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Semester-V

Major Paper Code: BENVS-501 & BENVS -591	SEM-V
Paper Name: Ecology & Ecosystem	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 0	Continuous Assessment: 30
Practical hour: 30	Practical/Seasonal internal continuous evaluatio
Total hours: 75	Practical/Seasonal external examination: 0
Credit: 3+2	Mode of Exam: Offline

Course Objective:

- To provide a comprehensive understanding of ecological principles and the structure and function of ecosystems.
- To develop knowledge of biotic and abiotic interactions in different ecosystems.
- To understand ecosystem dynamics and the role of biodiversity in maintaining ecological balance.

Course Outcome:

- Knowledge: Understand the basic concepts and structure of ecosystems and biodiversity.
- Scientific Skills: Demonstrate the ability to analyze ecological parameters and biodiversity indices.
- Environmental Problem-Solving: Evaluate ecosystem functioning and assess anthropogenic impacts.
- Environmental Policy and Regulation: Relate ecological knowledge to environmental policy and conservation strategies.
- Sustainable Practices: Promote conservation and sustainable use of natural resources aligned with SDGs.

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MODULE I: 8 Hours
Introduction to Ecology: Definition, scope, and relevance of ecology. Levels of organization. Ecological factors: abiotic (temperature, water, light, soil) and biotic components.

MODULE II: 10 Hours
Ecosystem Structure and Function: Components of ecosystems. Food chains, food webs, and ecological pyramids. Energy flow and productivity (GPP, NPP, NEP).

MODULE III: 10 Hours
Population and Community Ecology: Population characteristics and growth models. Species interactions. Community structure and ecological succession.

MODULE IV: 9 Hours
Types of Ecosystems: Forest, grassland, desert, freshwater, marine, estuarine, and wetland ecosystems and their significance.

MODULE V: 8 Hours
Biodiversity and Conservation: Types of biodiversity, threats and conservation measures, ecosystem services.

Reference Books:

- Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
- Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
- Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
- Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
- Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.

Practical
Major Paper Code: BENVS -591
Credit: 2

- Study of various ecosystems through field visits.
- Identification of flora and fauna.
- Measurement of environmental factors.
- Estimation of productivity and biodiversity indices.

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Major Paper Code: BENVS-502 & BENVS -592	SEM-V
Paper Name: Environmental Biotechnology	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 0	Continuous Assessment: 30
Practical hour: 30	Practical/Seasonal internal continuous evaluat
Total hours: 75	Practical/Seasonal external examination: 0
Credit: 5	Mode of Exam: Offline

Course Objective:

- To introduce the concepts of biotechnology with a focus on environmental applications.
- To understand the role of microorganisms in waste treatment and pollution control.
- To familiarize students with biotechnological tools for environmental monitoring and bioremediation.

Course Outcome:

- Knowledge: Describe the fundamentals of environmental biotechnology and microbial diversity.
- Scientific Skills: Apply microbial techniques in waste treatment and pollutant degradation.
- Environmental Problem-Solving: Analyze the use of biotechnology in bioremediation and pollution control.
- Environmental Policy and Regulation: Assess biosafety, legal, and ethical issues in the deployment of GMOs.
- Sustainable Practices: Support sustainable environmental management through biotechnological innovations.

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MODULE I: 8 Hours

Introduction to Environmental Biotechnology: Definition, scope and role of biotechnology in environmental protection. Microbial diversity in natural and polluted environments.

MODULE II: 10 Hours

Waste Treatment Technologies: Microbial degradation of organic pollutants. Biotreatment of solid and liquid wastes. Anaerobic digestion and composting.

MODULE III: 10 Hours

Bioremediation and Phytoremediation: In-situ and ex-situ bioremediation. Role of microbes and plants in degradation. Use of genetically engineered organisms.

MODULE IV: 9 Hours

Environmental Monitoring Tools: Biosensors – types, design and application. Bioindicators. Molecular tools – PCR, DNA probes.

MODULE V: 8 Hours

Sustainable and Emerging Technologies: Bioplastics, biofuels, microbial fuel cells. Environmental genomics and metagenomics.

Reference Books:

- Environmental Biotechnology: Principles and Applications, Bruce E. Rittmann & Perry L. McCarty, McGraw-Hill
- Environmental Biotechnology: A Biosystems Approach, Daniel A. Vallero,Academic Press
- Textbook of Environmental Biotechnology, Mohapatra P.K., I.K. International Publishing
- Biotechnology for Environmental Protection in the Pulp and Paper Industry,P. Bajpai

Practical
Major Paper Code: BENVS -592
Credit: 2

- Isolation and identification of pollutant-degrading microbes.
- Compost preparation and quality analysis.
- Biosensor design and testing.
- Environmental monitoring using molecular tools.

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Semester-VI

Major Paper Code: BENVS-601	SEM-VI
Paper Name: Ecotoxicology & Environmental S	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 30	Continuous Assessment: 30
Practical hour: 0	Practical/Seasonal internal continuous evaluation:0
Total hours: 75	Practical/Seasonal external examination: 0
Credit: 5	Mode of Exam: Offline

Course Objective:

- Introduce core concepts of ecotoxicology, including types of toxicants, exposure pathways, dose-response relationships, and toxicokinetic.
- Examine the fate, transport, and bioaccumulation of pollutants in the environment.
- Equip students with the knowledge to conduct ecological and human health risk assessments.
- Introduce bioassays and toxicity testing methods using indicator species
- Study global environmental issues like climate change, biodiversity loss, water and air pollution, waste management

Course Outcome:

- Understand key concepts like toxicity, exposure pathways, dose-response relationships, and types of toxicants.
- Analyze the impact of heavy metals, pesticides, industrial chemicals, and pharmaceuticals on aquatic and terrestrial organisms.
- Discuss the science and impacts of climate change, deforestation, water scarcity, pollution, and biodiversity loss.
- Demonstrate skills in report writing, data interpretation, presentations, and environmental impact analysis.

MODULE 1: 6 Hours

Introduction to Ecotoxicology Definition, scope, environmental contaminants, toxic chemicals in the environment (air, water, soil).

MODULE 2: 9 Hours

Toxicokinetics and Toxicodynamics Absorption, distribution, metabolism, and excretion (ADME), dose-response relationship, interaction of toxicants.

MODULE 3: 9 Hours

Bioaccumulation and Biomagnification Mechanisms, factors affecting bioaccumulation, food chain effects, examples from aquatic and terrestrial ecosystems.

MODULE 4: 10 Hours

Environmental Monitoring and Risk Assessment Ecotoxicological testing, biomarkers, ecological risk assessment methods, regulatory guidelines.

MODULE 5: 6 Hours

Case Studies and Global Perspectives Pesticide pollution, heavy metals, emerging contaminants (e.g., microplastics), and their mitigation strategies.

Reference Books:

1. Newman, M. C. (2014). Fundamentals of Ecotoxicology.
2. Connell, D. W., & Miller, G. J. (2006). Chemistry and Ecotoxicology of Pollution.
3. Walker, C. H. et al. (2012). Principles of Ecotoxicology.
4. Manahan, S. E. (2010). Environmental Chemistry.

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Major Paper Code: BENVS-602 & BENVS -691	SEM-VI
Paper Name: Environmental Engineering & Pollution Control Measures	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 0	Continuous Assessment: 30
Practical hour: 30	Practical/Seasonal internal continuous evaluation:0
Total hours: 75	Practical/Seasonal external examination: 0
Credit: 5	Mode of Exam: Offline

Course Objective:

- Understand the causes, characteristics, and environmental impacts of various pollutants.
- Familiarize students with national and international environmental standards
- Understand the legal and regulatory framework for pollution control and environmental protection.
- Understand water treatment processes such as sedimentation, filtration, disinfection, and coagulation.
- Explore wastewater treatment methods including primary, secondary, and tertiary treatment (e.g., activated sludge, trickling filters, anaerobic digesters).
- Learn about air pollutant dispersion, meteorological parameters, and emission sources.
- etc

Course Outcome:

- Understand the sources, characteristics, and effects of air, water, soil, and noise pollution.
- Understand legal frameworks related to environmental protection and pollution control.
- Explain the principles of physical, chemical, and biological treatment processes.
- Design control measures for industrial and vehicular emissions.
- Identify techniques for collection, segregation, treatment, and disposal of municipal and industrial solid wastes.

MODULE 1: 6 Hours

Introduction to Environmental Engineering Concept, scope, role of engineers, overview of environmental issues.

MODULE 2: 10 Hours

Air Pollution and Control Technologies Types, sources, effects of air pollutants, control equipment – scrubbers, filters, cyclones, ESPs.

MODULE 3: 10 Hours

Water and Wastewater Treatment Water quality parameters, primary, secondary and tertiary treatment processes, sludge management.

MODULE 4: 8 Hours

Soil and Solid Waste Management Sources and types of solid waste, composting, incineration, landfilling, soil contamination and remediation.

MODULE 5: 6 Hours

Environmental Standards and Pollution Control Acts Overview of CPCB, WHO standards, major Indian environmental laws and compliance mechanisms.

Reference Books:

1. *Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (1985). Environmental Engineering.*
2. *Masters, G. M. (1998). Introduction to Environmental Engineering and Science.*
3. *Rao, M. N., & Rao, H. V. N. (2004). Air Pollution.*
4. *Metcalf & Eddy. (2013). Wastewater Engineering: Treatment and Resource Recovery.*

Practical
Major Paper Code: BENVS -692
Credit: 2

- Determination of pH, Turbidity, and Electrical Conductivity of Water
- Determination of Total Dissolved Solids (TDS) and Total Suspended Solids (TSS)
- Determination of Dissolved Oxygen (DO) in Water

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Major Paper Code: BENVS-603	SEM-VI
Paper Name: Environmental Impact Ass Management	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 30	Continuous Assessment: 30
Practical hour: 0	Practical/Seasonal internal continuous evaluation:0
Total hours: 75	Practical/Seasonal external examination: 0
Credit: 5	Mode of Exam: Offline

Course Objective:

- Introduce the principles, purpose, and scope of Environmental Impact Assessment.
- Explain the historical development and legal frameworks governing EIA at national and international levels.
- Understand the stages of the EIA process: screening, scoping, baseline study, impact prediction, mitigation, reporting, review, and monitoring.
- Learn to develop Environmental Management Plans to mitigate, monitor, and manage identified impacts.
- Understand the role of stakeholder engagement, transparency, and public hearings in EIA.
- Emphasize the integration of EIA into the planning and policy-making process.

Course Outcome:

- Understand the concept, objectives, and evolution of EIA
- Describe national and international legal and policy frameworks governing environmental assessments.
- Explain the step-by-step process of conducting an EIA, including screening, scoping, baseline studies, impact prediction, mitigation, and monitoring.
- Understand the structure and content of an EIA report, including environmental management plans (EMP).
- Identify and assess environmental impacts for projects in sectors such as transportation, energy, industry, mining, and infrastructure.

MODULE 1: 6 Hours

Introduction to EIA Definition, purpose, historical development, legal and institutional framework.

MODULE 2: 10 Hours

EIA Process and Methodologies Screening, scoping, baseline studies, impact identification and prediction methods (checklists, matrices, modeling).

MODULE 3: 9 Hours

Environmental Management Plan (EMP) Mitigation measures, environmental monitoring, post-EIA audits and follow-up strategies.

MODULE 4: 8 Hours

Public Participation and EIA Reporting Stakeholder engagement, public hearing, structure and content of EIA report, decision making.

MODULE 5: 7 Hours

EIA Case Studies and Emerging Trends Case studies from infrastructure, mining, power and industrial sectors; strategic environmental assessment (SEA), life cycle analysis.

Reference Books:

1. *Canter, L. W. (1996). Environmental Impact Assessment.*

2. Glasson, J., Therivel, R., & Chadwick, A. (2013). Introduction to Environmental Impact Assessment.

3. Noble, B. (2015). Introduction to Environmental Impact Assessment: A Guide to Principles and Practice.

4. Petts, J. (Ed.). (2009). Handbook of Environmental Impact Assessment.

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Semester-VII

Major Paper Code: BENVS-701	SEM-VII
Paper Name: Natural Hazards and Disaster Mar	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 30	Continuous Assessment: 30
Practical hour: 0	Practical/Seasonal internal continuous evaluation:0
Total hours: 75	Practical/Seasonal external examination: 0
Credit: 5	Mode of Exam: Offline

Course Objective:

- To understand the nature, causes, and effects of natural hazards.
- To learn strategies and frameworks for disaster risk reduction and management.
- To develop skills for disaster preparedness and resilience building.

Course Outcome:

- Knowledge: Recognize the types and impacts of natural hazards and disasters.
- Scientific Skills: Analyze hazard data and interpret risk scenarios.
- Environmental Problem-Solving: Design and recommend disaster management strategies.
- Policy and Regulation: Understand national and international disaster management frameworks.
- Sustainable Practices: Promote community-based disaster preparedness and climate resilience.

MODULE I: 10 Hours

Introduction to Natural Hazards: Definition, types and global distribution. Natural vs. man-made hazards. Concept of risk, vulnerability and disaster.

MODULE II: 10 Hours

Geological Hazards: Earthquakes, volcanoes, landslides – causes, effects and mitigation strategies.

MODULE III: 10 Hours

Hydro-meteorological Hazards: Floods, cyclones, droughts, cloud bursts. Meteorological forecasting and early warning systems.

MODULE IV: 10 Hours

Disaster Management: Disaster cycle, institutional framework (NDMA, SDMA), disaster preparedness, response and recovery.

MODULE V: 5 Hours

Climate change and disaster risk. Community-based disaster management. Role of media and NGOs in disaster response.

Reference

- *Disaster Management: Future Challenges and Opportunities, Jagbir Singh, K W Publishers Pvt Ltd*
- *Natural Hazards and Disaster Management, R. B. Singh, Rawat Publications*
- *Introduction to International Disaster Management, Damon P. Coppola, Butterworth-Heinemann*
- *Disaster Science and Management, Tushar Bhattacharya, McGraw Hill Education*

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Major Paper Code: BENVS-702	SEM-VII
Paper Name: Environmental Legislation & Poli	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 15	Continuous Assessment: 30
Practical hour: 0	Practical/Seasonal internal continuous evaluation:0
Total hours: 60	Practical/Seasonal external examination: 0
Credit: 4	Mode of Exam: Offline

Course Objective:

- To introduce environmental policies and legislative frameworks in India and globally.
- To examine the legal instruments for environmental protection and enforcement.
- To evaluate the role of policy in sustainable development and governance.

Course Outcome:

- Knowledge: Understand the framework and principles of environmental laws.
- Scientific Skills: Analyze the implications of environmental legislation on practices and projects.
- Environmental Problem-Solving: Apply legal tools to address pollution and conservation challenges.
- Policy and Regulation: Interpret the objectives of key environmental acts.
- Sustainable Practices: Support compliance and ethical standards for sustainable development.

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MODULE I: 10 Hours

Introduction to Environmental Law: Concept, need, and scope. Legal definitions and principles.

MODULE II: 10 Hours

National Environmental Policies: Forest Policy, Wildlife Protection Act, Environmental Protection Act.

MODULE III: 10 Hours

Water Act, Air Act, Hazardous Waste Rules. Role of CPCB and SPCBs.

MODULE IV: 15 Hours

International Environmental Conventions: Stockholm, Rio, Kyoto Protocol, Paris Agreement.

Reference

- *Environmental Law, S.C. Shastri, Eastern Book Company*
- *Environmental Law and Policy in India, Shyam Divan & Armin Rosencranz, Oxford University Press.*
- *Environmental Law and Policy, N.S. Nandan, Himalaya Publishing House*
- *Environmental Policies in India: A Framework for Sustainable Development, A. D. Vidya Sagar Reddy*

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Major Paper Code: BENVS-703	SEM-VII
Paper Name: Research Methodology	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 30	Continuous Assessment: 30
Practical hour: 0	Practical/Seasonal internal continuous evaluation:0
Total hours: 75	Practical/Seasonal external examination: 0
Credit: 5	Mode of Exam: Offline

Course Objective:

- To introduce research design, methods, and tools for scientific inquiry.
- To develop competence in conducting and analyzing environmental research.
- To enable students to write and present scientific reports and dissertations.

Course Outcome:

- Knowledge: Understand research types, processes and ethics.
- Scientific Skills: Conduct field-based and experimental research with statistical analysis.
- Problem-Solving: Frame research questions, hypotheses, and methodologies.
- Policy and Regulation: Interpret the importance of evidence-based research in policymaking.

MODULE I: 10 Hours

Research fundamentals – definitions, objectives, types of research.

MODULE II: 10 Hours

Research design – sampling techniques, data collection tools and methods.

MODULE III: 10 Hours

Data analysis – statistical techniques, SPSS basics, hypothesis testing.

MODULE IV: 15 Hours

Report writing – thesis structure, citations, plagiarism, publishing process.

Reference

- *Research Methodology: Methods and Techniques, C.R. Kothari, New Age International*

- *Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, SAGE Publications*

Semester-VIII

Major Paper Code: BENVS-801	SEM-VIII
Paper Name: Environmental Statistics & Economics	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 15	Continuous Assessment: 30
Practical hour: 0	Practical/Seasonal internal continuous evaluation:0
Total hours: 60	Practical/Seasonal external examination: 0
Credit:5	Mode of Exam: Offline

Course Objective:

- To provide fundamental understanding of statistical tools in environmental studies.
- To introduce economic concepts related to natural resource use and sustainability.
- To equip students with the ability to analyze environmental data and economic policies.

- **Course Outcome:**
- Knowledge: Understand the role of statistics and economics in environmental management.
- Scientific Skills: Apply statistical methods to analyze environmental data.
- Environmental Problem-Solving: Evaluate economic trade-offs in environmental decisions.
- Policy and Regulation: Interpret environmental valuation and cost-benefit analyses.
- Sustainable Practices: Support evidence-based policymaking for sustainable development.

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MODULE I: 10 Hours
Basics of Statistics: Data types, frequency distribution, central tendency, measures of dispersion.

MODULE II: 10 Hours
Probability and Hypothesis Testing: Probability distributions, t-test, chi-square test, ANOVA.

MODULE III: 10 Hours
Environmental Economics: Scope and principles, market failure, externalities, public goods.

MODULE IV: 15 Hours
Valuation of Environment: Methods of environmental valuation, cost-benefit analysis, sustainable development.

Reference

- *Environmental Economics: An Introduction, Barry C. Field & Martha K. Field, McGraw-Hill*
- *Introduction to Environmental Data Analysis and Modeling,, Moses Eterigho Emetere & M. A. Adebayo, Springer*
- *Statistics for Environmental Science and Management,Bryan F.J. Manly,Chapman & Hall/CRC*

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Major Paper Code: BENVS-802	SEM-VIII
Paper Name: Organismal & Evolutionary Biolo	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Lecture hour: 45	End semester exam: 70
Tutorial hour: 15	Continuous Assessment: 30
Practical hour: 0	Practical/Seasonal internal continuous evaluation:0
Total hours: 60	Practical/Seasonal external examination: 0
Credit: 5	Mode of Exam: Offline

Course Objective:

- To introduce students to the structure, function, and evolution of organisms.
- To understand the mechanisms of evolution and adaptation.
- To explore the evolutionary basis of biodiversity.

Course Outcome:

- Knowledge: Comprehend principles of organismal biology and evolution.
- Scientific Skills: Analyze biological adaptations and phylogenetic relationships.
- Environmental Problem-Solving: Explain evolutionary responses to environmental changes.
- Policy and Regulation: Relate evolutionary insights to biodiversity conservation.
- Sustainable Practices: Understand evolutionary principles underlying ecosystem sustainability.

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MODULE I: 10 Hours
Animal and plant diversity, structural adaptations, physiological functions.

MODULE II: 10 Hours
Evolutionary theories: Darwin, Lamarck, Modern synthesis. Natural and sexual selection.

MODULE III: 10 Hours
Speciation, adaptation, and co-evolution. Phylogenetics and evolutionary history.

MODULE IV: 15 Hours
Molecular evolution, genetic drift, gene flow. Evolution and environment interaction.

Reference

- *Integrated Principles of Zoology, Cleveland P. Hickman, Larry S. Roberts, Allan Larson,McGraw-Hill*
- *Evolutionary Analysis, Scott Freeman & Jon C. Herron, Pearson*
- *Textbook of Evolutionary Biology, Vishwajeet S. Sinha,, Anmol Publications*