pollution:

Unit-II: Thermal, Marine Pollution and Radioactive:
Sources of Thermal Pollution, Heat Islands, causes and consequences. Sources and impact of Marine Pollution. Methods of Abatement of Marine Pollution. Coastal management. Radioactive pollution – sources, biological effects of ionizing radiations, radiation exposure and radiation standards, radiation protection

Unit-III: Solid Waste and its Management:-
Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste.

Unit –IV: - Environmental monitoring and Management:-

Unit- V: National Action Plan on Climate Change


PRACTICALS
1. Estimation of pollution load for wastewaters.
2. Characterization of Municipal Solid Waste.
3. Monitoring of Noise levels at strategic points.
5. Industrial visits for hands on experience of Industrial Pollution Management.

LEARNING OUTCOMES (LOS)
1. Students will be able to define noise, sources, calculate noise levels and related pollution with noise control regulations and their limit values
2. Student will have acquaint knowledge and understanding of fate/behavior of marine, thermal and radioactive pollution and their problems/solutions.
3. Students will be able to identify the sources of solid and hazardous wastes and manage them
4. Students are able to understand the importance of environmental monitoring and management in hazardous, e-waste, flyash and plastic waste pollution
5. Students will be aware of various national action plans and missions implemented by GoI for challenging climate change

Books for References:
- The Nature and Properties of Soil, Brady.
- Analysis of water and wastewater, APHA publication.
PAPER-304: EIA, ENVIRONMENTAL ECONOMICS, AUDIT AND LAW.

Course Outcome:
CO1: Acquire the knowledge on EIA Notification and legal requirements and process of EIA
CO2: Acquire the knowledge on EIA methodologies in preparing EMP and EIS
CO3: Provides the information on Objectives, scope and approaches for environmental audit in preparing and finding corrective/preventive actions
CO4 & 5: Understand the Acts, gazettes, guidelines on different environmental laws in India

Course Specific Outcome:
CSO1:- Able to sound knowledge on process of EIA for upcoming developmental projects and providing control measures through Environmental Management Plan
CSO2:-Able to understand the EIA methodologies and assessing the impacts of various projects.
CSO3:-Able to evaluate the environmental audit to find corrective/preventive actions.
CSO4:- Acquire the Information on Environmental Laws in India.
CSO5:- Ability to understand the benefits, challenges and gaps under the current scenarios of laws

UNIT – I: EIA (Environmental Impacts Assessment)
- EIA Notification of the Govt. of India - Definitions and Objectives of Environmental Impacts Assessment; Scope and Advantages; Legal requirements and compliance: Screening and identification of projects; public involvement. Project criteria and thresholds; Environmental criteria and thresholds; Initial Environmental Evaluation; Practical Applications.

UNIT – II: Methods and Tools for EIA
- Activities in EIA and Impact characteristics; Map-overlay methods; Checklists Method (Descriptive and Scaling); Matrix Methods; Networks; Scoping Methods on Baseline Studies – Preparation of Environmental Impact Statement (EIS) – Development of Environmental Management Plan (EMP) - Role of Monitoring and Auditing in EIA.

UNIT – III: Environmental Audit
- Definition; Objectives; Scope, Coverage – Policy development: Defining boundaries; Goals; Policy compliance – Organization and staffing of Audit team – Resources – Approaches to Audit: (a) Pre-visit Activity; (b) On-site Activities; (c) Post-Audit activities – Audit principles – Benefits to Industry.
- Audit Report and Environmental Statement (ES): Importance of Audit Report – Reporting Environmental Audit Findings;– Environmental Statement and Public Information; Preparation of Flow diagrams; Material Balance; Preparation of EIS.

UNIT – IV: Environmental Laws - I

UNIT – V: Environmental Law - II

PRACTICALS
2. Case study Analysis for EIA of a major Industry.
3. Case study Analysis for EIA of a Reservoir/Land Conversion/Mining activity.
4. Case study Analysis of Environmental Audit of a major industry.
5. Preparation of Environmental Statement.
8. Visit to understand Institutional arrangements and functioning of Pollution Control Boards.

LEARNING OUTCOMES (LOS)
1. Students will be able to gain knowledge on EIA and its process with legal requirements
2. Students will be capable of application of EIA methodologies and preparing EMP and EIS
3. Students will be skilled in practicing Environmental audit and findings
4. Students will learn about the significance of developments in international and national environmental law and the fundamental principles that have emerged
5. Students will be knowledgeable of various comprehending the statutory and regulatory mechanisms pertaining to environment in India

Books for REFERENCE:
Course Outcomes (Cos)
CO1: Understand the importance and scope of chemical ecology in the context of environmental pollution
CO2: Acquire knowledge on soil chemical ecology in relation to allelopathy and drought conditions
CO3: Understand the chemical ecology of interactions between plants and pollinator animals
CO4: Understand the chemical defenses in vascular plants and impact of air pollution on chemical defenses
CO5: Understand the climate change effects on interactions between plants and insects, and the effects of plastic on plant and soil microbial community

Course Specific Outcome (CSOs)
CSO1: Able to understand the effects of air pollution on biogenic volatiles, plant and insect herbivores
CSO2: Able to understand the weed chemical ecology
CSO3: Acquire knowledge on the role of plant-derived Pyrrolizidine alkaloids in butterflies
CSO4: Analyze and evaluate the relationships between volatile trees, air pollution and air quality
CSO5: Able to evaluate climate change effects on plants and insects and also the effects of microplastics on plant as well as soil microbial biota.

