

SYLLABUS OF UNDERGRADUATE PROGRAMME IN ENVIRONMENTAL SCIENCE

COURSE STRUCTURE FOR VII AND VIII SEMESTER

SEMESTER VII

COURSE TYPE	COURSE CODE & TITLE
Core	EN801: Wildlife Conservation and Management
	EN802: Introduction to Climate Change
	EN803: Research Methodology
DSE-3 Select any one	EN811: Water Treatment Technology
	EN812: Air Pollution Monitoring and Control
Dissertation	EN815: Dissertation - I

SEMESTER VIII

COURSE TYPE	COURSE CODE & TITLE
Core	EN804: Energy and Environment
	EN805: Natural Hazards and Disaster Management
	EN806: Environmental Impact Assessment
DSE-4 Select any one	EN813: Environmental Biotechnology
	EN814: Industrial Health and Safety
Dissertation	EN815: Dissertation - II

DETAILED SYLLABUS (CORE)

EN801: WILDLIFE CONSERVATION AND MANAGEMENT

Course Objective (Summary): The course introduces the concepts of wildlife, the threats to wildlife and the issues associated with wildlife conservation and management in the country. The paper highlights the need for wildlife education to conserve the remaining populations of wild organisms thriving in the jungles of India.

Course Learning Outcomes:

1	Articulate the fundamental concepts in wildlife conservation and management.
2	Apply understanding of cultural, historical, and current perspectives on the human-wildlife relationship to effectively address wildlife issues.
3	Understand the current threats to wildlife.
4	Be capable of assessing status of wildlife.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Wildlife	Definition of wildlife (instrumental, intrinsic, ecocentric, religious, conservational); Indian wildlife; keystone species; endemism; extinction; IUCN threatened categories.	15
II	Threats to wildlife	Habitat destruction, poaching, habitat fragmentation, exotic species and invasives, illegal wildlife trade, pollution; island biogeography; endemic and endangered species and vulnerability to extinction.	15
III	Human animal conflict	Definition, causal factors; some examples - Elephant-man conflict; Rhino-man conflict; River dolphin-man conflict; Tiger-man conflict; Leopard-man conflict; Conflict management and shifting from extraction to preservation; Response system.	15
IV	Current issue in wildlife conservation	Protected Areas Networks (PAN) in India; legal instruments; biodiversity within and outside protected areas; community-based conservation; climate change and wildlife movement; ecological services of wildlife; ecotourism and wildlife; habitat fragmentation and wildlife corridors; sustainability in wildlife management; collaborative partnership for sustainable wildlife management; education and awareness-raising.	15
V	Practical	Orientation to field biology and natural history; Observations and collection of study material, wildlife signs and evidences; Exercise on wildlife population parameters and census methods for various species; Estimation of frequency, density, abundance of species; Field tour designed to examine wildlife conservation issues in a variety of ecological situations in a bio-geographic zone of India.	60

Suggested Readings:

- 1 Saha, G.K., and Majumdar, S. Wildlife Biology: An Indian Perspective, Prentice Hall of India. 2017.
- 2 Rangaraj, M. India’s Wildlife History: An Introduction, Oxford Press, 2006.
- 3 Rangaraj, M. and Sivaramakrishna, K. Shifting Ground: People, Animals and Mobility in India's Environmental History, Oxford Press, 2014.
- 4 Bindra, P.S. The Vanishing: India’s Wildlife Crisis, Penguin Books. 2017.
- 5 Sinha, S. Handbook on Wildlife Law Enforcement in India, WWF Press. 2011.

EN802: INTRODUCTION TO CLIMATE CHANGE

Course Objective (Summary): The course aims to equip learners with a comprehensive understanding of the natural and anthropogenic factors driving the present climate change, identify evidence, recognize the social, economic, and environmental consequences, and educate on the mitigation strategies. The course also focuses on human behavioral change, developing skills, mitigation technologies, adaptation strategies, climate change assessment tools, plus relevant policies promoting a sustainable future.

Course Learning Outcomes:

1	The students will learn about the causal factors of global warming and climate change.
2	Understand how the climate of the Earth has changed in geological history.
3	Learn about various impacts of climate change on organisms, humans, and the ecosystem, plus the adaptation and mitigation technologies.
4	Learn about the policy response and mitigation strategies adopted at the national and international levels.
5	The practicum component will give the students basic ideas about how to collect atmospheric data and link the information to understand and resolve the problems of climate change.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	General introductory	Weather and climate; Climate change, Natural and human-induced climate change. Global warming; Earth’s climatic history; Milankovitch Cycle.	15
II	Impacts and vulnerability	Impact of climate change on organisms, ecosystems, agriculture, and food security; Sea level rise; Coral bleaching; Extinction risk of temperature-sensitive species; Melting of snow, ice, and glaciers; Extreme weather events; Climate change vulnerability.	15
III	Mitigation and adaptation	Climate Change mitigation strategies; Carbon capture and storage; Climate change adaptation and resilience; Carbon credit, Carbon trading, carbon sequestration, CDM; Clean energy options; CFCs – uses and trends; Reducing Carbon footprint; Net-zero emissions.	15
IV	Policy and governance	Policy response and mitigation strategies; Climate Change Conventions, UNFCC, Kyoto Protocol, Implementation of the Paris Agreement; International Climate Change Negotiations.	15
V	Practicum	Fieldwork and on-site survey, data collection, and analysis of areas affected by extreme weather events and climate change; Visit the meteorological stations; Collection of meteorological data and their analysis; Research projects, or internships with organizations working on climate solutions.	60

Suggested Readings:

- 1 Archer, D. (2007). *Global Warming: Understanding the Forecast*. Blackwell Publication.
- 2 Bahadur (2004). *Himalayan Snow and Glaciers*, Concept Pub.
- 3 Dash, S. K. (2007). *Climate change: An Indian Perspective*. CEE, Ahmedabad.
- 4 Lal, D.S. (2004). *Climatology*, Chaitanya Publishing House, Allahabad.
- 5 Pal Arya, S. (1988). *Introduction to Micrometeorology*, Academic Press.
- 6 Thomas E.L., and Hannah L.J. (2006). *Climate change and Biodiversity*. Yale University Press.

EN803: RESEARCH METHODOLOGY

Course Objective (Summary): The course is aimed to highlight the basic concepts of Environmental Research. Student are expected to learn the basic components sample, population, sample design and sampling methods for qualitative and quantitative research. It will introduce the concepts of environmental research using various issues in the environments, hypothesis testing and drawing inferences of environmental data.

Course Learning Outcomes:

1	Students will learn the fundamentals of environmental research and their scope and uses
2	Students will learn basic concepts of statistical methods and their significance in environmental data analysis for both qualitative and quantitative research
3	Students will learn basic concepts of data collection, presentation and interpretation of environmental data using statistical and computing software
4	Students will learn the fundamental concepts of computer applications for various environmental research

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Environmental Research	Basic Concepts and fundamentals of research and research design; Environmental data –types, methods, collection and classification; tabulation and presentation of data; scope of qualitative and quantitative research; communication of research findings; Research ethics	15
II	Sample design	Population and Sample, Sample design- techniques; Measure of central values; Measure of dispersion; Correlation & Regression; Time series analysis- Components, measurement of trend and models.	15
III	Hypothesis testing	Basics of concepts of probability-Probability distribution functions; Fitting of probability distributions; Sampling distribution and test of significance; Concept of Null hypothesis and uses; Parametric and non-parametric test; Standard error and its uses	15
IV	Test of Significance	Test of significance of small and large samples (t- test, F-test, χ^2 -test etc.) and their applications; Analysis of Variance (ANOVA)- types, basic assumptions, and their applications	15
V	Practical	Computer fundamentals and application software; Concept & working knowledge of Spreadsheet, excel, and other computing Software; Practical on methods of collection, data presentation & Interpretation of Environmental data using computing software Calculation of environmental data using measures of central values, measures of dispersion, Correlation, and Regression analysis. Calculation and estimation or trend analysis of time series data (rainfall, temperature, humidity etc), Calculation of and estimation of trends for Parametric test using t-test, F-test, ANOVA one-way and two-way. Calculation of and estimation of non-parametric tests such as χ^2 -test, MW test.	60

Suggested Readings:

- 1 Aho, A.V. and Ullman, J.D. (1992). Foundation of Computer Science, W.H. Freeman..
- 2 Aslam Mahmood (1976). Statistical Methods in Geographical Studies, Rajesh Publications, N. Delhi
- 3 Gupta. S.C. (1995). Statistical Methods, S. Chand & Co..
- 4 Gupta. S.C. and Kapoor V. K. (1995).Fundamentals of Mathematical Statistics, S. Chand & Co.
- 5 Medhi, J. (2013). Statistical Methods: Introductory Text, New Age International Ltd. Publishers.
- 6 Ranjan, V. (1997). Fundamentals of Computer, Prentice Hall of India, New Delhi.
- 7 Rosener, B. (1999). Fundamentals of Biostatistics, Duxbury Press.
- 8 Singh, D. (2003). Practical Statistics (vol 1&2), Atlantic.

EN804: ENERGY AND ENVIRONMENT

Course Objective (Summary): The prime objectives of the course are to understand the multiple linkages between the present-day pattern of conventional energy consumption and the related environmental problems, ranging from the local to the global scale. It will help in exploring alternative and sustainable energy sources, reduce carbon footprint, improve energy efficiency, energy security, energy equity, reduce pollution, minimise health impacts on humans and the environment.

Course Learning Outcomes:

1	The students will learn about the various energy sources and patterns of utilization.
2	Should be able to make a distinction between conventional and renewable energy sources.
3	They will also learn about the dependence of the present civilization on fossil fuel for energy and the pattern of energy consumption prevailing in different parts of the world.
4	Should be able to state how the consumption of fossil fuels and biomass leads to adverse impacts on health and the climate, plus become aware of the government's energy policy.
5	The experiments conducted in the practical classes will make them learn how alternative energy can be generated from locally available materials.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Energy Resources	Sources of energy and their classification; Energy forms and transformation; Sun as a source of energy, Global energy balance, Renewable and non-renewable energy; Energy and environment; Energy use patterns.	15
II	Fossil and biomass energy	Environmental problems associated with energy use; Biomass energy; Biomass conversion processes; Energy plantation; Energy from municipal solid waste and agricultural wastes; Improved Chula; Prospects and constraints of biomass energy.	15
III	Nuclear energy	Nuclear fission and fusion, Nuclear reactors; Mining and processing of Uranium, radioactive wastes and environmental implications; Solar Energy: Solar thermal application; Solar photovoltaic system	15
IV	Other Alternative energy	Wind energy; Hydroelectric power, Environmental impacts due to hydropower generation, Magneto-hydrodynamics power; Geothermal energy; Tidal and wave energy; Ocean thermal energy conversion.	15
V	Practical	Evaluation of biogas production potential of bio-wastes; Estimation of energy consumption in households, institutions, and industries; Case studies on energy consumption patterns in rural and urban areas and health impacts.	60

Suggested Readings:

- 1 Fowler, J. M. (1984). Energy and Environment, McGraw-Hill. USA.
- 2 Dunderdale J., (1990) Energy and Environment (Royal Society of Chemistry).
- 3 Chaturvedi, P. (1995). Bio-Energy Resources: Planning, Production and Utilization, Concept Pub.
- 4 Agarwal, S. K. (2003). Nuclear Energy-Principles, practice and prospects, APH Publishing Corporation
- 5 Devins D. W., (1982) Energy and its Physical Impact on Environment (John Wiley & Sons).

EN805: NATURAL HAZARDS AND DISASTER MANAGEMENT

Course Objective (Summary): This course will help students understand different natural and human-made hazards, their causes, impacts, and management. It introduces disaster management concepts, tools, and strategies, including preparedness, mitigation, and community participation. Students will learn real-world case studies and practical approaches to reduce risks, protect communities, and promote sustainable, disaster-resilient development.

Course Learning Outcomes:

1	The students will be able to identify different types of natural and human-made hazards and understand their causes and effects.
2	Students will understand disaster management concepts, cycles, and key terms like risk, vulnerability, and capacity.
3	Students will be better equipped to suggest preparedness and mitigation strategies for various hazards.
4	Basic knowledge of tools like GIS and remote sensing to understand and plan for disasters.
5	Students can analyse real-life disaster case studies and apply lessons learned to promote safer, sustainable communities.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Natural Hazards	Natural hazards: hydrological, atmospheric & geological hazards; earthquake, seismic waves, epicenter; volcanoes; flood; landslides, landslides, drought, cyclone & hurricanes; tsunamis: coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.	15
II	Anthropogenic Hazards	Impacts of anthropogenic activities such as urbanization, deforestation, mangrove destruction; large-scale developmental projects like dams and nuclear reactors; nature and impact of wildfires and biophysical hazards; Case studies of Bhopal gas tragedy, Minamata, and Chernobyl disasters.	15
III	Fundamentals of Disaster Management	Definition, concepts, and types of disasters; Disaster management cycle; Risk, hazard, vulnerability, and capacity assessment; Institutional frameworks for disaster management in India (NDMA, SDMA, DDMA); GIS, and remote sensing in disaster planning and response.	15
IV	Disaster Preparedness and Mitigation Strategies	Early warning systems and communication in disaster management; Community-based disaster preparedness and capacity building; Structural and non-structural mitigation measures; Case studies of major disasters in India and lessons learned; Integration of disaster management with sustainable development and climate change adaptation.	15
V	Practical	Plotting of earthquake-prone areas on a outline map of India; Plotting of flood-prone areas on an outline map of India; To study on distribution of major wind patterns on the world map; To study on impacts of wildfires/landslides prone areas in NE India; Detailed field report on a recent disaster (natural or anthropogenic), covering causes, impacts, response, and lessons learned.	60

Suggested Readings:

1. Pine, J.C. 2009. *Natural Hazards Analysis: Reducing the Impact of Disasters*. CRC Press, Taylor and FrancisGroup.
2. Schneid, T.D. & Collins, L. 2001. *Disaster Management and Preparedness*. Lewis Publishers, New York, NY.
3. Smith, K. 2001. *Environmental Hazards: Assessing Risk and Reducing Disaster*.Routledge Press.
4. Coppola, D.P. 2007. *Introduction to International Disaster Management*. Butterworth Heinemann.
5. Cutter, S.L. 2012. *Hazards Vulnerability and Environmental Justice*. EarthScan, Routledge Press.
6. Keller, E.A. 1996. *Introduction to Environmental Geology*. Prentice Hall, Upper Saddle River, NewJersey.

EN806: ENVIRONMENTAL IMPACT ASSESSMENT

Course Objective (Summary): The course is aimed to highlight the basic concepts of Environment Impact Assessment (EIA), their history and development to the beginners in the field. It will introduce the concepts of environmental impacts assessment, various issues and EIA guidelines for the developmental projects, planning, programmes and guidelines. The Course seeks the students to understand the basic about preparation of EIA for Environmental Clearance (EC) and public participations processes.

Course Learning Outcomes:

1	The students will learn about the history and development concept of EIA in the world and India.
2	Students will learn about fundamental approaches, guidelines and regulations on EIA in India and various types of EIA case studies on developmental projects, programs, plans and guidelines
3	Students will learn about the types of developmental activities and associated impacts and mitigation measures.
4	Students will learn about the conceptual framework for EIA, public participation process and various methodologies for different environment component.
5	The students will learn about role of various stakeholders in EIA, Preparation of EIA report and Environment Clearance procedure.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Basic concept of EIA	Environmental impact assessment (EIA): definitions, introduction, concepts, needs and scope of EIA; rationale and historical development of EIA; Components of EIA; EIA of developmental projects and process of Environmental Clearance, EIA Guidelines in India and world	15
II	Components of EIA	The EIA methodologies; role of project proponents, project developers and consultants; Terms of Reference; Impact Identification and Prediction; Baseline data collection; Public Participation (PP) in EIA, Environmental Impact Statement (EIS)	15
III	EIA Methodologies	Environmental Impacts, their significance, Framework for Prediction and Assessment of Air, Surface Water, Groundwater and Soil, Noise, Biological, Socio-economically and Cultural Environment; Standards and guidelines; Prediction and determination of impact-Risk Prediction and Assessment and mitigation measures for environmental impacts.	15
IV	SIA and LCA	Strategic EIA; Social Impact Assessment (SIA); Cost-Benefit analysis; Life cycle assessment; Public participation (PP) in Environmental decision making; Evaluation of alternatives and Trade-off Analysis; Decision making and Environmental Clearance; Environmental Management Plan (EMP)	15
V	Practical/Case Studies	Prediction and Assessments of Air Quality, Water Quality, Noise Environment for EIA of Developmental Projects; Assessment and prediction of Biological, Socio-economically and Cultural Environment of any Developmental projects; EIA Case studies of Power Plants, Industries, Transportation and Communication projects, Mining and Explorations, Infrastructure development projects etc.)	60

Suggested Readings:

1. Anjaneyulu, Y. and Manickam, W. (2010) *Environmental Impact Assessment Methodologies*, BSP Books Pvt, Ltd., Hyderabad.
2. Canter, L. (1996) *Environmental Impact Assessment*, McGraw-Hill, New Delhi.
3. Eccleston, C. H., (2011) *Environmental Impact Assessment*, CRC Press, New York
4. Glasson, J., Therival, R., Chadwick, A. (1994) *Introduction to Environmental Impact Assessment- Principles and Procedures*, Process, Practice and Prospects, Research Press, New Delhi.
5. Glasson, T. and Chadwick (1999) *An Introduction to Environmental Impact Assessment*, UCLCA, Los Angeles.
6. Lawrence, D.P. (2003) *Environmental Impact Assessment: Practical, Solutions to Recurrent Problems*, John Wiley and Sons, New Delhi.

DETAILED SYLLABUS (DSE)

EN811: WATER TREATMENT TECHNOLOGY

Course Objective (Summary): This course aims to introduce the fundamental concepts and principles of water and wastewater management. Students are expected to learn about primary, secondary, and tertiary physicochemical and biological methods for treating water and wastewater, as well as their applications. It will also introduce the concepts of different water quality parameters, water quality guidelines, and standards. This course is expected to teach about different engineered water treatment systems, their designs, and basic working principles.

Course Learning Outcomes:

1	Select the sources of water for various water uses.
2	Explain unit operations and processes of water treatment systems.
3	Apply the principles and design water treatment units.
4	Apply concepts and will be able to design the water treatment plant.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Introduction to Water Quality	Water Sources, Usage and Water Demand; Water Quality-Definitions, Characteristics and Perspectives; Physical, Chemical and Biological water quality parameters, Water quality guidelines, and standards for various water uses.	15
II	Physicochemical Water Treatment Process	Primary, secondary and tertiary water treatment process; Overview and principle of the Physico-chemical Water and Wastewater Treatment Process (coagulation, flocculation, sedimentation, chemical precipitation, porous media filtration, disinfection, ion-exchange, adsorption, membrane processes).	15
III	Biological Water Treatment Process	Overview of Biological and Biochemical Process Water Treatment Processes, Biology of sewage treatment; BOD growth curve and analysis; types of biological treatment processes; process description and design principles; removal of nitrogen and phosphorus; Response of Streams to Biodegradable Organic Waste, and Application of Natural Processes	15
IV	Engineered Water Treatment Systems	Aerators and aeration systems; Sedimentation –types of settling and settling equations, design criteria and design of settling/sedimentation tanks; Filtration types and design of filters, hydraulic design criteria of filters, filter backwash, factors affecting efficiency of filtration and operational issues; Coagulation and Flocculation- types, coagulation theory and design criteria, estimation of coagulant dose, factors influencing coagulation; Purpose and mechanism of flocculators and flocculation; Disinfection-Types of chemical and non-chemical methods of disinfection; Chick’s law; factors affecting disinfection, chemistry of chlorination; Water Softening process; Treatment process including Adsorption, Reverse Osmosis, Electro-dialysis, Ion-exchange; Chemical, and Distillation techniques.	15
V	Practical	Laboratory experiments: Physicochemical analysis of water and wastewater parameters (pH, EC, TDS, Salinity, Alkalinity, Turbidity, Hardness; Estimation of DO, BOD and COD; Estimation of residual chlorine). Field Visit: Conduct a visit to a water treatment site, including sampling, analysis, and reporting; and visit a STP or ETP site, with reporting.	60

Suggested Readings:

1. Peavy H.S., Rowe D.R. & Tchobanoglous G., “Environmental Engineering”. McGraw Hill International Edition.
2. Karia G.L., Wastewater Treatment: Concepts and Design Approach, PHI, 2013
3. McGhee T. J., “Water Supply and Sewerage”, McGraw-Hill, Inc., 1991.
4. Davis M. L. & Cornwell D. A., “Introduction to Environmental Engineering”, McGraw- Hill, Inc.,1991.
5. Metcalf & Eddy, “Wastewater Engineering- Treatment and Reuse,” Tata McGraw Hill, 4thEdn., 2003.
6. Sawyer C. N., McCarty P. L., Parkin G. F., “Chemistry for Environmental Engineers”, McGraw-Hill, 1994.
7. Punmia B.C., Environmental Engineering (Vol-I & II), Laxmi Publishers.

EN812: AIR POLLUTION MONITORING AND CONTROL

Course Objective (Summary): The primary objective of the course is to equip students with the knowledge and skills to understand, assess, and mitigate air pollution across various environmental settings. The course aims to highlight the sources, extent, and health and environmental impacts of air pollution. The course also aims to develop practical skills in sampling techniques, handling instruments, pollution monitoring, data interpretation and analysis, and the application of air pollution control technologies.

Course Learning Outcomes:

1	The students will learn about the sources of pollutants, both natural and anthropogenic, and their impact on the biota and environment.
2	Familiarise the students with different sources and sinks of common air pollutants
3	Develop an understanding of the various monitoring techniques available for gaseous and particulate matter.
4	Learn about the global environmental changes linked with air pollution, such as ozone depletion & global warming.
5	The experiments conducted in the practical classes will make them familiar with the various emerging techniques used in analysing air pollution.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Introduction	Definitions, types of air pollutants, Sources of air pollution: Point source, area source, Volume source; criteria pollutant, Air Quality Index, Ambient air quality standards, Vehicle emission standards.	15
II	Impacts of Air Pollution	Air Pollution Meteorology, Atmospheric Reactions, and Scavenging Processes. Effect of Air pollution on plants, animals, humans, biodiversity, agriculture etc.	15
III	Sampling Method	Sampling from point sources (Stack Monitoring, vehicles), and ambient sampling methods. Online and offline sampling instruments for gaseous and particulate air pollutants.	15
IV	Control Method	Industrial Source Control Technology: Cyclone, Electrostatic Precipitator, Baghouse Filter, Venturi Scrubber – Principles and uses, and their limitations.	15
V	Practical	Monitoring of Total Suspended Particulate Matter (TSPM); monitoring of SO ₂ , NO ₂ NH ₃ , CO and O ₃ . Exposure analysis of SO ₂ , NO ₂ and CO, to plant leaves. Field Visit to nearby industries for studying different control technologies.	60

Suggested Readings:

- 1 Allegrini I, DeSantis F. (Ed), Urban Air Pollution: Monitoring and Control Strategies, Springer
- 2 Clarke A.G., Industrial Air Pollution Monitoring, Springer.
- 3 Trivedi R.K. (2003) An Introduction to Air Pollution, DVS Publication.
- 4 Arya, S.P. (1999) Air Pollution Meteorology and Dispersion, Oxford University Press.
- 5 Sokhi, R. S. (Ed.). (2024). Air Quality: Science, Impacts, and Management (1st ed.). Elsevier.

EN813: ENVIRONMENTAL BIOTECHNOLOGY

Course Objective (Summary): The course highlights the application of biotechnology for pollution control. It covers the concepts of molecular genetics and rDNA technology. It deals with various remediation mechanisms that treats pollution using living organisms in nature.

Course Learning Outcomes:

1	Knowledge on the scope of biotechnology.
2	Ability to apply molecular biological techniques in pollution management and industrial applications.
3	Knowledge of advanced biotechnological applications, and biosafety in analytical procedures.
4	Ability to apply molecular biological techniques in pollution management and industrial applications.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Environmental Biotechnology	Environmental Biotechnology: definition, scope, types, advantages and history; Biotechnology – definition, scope and applications. Advantages and disadvantages of biotechnology in the conservation of biota.	15
II	Molecular Genetics & GMOs	Pioneer experiments leading to the development of molecular genetics, Structure of nucleic acids; Gene expression - DNA replication: Transcription of DNA, protein synthesis; Genetic Engineering or rDNA technology: steps involved in the production of GMOs, advantages, issues and controversies; biosafety. GM crops in India.	15
III	Microbes in the environment	Enhancement of soil fertility - biofertilizers, mycorrhiza, biological nitrogen fixation, composting, vermicomposting; Biopesticides, Bio-energy.	15
IV	Bioremediation	Bioremediation - Need, scope, constraints and advantages, types of bioremediation; Biotechnological application of microbes and plants in pollution abatement; Degradation of xenobiotics in environment; Heavy metals bio-accumulation.	15
V	Practical	Preparation of different culture media, sterilization of media, pour plate techniques, solid media in test tubes. Microbial culture, inoculation techniques, streaking and spreading. Microbial cell counting by serial dilution technique and pour plate technique. Identification of microorganisms through biochemical tests (bacteria/fungi/virus). Bioremediation of polluted water and soil using microorganisms and plants. Experiments on composting and vermicomposting.	60

Suggested Readings:

- Jördening, H.J. and Winter, J. eds., Environmental biotechnology: concepts and applications. John Wiley & Sons, 2005.
- Singh, B.D. and Singh, B.D., Biotechnology expanding horizons. Kalyani publishers. 2007.
- Lehninger, A.L., Nelson, D.L., Cox, M.M., Lehninger principles of biochemistry. Macmillan, 2005.
- Elliott, W.H., Elliott, D.C. and Jefferson, J.R., Biochemistry and molecular biology (Vol. 2001, p. 586). Oxford: Oxford University Press, 1997.
- Wang, L.K., Ivanov, V., Tay, J.H. and Hung, Y.T. eds., Environmental biotechnology (Vol. 10). Springer Science & Business Media, 2010.
- Rittmann, B.E. and McCarty, P.L., Environmental biotechnology: principles and applications. Tata McGraw-Hill Education, 2012.

EN814: INDUSTRIAL HEALTH AND SAFETY

Course Objective (Summary): The course will introduce the principles of industrial health and occupational safety focusing on ISO 45001: Occupational Health and Safety Management Systems (OHSMS). It will help understand and identify workplace hazards, occupational diseases, risk assessment. Students are expected to understand legal compliance, accident prevention, and systematic implementation of ISO 45001 in industrial sectors.

Course Learning Outcomes:

1	Ability to provide industry with inputs on health and safety.
2	Internalize ISO 45001 and its implications for an industry.
3	Learn and disseminate issues related to occupational health and hazards
4	Protocol development for an industry on disaster prevention, health issues, safety measures and environment management.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Introduction	Concept, scope, and importance of industrial health and safety; Basics on hazard, risk, accident, incident, dangerous occurrence, near miss; Causes and consequences of industrial accidents. Safety culture, policy and management systems in organizations.	15
II	Occupational Health	Occupational health – definition, occupational health hazards; human health impacts of the hazards; occupational diseases – silicosis, asbestosis, pesticide poisoning; occupational health and safety administration. Hazard Identification and Risk Assessment (HIRA) in industries; Job Safety Analysis (JSA) and hierarchy of controls.	15
III	Industrial Safety Practices	Industrial hygiene practices. Roles and responsibilities of employer, occupier, manager, workers, and safety officers. Machine safety (ISO, BIS standards), Electrical safety, Fire safety, Chemical safety, Personal Protective Equipment (PPE).	15
IV	Legal Framework and ISO 45001	Overview of Indian occupational health and safety legislation; Factories Act, 1948, Occupational Safety, Health and Working Conditions Code, 2020. Role of Directorates of Factories and Boilers, Central and State Pollution Control Boards; ILO conventions ratified by India. Introduction, scope, and benefits of ISO 45001 for industries.	15

Suggested Readings:

1. Reese C.D. (Occupational Health and Safety Management: A Practical Approach, Third Edition, CRC Press, 2017.
2. Smedley J., Dick F., and Sadhra S. (Eds), Oxford Handbook of Occupational Health (2 ed.), Oxford University Press, 2013.
3. Dentch M.P., The ISO 14001:2015 Implementation Handbook: Using the Process Approach to Build an Environmental Management System , ASQ, 2016.
4. Hughes, P., & Ferrett, E. Introduction to Health and Safety at Work.
5. Goetsch, D. L. Occupational Safety and Health for Technologists, Engineers, and Managers.
6. ISO 45001:2018 – Occupational Health and Safety Management Systems (Standard Document).
7. Guidelines on occupational safety and health management systems ILO-OSH 2001, 2nd edition, International Labour Office. Geneva, ISBN 92-2-111634-4.

DETAILED SYLLABUS (DISSERTATION)

EN815: DISSERTATION - I

Course Objective (Summary): The course is aimed to highlight the basic concepts of Environmental Research. Students are expected to learn the basic components such as sample, population, sample design and sampling methods for qualitative and quantitative research. It will introduce the concepts of environmental research using various issues in the environment, hypothesis testing and drawing inferences of environmental data.

Course Learning Outcomes:

1	Students will learn the fundamentals of environmental research and their scope and uses.
2	Students will learn basic concepts of data collection, presentation and interpretation of environmental data using statistical and computing software.
3	Students will learn the knowledge of scientific research.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Dissertation work	Dissertation work: Introduction. Review, Methodology (Synopsis).	90

Suggested Readings:

1. Aho, A.V. and Ullman, J.D. (1992). *Foundation of Computer Science*, W.H. Freeman.
2. Aslam Mahmood (1976). *Statistical Methods in Geographical Studies*, Rajesh Publications, N. Delhi
3. Gupta. S.C. (1995). *Statistical Methods*, S. Chand & Co.
4. Gupta. S.C. and Kapoor V. K. (1995). *Fundamentals of Mathematical Statistics*, S. Chand & Co.
5. Medhi, J. (2013). *Statistical Methods: Introductory Text*, New Age International Ltd. Publishers.
6. Ranjan, V. (1997). *Fundamentals of Computer*, Prentice Hall of India, New Delhi.
7. Rosener, B. (1999). *Fundamentals of Biostatistics*, Duxbury Press.

EN816: DISSERTATION - II

Course Objective (Summary): The course is aimed to highlight the basic concepts of Environmental Research. Students are expected to learn the basic components such as sample, population, sample design and sampling methods for qualitative and quantitative research. It will introduce the concepts of environmental research using various issues in the environment, hypothesis testing and drawing inferences of environmental data.

Course Learning Outcomes:

1	Students will learn the fundamentals of environmental research and their scope and uses.
2	Students will learn basic concepts of data collection, presentation and interpretation of environmental data using statistical and computing software.
3	Students will learn the knowledge of scientific research.

Detailed Syllabus Content:

Unit	Unit Name	Detailed Syllabus	CH
I	Dissertation work	Dissertation work: Thesis writing: Experimentation, Results, Discussion and Conclusion. Thesis submission and viva.	180