UNIT 1:
Definition, scope and importance of chemical ecology; effects of air pollution on biogenic volatiles and ecological interactions; Interaction between plant and insect herbivores in elevated CO2 atmosphere

UNIT II:
Soil chemical ecology: Allelopathy, allelochemicals, weed chemical ecology; Chemical defense of organisms in terrestrial and aquatic habitats; Role of drought in chemical ecology of plants

UNIT III:
Chemical ecology of plant-pollinator interactions (bees, butterflies, moths, birds and bats); Role of plant-derived Pyrrolizidine alkaloids in butterflies; Chemical ecology of fruit defense

UNIT IV:
Phytoliths (solid biosilicates) as chemical defenses in vascular plants; Negative and positive effects of heavy metal pollution in plants and animals; relationships between volatile trees, air pollution and air quality; ecological roles of biogenic volatile organic compounds.
UNIT V:
Climate extreme conditions effect on plant chemical composition; Global climate change effects on plant-insect interactions, insect pests and crop production; Micro-plastics and their effect on plant growth, litter decomposition, plant community and soil microbial community

PRACTICALS
1. Measurement of nectar volume
2. Nectar analysis for sugar types
3. Nectar analysis for amino acids
4. Determination of nectar sugar content
5. Examination of butterflies that feed on plant species that produce Pyrrolizidine alkaloids
6. Qualitative analysis of sugar concentration of pulpy fruits of zoochorous species
7. Examination of Phytoliths in grasses
8. Listing of plant species producing fragrant flowers
9. Classification of flower syndromes using chemical aspects of nectar
10. Field study on foraging activity of pollinators on different plant species

LEARNING OUTCOMES (LOS):-
1. Students will be able to learn what is chemical ecology and its connection to plants, animals and pollution chemistry
2. Students will be able to understand what is allelopathy and its importance in weed chemical ecology, chemical defense of organisms in different ecosystems
3. Students will be able to understand the chemical ecology of plants and their pollinating and fruiting dispersing animals.
4. Students will be able to learn how Phytoliths act as chemical defenses in plants, how heavy metals effect plants and animals, and how the relationships exist between trees and air pollutants
5. Students will be knowledgeable of the climate change effects on plant chemical composition, plant-insect interactions, plant pests, and also effect of micro-plastics on plant growth, litter decomposition and soil microbial community
BOOKS FOR REFERENCE:

PAPER – 402: SAFETY, HEALTH AND ENVIRONMENT

Course Outcome:
CO1: Acquire the knowledge on importance of SHE practices in industrial and occupational safety
CO2: Provides the information of Planning and purpose of health and safety practices involved in Industrial units
CO3: Understand the Educating and Training of employees in SHE from grass root levels.
CO4: Acquire the knowledge on Competency building techniques (CBT) involved in training various standard operating procedures in safety methods and their applications.
CO5: Obtain information on accidents occurred due to human factors and their behavior in effecting safety positive culture.

Course Specific Outcome:
CSO1: Acquire knowledge on importance of SHE in practices of industrial and occupational safety
CSO2: Able to be familiar with safety planning and developing an understanding about the role in health and safety in workplaces.
CSO3: Able to understand the Imparting training, education, competence building techniques to the manpower working at all levels of industry
CSO4: Able to have knowledge about Hazard assessment studies and ways to handle hazard situations in industry
CSO5: Able to provides information on human errors and their behavior towards safety practices

UNIT-I:
1.1. Introduction- Management Principles & Types of Management; Managerial Role, Authority, Responsibility and Power. Span of Management, Delegation and decentralization of authority,

UNIT 2:-

UNIT: 3
Education and training: SHE: Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies, types of training. Evaluation and review of training programs. Communications and types

UNIT 4:-
UNIT 5:-

Human factor: Human factors contributing to accidents. Human behavior: Individual differences, behavior as function of self and situation, perception of danger and acceptance of risk, knowledge, and responsibility vis-a-vis safety performance, theories of motivation and their application to safety, role of, supervisors and safety departments in motivation. Conflicts & frustration:

PRACTICALS
1. Monitoring of
   a) Air quality
   b) water quality and
   c) Soil quality parameters.

2. Visit to a health center in an industry to understand the monitoring of health quality of work force

3. Visit to understand Institutional arrangements and functioning of SHE in industry.

4. Visit to understand functioning of safety aspects in an organization.

LEARNING OUTCOMES (LOS)
1. Students will be able to gain a comprehensive knowledge at the introductory level, in the area of Safety, Health and Environment
2. Students will be able to Identify and apply safety policy in an industry and List out the duties and implement Safety Targets, Objectives, Standards, Practices and Performances.
3. Students will be able to understand the role of occupational health, safety and environment in the workplace in the prevention of incidents, injury and illness
4. Students will have knowledge about Hazard assessment studies and ways to handle hazard situations in industry acting as Environment and Safety officers
5. Students will be able to create a job safety analysis by applying the concepts of workplace injury prevention, hazard and risk management

Text Books: