



DEPARTMENT OF ENVIRONMENTAL SCIENCE

NAGALAND UNIVERSITY

Lumami- 798627

Revised M.Sc. Syllabus 2024

(Major Revision)

M.Sc. Course Scheme and Syllabus

Outcome Based Education System (OBES)/ Learning

Outcomes based Curriculum Framework (LOCF)/ Choice

Based Credit System (CBCS)

(Revised 2024)

DEPARTMENT OF ENVIRONMENTAL SCIENCE
NAGALAND UNIVERSITY
Lumami- 798627

VISION

1. To produce finest manpower in the country to cater to the needs of the society.
2. To develop into state-of-art R&D hub of contemporary and classic environmental issues.

MISSION

1. To impart training for capacity building to tackle various Environmental challenges in a sustainable manner.
2. To provide holistic education to develop Environment leaders, policy makers and solution seekers.
3. To provide interdisciplinary and transformative research in the field of Environmental Science & Engineering.
4. To provide technological exposure to the students through industrial training programs.
5. To promote outreach activities for public awareness and societal benefit

ABOUT THE PROGRAM: M.Sc. ENVIRONMENTAL SCIENCE

The M.Sc. in Environmental Science programme of the Department of Environmental Science, Nagaland University comprises of four semester spread over a period of two years. Students would be required to earn 82 credits for award of the degree of M.Sc. (Environmental Science). The credits earned shall have a minimum of 78 credits by way of core courses offered by the department and 4 credits by way of Choice Based offered in the fourth semester by the department. The department shall announce the CBCS course available in the semester. The students shall convey in writing to the department at the start of the session, the name of the CBCS course they would be registering for.

The M.Sc. Degree programme in Environmental Science shall comprise of 21 core courses out of which 16 are theoretical, 4 are practical and 1 is study tour in nature. Each core course is of 4 credits (100 marks) except study tour which is of 2 credits (50 marks). The students shall be evaluated by way of continuous assessment (internal test, seminar and assignment) comprising 25% of the credit value (25 marks for all the papers). The duration of end semester examination for theory papers shall be 3 hours and practical papers 4 hours. Along with the core courses the students have to opt for one CBCS course of 4 credits (theory) offered in the fourth semester.

Besides this out of the four practical papers one paper shall be dissertation/project work. The topics for the project work will be allotted to individual students by their mentor in the start of the fourth semester and project report (dissertation) will have to be submitted and evaluated at the end of the fourth semester. The project work shall be of 4 credits (100 marks) and the marks shall be awarded on the basis of the dissertation (75%) and presentation (25%) of the project report.

There will be three internal assessment (two test, one assignment cum seminar) per paper (both theory and practical separately) and one must appear in at least two internal assessments failing which he/she will not be allowed to write the end semester examination. In internal assessment a student must score a minimum of 40% marks to qualify for the end semester examination. Each student must attend at least 75% of the classes in individual paper failing which students will not be allowed to write the end semester examination.

DEPARTMENT OF ENVIRONMENTAL SCIENCE
Revised Syllabus for M.Sc. in Environmental Science Programme
YEAR-2024
TOTAL CREDIT: 82, TOTAL MARKS: 2050

Sem ester	Course No.					Total Marks=2050 Total Credit=82	
		Course Title	Credit	Nature	Internal	End- term	Total Marks
I	ES-101	Fundamentals of Environmental Science	4	T	25	75	100
	ES-102	Environmental Chemistry	4	T	25	75	100
	ES-103	Environmental Biology	4	T	25	75	100
	ES-104	Earth Surface Processes	4	T	25	75	100
	ES-105	Practical – I	4	P	25	75	100
II	ES-201	Environmental Pollution & its Control	4	T	25	75	100
	ES-202	Ecology & Environment	4	T	25	75	100
	ES-203	Disaster Management and GIS Applications	4	T	25	75	100
	ES-204	Environmental Management, Assessment and Legislation	4	T	25	75	100
	ES-205	Practical – II	4	P	25	75	100
III	ES-301	Meteorology & Climatology	4	T	25	75	100
	ES-302	Biodiversity Conservation	4	T	25	75	100
	ES-303	Environmental Analytical Methods	4	T	25	75	100
	ES-304	Waste Management	4	T	25	75	100
	ES-305	Practical-III	4	P	25	75	100
	ES-306	Industrial Visit/ Study Tour and Report Writing	2	P	-	-	50
IV	ES-401	Energy & Environment	4	T	25	75	100
	ES-402	Research Aptitude & Biostatistics	4	T	25	75	100
	ES-403	Contemporary Environmental Issues & Sustainability	4	T	25	75	100
	ES-404	*CBCP A. Remote Sensing & GIS B. Wildlife & Conservation Biology C. Environmental Health and Toxicology	4	T	25	75	100
	ES-405	Project Work and Dissertation Seminar	4	P	25	75	100
			82				2050
*A student will choose any one of the CBCPs offered by the department in 4 th Semester.							

PROGRAM SPECIFIC OUTCOMES (PSOs)

The MSc programme aims to produce skilled and employable human resources in the field of Environmental Science and allied disciplines that possess:

1. A potential to articulate the interconnected and interdisciplinary nature of environmental studies and be able to communicate complex environmental information to both technical and non-technical audiences;
2. A fundamental perceptive of environmental science principles and their application to environment management, conservation, resource exploitation, international climatic issues, mitigation measures, sustainable development and related issues.
3. A competence to amalgamate hypothesis, technical knowledge and appropriate procedures in effectively analyzing and solving environmental degradation, resource depletion, climate change, urban sprawling and other related problems.
4. Proficiency to reflect critically on their roles, responsibilities, and identities as citizens, consumers and environmental actors in a complex, interconnected world.

COURSE CODE: ES 101

COURSE TITLE: Fundamentals of Environmental Science

COURSE OUTCOMES:

- CO1.** Ability to demonstrate comprehensive understanding of the environment, environmental processes, theories and ethics.
- CO2.** Ability to describe the mechanism of interactions between different spheres of environment.
- CO3.** Ability to recognize, describe resource management and sustainability

COURSE CONTENT:

Unit- I: Introduction to the Environment:

Meaning; Principles and scope of Environmental Science; Multidisciplinary and interdisciplinary nature of Environmental Science; Environmental factors; The Global environment and its segments; Environmental Education and awareness; Concept of Eco-clubs and Eco Mark; Structure and composition of atmosphere; hydrosphere, lithosphere and biosphere.

Unit-II: Natural Resources and its Conservation:

Definition; Types of natural resources and its management; Land Resource; Water Resource; Mineral Resource; Forest Resource; Marine Resource; Energy Resource; Problems associated with the exploitation of resources; Natural resource conservation strategies.

Unit-II: Environment, Society and Ethics:

Society and environmental issues; Environment and human health; Population explosion; Poverty; Nexus between development, energy and the environment; Environmental episodic events; Environmental ethics and global imperatives; Organic Farming; Integrated Pest Management (IPM); Environmental Restoration.

Unit-IV: Basics of Watershed Management:

Wetlands - definition and classification; Hydrologic regimes- Reduction of flash flood; Storage of water; Role in ground water recharge; Watershed Management- Concept, objectives, planning and measures; Land use planning for watershed management; Flood control and watershed management, Socio-economic aspects of watershed management.

Suggested Readings:

1. Wright, R.T. & Nebel, B. J., Environmental Science: Toward a Sustainable Future, 10th Ed. Pearson Educational, 2007.
2. Manahan, S. E., Environmental Science & Technology – A sustainable approach to Green, Science and Technology, Taylor & Francis, 2006.
3. Allaby, M., Basics of Environmental Science, Taylor & Francis, 1996.
4. Jackson, A.R.W. and Jackson, J. M., Environmental Science - The natural environment and human impact (2nd ed.), Prentice Hall, 2000.
5. Masters, G. M., Introduction to Environmental Science and Engineering (2nd Ed.), Pearson Education, 2004.

6. Charles, P. and Vincent, J.R., Natural Resource Accounting and Economic Development: Theory and Practice, Edward Elgar Publishing Ltd. U.K., 2003.
7. Haab, T. and Mc Connell, K.E., Valuing Environmental and Natural Resources, Edward Elgar Publishing Ltd. U.K., 2003.
8. Bell, M.M., An Invitation to Environmental Sociology (4th ed.), Pine Forge Press, SAGE, Landon, 2012.

COURSE CODE: ES 102

COURSE TITLE: Environmental Chemistry

COURSE OUTCOMES:

- CO1.** Develop concepts of basic chemistry associated with the occurrence of environmental pollutants.
- CO2.** Understand various chemical constituents present in air and water, interactions among them and manner in which changes are brought about due to pollution.
- CO3.** Analyze the toxic chemical behaviour in environmental.
- CO4.** Familiarize with the latest green chemistry principle and applied in daily life for pollution reduction

COURSE CONTENT

Unit-I: Fundamentals of Environmental Chemistry:

Concept and scope of Environmental Chemistry; Classification of Elements; Acid base reactions; pH and pOH; Buffer solutions; Oxidation and reduction; Stoichiometry; Gibbs energy; Chemical potential; Chemical equilibrium; Unsaturated and saturated hydrocarbons; Radionuclides; Solution chemistry; Solubility product; Solubility of gases; Chemical Kinetics; Catalysis; Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, Ozone, PAN, MIC and other carcinogens; Concept of green chemistry; Green technology and synthesis process.

Unit-II: Atmospheric Chemistry:

Chemical composition of the atmosphere; Chemical speciation; Chemical processes in the formation of inorganic and organic matter; Chemical and photochemical reactions in the atmosphere; Photochemical Smog; Ozone chemistry; Concept of atmospheric aerosol chemistry; Greenhouse gases and global warming

Unit-III: Soil & Water Chemistry:

Chemical & mineralogical composition of soil; Biogeochemical cycles: Nitrogen, Carbon, Phosphorus and Sulphur; The carbonate system; Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters- DO, BOD, COD, pH and Redox potential.

Unit-IV: Geochemistry:

Elements, atoms and chemical bonds; Geochemical classification of elements; Abundance of elements in bulk earth, crust, hydrosphere and biosphere; Partitioning of elements during

surficial geologic processes; Geochemical recycling of elements; Introduction to mineral structures and compositions; The earth's core and its composition; Mantle geochemical reservoirs.

Suggested Readings:

1. De, A. K., Environmental Chemistry (8thed.), New Age Publishing Pvt. Ltd., New Delhi, 2016.
2. Manahan, S.E., Fundamental of Environmental Chemistry (8th ed.), CRC Press, Florida, 2004.
3. Shaw, I.C. and Chadwick J., Principles of Environmental Toxicology, Taylor& Francis ltd, 2008.
4. Gupta, P.K., Methods in Environmental Analysis- Water, Soil and Air, Agrobios, 2000.
5. Connell, D.W., Basic Concept of Environmental Chemistry, Lewis, 1997,
6. Moore, J. W. and Moore, E. A., Environmental Chemistry, Academic Press, New York, 1976.
7. Vantoon, G. W. & Duffy, S. J., Environmental Chemistry – A global perspective (4thed.) Oxford University Press, U.K. 2017.
8. Koren, H., Handbook of Environmental Health and Safety – principle and practices (Vol. II) Lewis Publishers, Chelsea U.K., 1991.
9. Weil, R.R. and Brady, N. C., Nature and Properties of Soil (15thed.) Pearson Education, U.K., 2016.

COURSE CODE: ES 103

COURSE TITLE: Environmental Biology

COURSE OUTCOMES:

- CO1.** To understand the fundamental principles of various subjects in context of environmental related studies.
- CO2.** To have a thorough understanding of the applications of microbiology and biotechnology, as well as strategies for environmental protection.
- CO3.** To understand the integrative approach to developing sustainable solutions to address environmental issues.
- CO4.** Able to examine bioethical concerns relating to the safe handling of genetically modified crops and think critically for the production of biodegradable and environmentally friendly products.

COURSE CONTENT

Unit-I: Environmental Biochemistry:

Biomolecules; Protein structure and their biological functions; Nucleic acids, types and their biological functions; Energy metabolism; Phosphorylation; Photorespiration; Environmental pollutants and their effects on living system; Mutation and mutagenic agents and their significance; Stress biochemistry; Biodegradation and biotransformation of pollutants; Role of cytochrome P₄₅₀.

Unit-II: Environmental Biophysics:

Principle of thermodynamics; Homeostasis; Living system and entropy changes; ATP Bioenergetics; Conduction of impulses; Radiation and molecular response; fundamental and applied aspects of extremely low frequency; Photobiology; Bioluminescence; Magnetic environments and geomagnetism.

Unit-III: Environmental Microbiology:

Classification, characteristics, occurrence, distribution and ecological importance of microorganism; Sampling techniques; Culturing of Microorganisms: Types and composition of culture media and sterilization; Microbial interactions and associations; Microbial toxins and their role in environment; Micro-organisms and their association with animals and plants; Major water borne diseases and air borne microbes; Indicator microorganisms and their quantification; Bio-fouling; Bio-corrosion; Microbiological application for human welfare; Application of extremophiles in pollution studies; Role of microbes in biogeochemical cycles; Microbiological management of hazardous waste and wastelands.

Unit-IV: Environmental Biotechnology:

Concept of Genetic Engineering and its applications; Selection for nutritional quality, disease resistance, salt and drought tolerance; Concept of gene pool and gene-bank; Conservation techniques; Tissue culture technology; Enzyme technology; Fermentation technology, Vermiculture technology and Bio-fertilizer technology; Bio-pesticides; Microbes in the recovery of minerals; Microbes in energy production; Microbial biomass or single cell protein production; Bioindicators; Biosensors; Bioremediation technology; Cell immobilization in waste treatment; Release of genetically engineered microbes and environmental risk.

Suggested Readings:

1. Mahapatra, P. K., Textbook of Environmental Biotechnology, Amazon, 2008.
2. Hames, D. and Hooper, N., Biochemistry, Taylor and Francis, 2010.
3. Wilson, K. and Walker, J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, 2009.
4. Odum, E.P. and Barrett, G.W., Fundamentals of Ecology (5th Revised ed.), Brooks Cole, 2004.
5. Kormondy, E. J., Concepts of Ecology, Prentice Hall of India, 1994.
6. Rao, K. S., Practical Ecology, Anmol Publication Pvt. Ltd., 1998.
7. Smith, R.L. and Smith, T.M., Ecology and Field Biology (6th ed.), Benjamin Cummings, San Francisco, 2001.
8. Ricklefs, R.E. and Miller, G.L., Ecology (4th ed.), W H Freeman and Company England, 2000.
9. Bingro, H., Plants- Environment Interaction (3rd ed.), Taylor & Francis Group, 2007.
10. Gurevitch, J., Scheiner, S.M. and Fox, G.A., The Ecology of Plants, Sinauer Associates, Inc. Sunderland, MA, U.S.A. 2002.

COURSE CODE: ES 104

COURSE TITLE: Earth surface processes

COURSE OUTCOMES:

- CO1.** Understand the form, physical properties, composition, function, and evolution of Earth's surface
- CO2.** This course explores surface processes across Earth's dynamic landscapes.
- CO3.** The course introduces methods for analysing and predicting landform change, and provides a foundation for managing geomorphic issues impacting society and the environment.

COURSE CONTENT

Unit-I: Earth's Geodynamics:

Origin and evolution of the earth- Nebular hypothesis, Revised Nebular Hypothesis, Binary Theory, Big Bang Theory; Earth's structure- Crust, Mantle, Core; lithosphere; Isostasy and isostatic adjustments; Plate tectonics- Theory of Plate tectonics, Major Tectonic Plates, Convergent, Divergent and Transform Boundaries, Plate tectonics and sea floor spreading; Concepts of stress and strain; Types of stress- Tensional, Compressional, Shear; Folds and faults; Types of folds- Symmetrical, Asymmetrical, Isoclinal, Overturned, Recumbent, Chevron; Types of faults - Normal, Reverse/thrust, Strike-slip.

Unit-II: Earth's Materials:

Weathering of rocks- Physical, Chemical and Biological; Controls on weathering, Rocks and rock types - Igneous, Metamorphic and Sedimentary; Mass-wasting; Factors that influence mass wasting processes; Mass movements; Slow movements- Creeping, Solifluction, Earthflow, Rapid movements- Mudflow, Debris Avalanche, Landslides, Major causes of mass movements; Soil formation process- Weathering, Accumulation of materials, Leaching, Transformation, Calcification; Factors affecting soil formation- Parent material, Topography, Climate, Organisms, Time, Soil profile; Soil types in India- Alluvial Soil, Black Cotton Soil, Red Soil, Laterite Soil, Mountainous or Forest Soils, Arid or Desert Soil Saline and Alkaline Soil, Peaty, and Marshy Soil/Bog Soil; Mineral and mineral deposits, Classification of mineral deposits, Major Minerals in India.

Unit-III: Hydrology:

Hydrologic cycle and hydrologic budget; Human impacts on hydrological cycle; Surface and sub-surface environment in hydrology; Drainage Pattern- Dendritic, Parallel, Trellis Rectangular, Radial, Centripetal; Types of stream- Perennial, Ephemeral, Intermittent; Stream ordering; Types of lakes found in India – Freshwater, Saltwater, Natural, Oxbow, Artificial, Crater; Ground water- Saturation zone, Water table, Soil moisture, Aquifers, Abstraction of groundwater, Environmental influences on ground water, Ground water recharging, Artificial recharge; Rain water harvesting- Components of a rainwater harvesting system and its positive impacts.

Unit-IV: Geomorphology:

Geomorphology, Endogenic and Exogenic forces; Erosion, Transportation, Deposition and development of landforms; Fluvial processes and landforms- Drainage basins, transport and deposition of sediments, Landforms associated with fluvial processes; Glacial processes and landforms- ice flow patterns and temperatures, Glacial budgets, Glacial erosion, Transportation and deposition of material, landforms of glacial erosion, landforms of glacial deposition, glacial meltwater processes and associated landform; Coastal processes and landforms- Tides, Waves and Currents, Depositional and Erosional coasts, Coastal processes and Landforms, Deltas and Estuaries; Aeolian processes and Landforms , Factors affecting wind erosion; Karst Landforms

Suggested Readings:

1. Grotzinger, J. and Jordan, T.H., Understanding Earth (7th ed.), W.H. Freeman and company, 2014.
2. Valdiya, K. S., Environmental Geology, Tata McGraw-Hill, 1987.
3. Strahler, A.N. and Strahler, A.H., Environmental Geoscience - Interaction between Natural Systems and Man, Santa Barbara, California: Hamilton Publishing, 1973.
4. Bell F.G., Environmental Geology - Principles and Practice, Blackwell Science, 1998
5. Valdiya, K. S., Environmental Geology, Tata McGraw-Hill, 1987.
6. Singh, V. P., Elementary Hydrology, Prentice-Hall, India, 1994.
7. Chow, V.T., Handbook of Applied Hydrology, McGraw-Hill, New York, 1964).
8. Sear, D.A., Newson, M.D., Thorne, C.R., Guidebook of applied fluvial geomorphology, Thomas Telford Ltd., 2009.
9. Leopold, L. B., Wolman, M.G., Miller, J. P., Fluvial processes in geomorphology, Dover Publications, New York, 1992.

COURSE CODE: ES 105

COURSE TITLE: Practical – I

COURSE OUTCOMES:

- CO1:** Accustomed with application of meteorological instruments
- CO2:** Learn culturing and identification of microbes using the basic and advanced tools
- CO3:** Understanding of laboratory techniques applied for conservation of biological resources
- CO4:** Estimate the pollution levels in water, wastewater and soil

COURSE CONTENT

1. Analysis of Seismogram and identification and interpretation of various phases; Determination of epicentre of an earthquake using P- and S-wave travel time difference.
2. Isolation and culturing of microbes from soil/water samples.
3. Gram staining of isolated bacterial sample.
4. Estimation of Biomolecules.
5. Bacterial examination of water–Total and Faecal coliforms by MPN and MF techniques.
6. Familiarization with meteorological instruments and their use.
7. Potentiometric experiments – Estimation of halides in water samples.
8. Physicochemical Analysis of Soil.

Suggested Readings:

1. Mahapatra, P. K., Textbook of Environmental Biotechnology, Amazon, 2008.
2. Hames, D. And Hooper, N., Biochemistry, Taylor and Francis, 2010.
3. Wilson, K. and Walker, J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, 2009.
4. Smith, R.L. and Smith, T.M. Ecology and Field Biology, (6th ed.), Benjamin Cummings, San Francisco, 2001.
5. Ricklefs, R.E. and Miller, G.L., Ecology (4th ed.), W H Freeman and Company England, 2000.
6. Ibanez, J.B., Hernandez-esparza, M.H., Doris Serrano ArturoFregoso-Infante, C., Singh, M.M., Environmental Chemistry Fundamentals, Springer, 2007.
7. Grotzinger, J. and Jordan, T.H., Understanding Earth (7th ed.), W.H. Freeman and company, 2014.
8. Fifield, F.W. and Haines, P.J., Environmental Analytical Chemistry, Blackwell, 1998.
9. Keith, L.H., (edited) Principles of Environmental Sampling, American Chemical Society, 1988.
10. Clesceri, L.S., Standard Methods for Examination of Water and Waste Water (28th ed.), American Public Health Association, 1998.
11. Lodge, J.P. Jr., (edtr) Methods of Air Sampling and Analysis, Lewis, 1988.

COURSE CODE: ES 201

COURSE TITLE: Environmental Pollution and its Control

COURSE OUTCOMES:

- CO1:** Develop concepts of basic chemistry associated with the occurrence of environmental pollutants.
- CO2:** Understand various chemical constituents present in air and water, interactions among them and manner in which changes are brought about due to pollution.
- CO3:** Analyze the toxic chemical behaviour in environment.
- CO4:** Acquaintance with the latest green chemistry principle and applied in daily life for pollution reduction.

COURSE CONTENT

Unit-I: Introduction:

Definition; Classification of pollutants and their global, regional and local aspects; Transport, transformation and fate of chemicals in the environment. Dispersion of air pollutants, Mixing height/depth, Environmental lapse rates, Gaussian plume model, line source model and area source model.

Unit-II: Water Pollution:

Types and sources of water pollutants; Effects on human, plants and animals; Treatment of water and waste water; Indian standards for drinking water; Eutrophication- Causes, effects and control measures; Important pollution parameters- DO, BOD and COD; Effect of oil pollution

on marine ecology; Thermal Pollution: Sources, Chemical and Biological effects; Control measures.

Unit-III: Air & Noise Pollution:

Types and sources of air pollutants; Effects of air pollutants on flora and fauna; Management of air pollution- Control of air pollutants through adsorption, absorption, condensation, and combustion; Particulate matters- SPM and RSPM, PM₁₀ & PM_{2.5}; Control devices for particulate matter; Euro and BS vehicular pollution Norms; AQI; Indoor air pollution. Sources of Noise Pollution- Measurement and analysis of sound; Adverse impacts, Measures to control noise pollution.

Unit-IV: Soil & Nuclear Pollution:

Causes of soil pollution; Pesticides and Synthetic fertilizers- Types, Toxicity and Pollution, Impacts of soil pollution; Solid waste pollution and its Management; Pollution due to Hazardous waste, its effects and management- Treatment Methods and final disposal; Pollution due to E-waste- Classification, Effects and Methods of handling and disposal; Plastic Pollution- Sources, Consequences and Management; Radioactive decay; Biological impact and health hazards associated with radiation.

Suggested Readings:

1. De, A. K., Environmental Chemistry (8th ed.), New Age Publishing Pvt. Ltd., New Delhi, 2016.
2. Manahan, S.E., Fundamental of Environmental Chemistry (8th ed.), CRC Press, Florida, 2004.
3. Shaw, I.C. and Chadwick J., Principles of Environmental Toxicology, Taylor & Francis Ltd, 2008.
4. Gupta, P.K., Methods in Environmental Analysis- Water, Soil and Air, Agrobios, 2000.
5. Connell, D.W., Basic Concept of Environmental Chemistry, Lewis, 1997,
6. Vantoon, G.W. & Duffy, S.J., Environmental Chemistry- A global perspective (4th ed.) Oxford Press.
7. Koren, H., Handbook of Environmental Health and Safety – principle and practices (Vol.II) Lewis Publishers, Chelsea U.K., 1991.
8. Weil, R.R. and Brady, N. C., Nature and Properties of Soil (15th ed.) Pearson Education, U.K., 2016.
9. Keith, L.H., (edited) Principles of Environmental Sampling, American Chemical Society, 1988.
10. Clesceri, L.S., Standard Methods for Examination of Water and Waste Water (28th ed.), American Public Health Association, 1998.

COURSE CODE: ES 202

COURSE TITLE: Ecology and Environment

COURSE OUTCOMES:

- CO1.** Ability to demonstrate sound understanding on scientific inquiry in the field of modern ecology.
- CO2.** Ability to structure and functions of ecosystem.

CO3. Ability to examine the main limitations/ stress on patterns of productivity, energy flow through natural food webs, and ecosystems dynamics.

CO4. Ability to set up basic and advanced ecological sampling techniques in different ecosystems.

COURSE CONTENT

Unit-I: Ecosystem Ecology:

Basic concepts in ecology; Level of organization in ecology; Applied ecology; Environmental complexes; Interaction of ecological factors; Types of ecosystems (Hot and Cold deserts, Forest, Rangeland, Wetlands, Lotic, Lentic, Estuarine, and Marine), structure, functions, and economic importance; Major biomes of the world (Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chaparral, Savanna, Tropical rain forest); Bio-geographical regions of India.

Unit-II: Ecological Energetic:

Energetics, Energy flow models, Food chain and Food web; Concepts of productivity, standing crops and factors affecting productivity; Ecological Pyramids-types, Ecological succession-concept, causes and trends; Ecological indicators; Ecological efficiencies; Ecosystem stability and factors affecting stability; Ecosystem services; Biogeochemical cycles in ecosystems; Concept of industrial ecology.

Unit-III: Community Ecology:

Concept of biotic community, Community diversity, Structure, Dominance, Stratification and periodicity; Types and interaction- Predation, Herbivory, Parasitism and Allelopathy; Ecotones, Concept of edge effect; Ecological habitats and niche; Fundamental and realized niche; Gause's Principle; Foundation species; Flagship species; Keystone species; Biological invasions.

Unit-IV: Population Ecology:

Concept of population ecology; Population characteristics; Density, Natality, Mortality, Biotic potential, Survivorship curves, Age distribution, Growth curves, Growth regulatory factors; Exponential Growth Model and Logistic Growth Model; r and k selection; Population interaction; Prey-Predator Relationship; Population Models- Lotka-Volterra model and Leslie's matrix model; Different ecological principles and limiting factors (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept of limiting Factors).

Suggested Readings:

1. Odum, E.P. and Barrett, G.W., Fundamentals of Ecology (5th Revised ed.), Brooks Cole, 2004.
2. Kormondy, E. J., Concepts of Ecology, Prentice Hall of India, 1994.
3. Rao, K. S., Practical Ecology, Anmol Publication Pvt. Ltd., 1998.
4. Smith, R.L. and Smith, T.M., Ecology and Field Biology (6th ed.), Benjamin Cummings, San Francisco, 2001.
5. Ricklefs, R.E. and Miller, G.L., Ecology (4th ed.), W H Freeman and Company England, 2000.
6. Bingro, H., Plants-Environment Interaction (3rd ed.), Taylor & Francis Group, 2007.
7. Gurevitch, J., Scheiner, S.M. and Fox, G.A., The Ecology of Plants, Sinauer Associates, Inc. Sunderland, MA, U.S.A. 2002.

8. Global Biodiversity strategy: WRI, IUCN & UNEP Reports.

COURSE CODE: ES 203

COURSE TITLE: Disaster management and GIS applications

COURSE OUTCOMES:

- CO1.** Provides basic conceptual understanding of disasters and approaches of Disaster Management
CO2. Familiarize hazards and build skills to respond to disaster

COURSE CONTENT:

Unit 1: Introduction on Disaster Management:

Different types of Disaster including cause and effects- Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc and Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc.

Unit 2: Risk and Vulnerability Assessment:

Two components of risk- Likelihood and Consequences; Qualitative likelihood measurement index; Categories of consequences (Direct losses, Indirect losses, Tangible losses and Intangible losses).

Unit 3: Disaster management:

Basic principles of disasters management; Disaster Management cycle; Disaster management policy; National and State Bodies for Disaster Management; Early Warning Systems; Building design and construction in highly seismic zones; Retrofitting of buildings; Community planning and education, Hazard zonation and mapping- Risk Reduction Measures; Past disaster events in India and role of government bodies; Armed forces and media in disaster management.

Unit -IV: Role of GIS in disaster management:

Remote sensing and GIS; GIS components; Application of GIS in hazard, risk & vulnerability assessment, Role of remote sensing and GIS in surveillance- Monitoring, Risk assessment, Estimation of losses and planning.

Suggested Readings:

1. Keith S., Environmental Hazards - Assessing Risk and Reducing Disaster, Routledge, New York, 2013.
2. Bell F.G., Geological Hazards: Their Assessment, Avoidance & Mitigation, Taylor and Francis, 2003.
3. Nicolas R. Dalezios, Environmental Hazards: Methodologies for Risk Assessment and Management, IWA publisher, 2017.
4. Shailesh N., Sisi Z., Remote Sensing and GIS Technologies for Monitoring and Prediction of Disasters

COURSE CODE: ES 204

COURSE TITLE: Environmental Management, Assessment and Legislation

COURSE OUTCOMES:

- CO1.** Students will learn various environmental management systems, tools, techniques, standards and their guidelines and requirements.
- CO2.** Students will learn skills for environmental impact assessment, EMS implementation and evaluation of environmental performance for better environmental decision-making.
- CO3.** Students will learn important national and international environmental legislations and rules and can analyze the legal procedure/Compliances required for sustainable business development.
- CO4.** Students will learn best practice techniques, ecofriendly behaviours to achieve continual improvement in an organization.

COURSE CONTENT:

Unit-I: Environmental Management Systems:

Concept, scope, approaches and benefits of EMS; EMS models; Accreditation and Standards- International and National, ISO-14000 & 14001 series, IS & BIS; Environmental auditing- Scope and objectives, standards, procedures and benefits; Ecosystem Management- Ecotourism, Heritage management, Eco-restoration; Ecomark scheme; Environmental/Green tax; Product design for the environment (ISO-14062); Principles of clean production and Packaging; Total Environmental Quality Management (TQEM); Ecolabelling; Environmental Performance Index; Ecological and Carbon footprints.

Unit-II: Environmental Assessment Tools and Techniques:

Environmental Impact Assessment (EIA)- Origin and Development, Definitions and Objectives; Scope and Advantages; The EIA Process- Screening, Scoping and consideration of alternatives, Baseline study, Impact identification and prediction, Evaluation and mitigation, Environmental Management Plan (EMP), Public consultation and participation, Environmental Impact Statement (EIS); Assessment methodologies- Ad-hoc, Overlay, Network, Matrix, Checklist and Cost benefit analysis; Post EIA Monitoring and Auditing; The Indian EIA regime- Notifications, Guidelines, Project categories requiring Environmental Clearance (EC), Procedure for EC, EIA expert committee and Stakeholders; EIA case studies- River valley projects, Mining, Power plants, Highways etc.; Overview to LCA and ERA.

Unit-III: International Environmental Legislations:

Fundamental principles of Environmental laws, Evolution and development of International Environmental rules and regulations with reference to Stockholm Conference, Rio Conference, Rio+10, Rio+20, Agenda 21, MAB programme and Paris Agreement; Global Environment Facility (GEF); Johannesburg Earth Summit; Millennium Development Goals; International conventions and protocols to control various environmental issues- Ramsar convention, CBD, UNFCCC, Kyoto protocol, Montreal protocol; Cartagena protocol on Bio-safety, CITES, Nagoya protocol etc.

Unit-IV: Indian Environmental laws:

Overview of legal and regulatory framework for environmental protection in India- Constitutional provisions (Article 48A and 51A); Wildlife Protection Act, 1972; Forest Conservation Act, 1980; Indian Forest Act revised, 1982; Public Liability Insurance Act, 1991, The water Act, 1974; The Air Act, 1981; The Environment Protection Act, 1986; Wild Life Protection Act, 1972; The Biodiversity Act, 2002 and its amendment in 2021; The Forest Dweller's Act, 2006; The Hazardous and other waste (Management and Transboundary Movement) Rules, 2016 & 2021; The Plastic Waste Management Rules, 2016; The Bio-medical Waste Management Rules, 2016; The Municipal Solid Waste Management Rules, 2016; The Batteries (Management and Handling) Rules, 2010; Noise Pollution (Regulation and Control) Rules, 2000; E-Waste management Rules, 2022; Coastal Regulation Zone Notification, 1991; National Green Tribunal Act, 2010; National policies on Forest (1988), Water (2002) and Environment (2006).

Suggested Readings:

1. White, P.R. et al., Integrated Solid Waste Management, Lewis Publisher, 1989.
2. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Govt. Of India, New Delhi, 2000.
3. David, L.H.F. and Liptak, D.G., Hazardous waste and solid waste, Lewis Publisher, 2000.
4. Oberoi, N.K, Environmental Management, (2nd ed.), Excel Books, New Delhi, 2003.
5. Glasson, J., Therival, R., Chadwick, A., Introduction to Environmental Impact Assessment (4th ed.), Routledge, 2011.
6. Morgan, R.K., Environmental Impact Assessment – A Methodological Approach, Springer, 1998.
7. All guidelines and notifications of Government of India related to EIA rules.
8. Dev, A., Dev, I.A., Das, S., Human Right: A Source Book, NCERT, 1996.
9. Thomas, J.M. and Callan, S.J., Environmental Economics and management: Theory Policy and applications (5th ed.), South-Western CENGAGE Learning, Ohio, U.S.A. 2009.
10. Marshall, G.R., Economics of Collaborative Environmental Management: Renegotiating the commons, Earthscan, U.K. and U.S.A., 2005.
11. Solid Waste Management Manual CPCB, New Delhi.

COURSE CODE: ES 205

COURSE TITLE: Practical – II

COURSE OUTCOMES:

- CO1:** Apply the appropriate method of physico-chemical analysis of water and waste water to research and in field applications.
- CO3:** Estimate the pollution levels in water and wastewater.
- CO4:** Familiarization of Remote Sensing and GIS Techniques
- CO5:** Ability to examine the structure, functioning, and processes of different ecosystems.
- CO6:** Apply techniques for qualitative and quantitative sampling of plant diversity
- CO7:** Design scientific methods/experiments to study various ecological parameters and biodiversity in laboratory/field conditions

COURSE CONTENT

1. To familiarize with modules of ArcGIS Software.
2. Estimation of return period and probability of occurrence of flood.
3. Analysis of Physicochemical parameters of Water and Wastewater Samples.
4. Estimation of flora and fauna population (seen) by quadrat method.
5. Study of Ecological adaptations – a) Hydrophytes and xerophytes, b) Rocky shore and sandy shore fauna.
6. Estimation of chlorophyll in terrestrial plants.
7. Estimation of biomass/standing crop of a terrestrial habitat.

Suggested Readings:

1. Mahapatra, P. K., Textbook of Environmental Biotechnology, Amazon, 2008.
2. Hames, D. and Hooper N., Biochemistry, Taylor and Francis, 2010.
3. Wilson, K. and Walker, J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, 2009.
4. Gupta, P.K., Methods in Environmental Analysis- Water, Soil and Air, Agrobios, 2000.
5. Keith, L.H., (edited) Principles of Environmental Sampling, American Chemical Society, 1988.
6. Clesceri, L.S., Standard Methods for Examination of Water and Waste Water (28th ed.), American Public Health Association, 1998.
7. Lodge, J.P. Jr., (edtr) Methods of Air Sampling and Analysis, Lewis, 1988.

COURSE CODE: ES 301

COURSE TITLE: Meteorology & Climatology

COURSE OUTCOMES:

- CO1.** Ability to demonstrate sound understanding of the atmosphere and climate as integral part of the physical environment.
- CO2.** Ability to appreciate the interaction between earth and atmosphere system, particularly the microclimate
- CO3.** Ability to integrate and use meteorological knowledge in the matrices of environmental research

COURSE CONTENT:

Unit-I: Earth's Atmosphere:

An introduction to Earth's atmosphere, composition of the atmosphere, constant and variable gasses; Vertical structure of the atmosphere- Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere; Significance of Earth's atmosphere; Origin and Evolution of the Atmosphere- History and addition of oxygen to the Atmosphere; Clouds and humidity; Absolute and Relative Humidity; Formula of Relative Humidity; Pressure and density of atmosphere; Concept of cloud formation- Cloud condensation nuclei; Mechanisms of cloud formation; Terminology of Earth's atmosphere- Vapour pressure and atmosphere; Sublimation curve; condensation level; Factors leading to air rising and cooling- Surface heating, Topography, Frontal, Convergence, Turbulence; Types of clouds, High-level clouds- Cirrus, Cirrostratus,

Cirrocumulus; Mid-level clouds-Altostratus, Altocumulus; Low-level clouds- Stratocumulus, Nimbostratus

Unit-II: Earth-Atmosphere Heat Exchange:

Insolation and heat budget; Terminology – Latent heat, Albedo, Conduction, convection and radiation; Reflection, absorption, Scattering; Terrestrial radiation – Latent heat transfer, sensible heat transfer, Emission by vapour and clouds; electromagnetic radiation and its properties - Propagation of Light, Law of Reflection, Refraction, Dispersion, Superposition and Interference, Diffraction, Polarization, electromagnetic spectrum, solar intensity and angle of incidence, atmospheric heating and cooling process- Partial absorption of solar radiation by the atmosphere, Conduction, Terrestrial radiation, Convection and advection, Latent heat of condensation, Expansion and compression of the air; Adiabatic cooling and warming; Atmospheric scattering – Rayleigh, Mie and Non-selective scattering; Absorption; Earth's net flux, Earth-atmosphere energy balance.

Unit-III: Movement of Air:

Forces acting on horizontal movement of air - pressure gradient force, advection. centrifugal force, coriolis force, Turbulent drag; Wind components: Scales of motion, local wind systems, types of local winds - Sea breezes and land breezes, anabatic and katabatic winds, Foehn winds; thermal circulations; monsoon, Indian monsoon, westerly Jet stream, desert wind, loo, El-Nino, La-Nina; atmospheric circulation, single cell model, three cell model; horse latitudes, doldrums.

Unit-IV: Global Climate:

Climate change as per UNFCCC and IPCC; Natural and Man-made influences on climate change; Natural - volcanic eruptions, ocean currents, Earth's orbital changes, solar variations and internal variability; Anthropogenic - Burning of fossil fuels, Cutting down forests, farming livestock etc.; Global warming; Greenhouse gases; Causes for rising emissions; Countering climate change, Kyoto Protocol, Montreal protocol.

Suggested Readings:

1. Ahrens, C.D. and Henson, R., Meteorology Today (12th ed.), Brooks Cole, U.S.A, 2018.
2. Byers, H. R., General Meteorology, McGraw-Hill, 1974.
3. Trewartha, G.T., An Introduction to Climate, McGraw-Hill, 1968.
4. Oliver, J.E. and Hidore, J.J., Climatology: An atmospheric science (2nd ed.), Pearson Education, 2003.
5. Das, P.K., Monsoon (12th ed.), National Book Trust of India, 2013.
6. Bengtsson, F. O., Geosphere Biosphere Interaction and Climate, Cambridge University Press, 2001.
7. Berdowski, J., Guichert, R., Heil, B.A.A., The Climate System, Blakema Publisher, 2000.

COURSE CODE: ES 302

COURSE TITLE: Biodiversity Conservation

COURSE OUTCOMES:

CO1. Ability to demonstrate sound understanding on importance of biodiversity.

- CO2.** Ability to analyse the sustainable utilization and conservation.
- CO3.** Ability to critically analyse the socio-cultural dimensions and broad legal framework for conservation of biodiversity
- CO4.** Ability to develop new conservation strategies for new or endangered species in a specific area.

COURSE CONTENT

Unit-I: Introduction:

Concepts and components of biodiversity, significance, magnitude and distribution; biodiversity indices; Uses of biodiversity; Threats to biodiversity, major causes and extinctions; vulnerability of species to extinction; strategies for sustainable usage of biodiversity.

Unit-II: Strategies for Biodiversity Conservation:

In-situ conservation: sanctuaries, biospheres reserves, national parks, sacred grooves, and preservation plots; Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation of plant tissue culture; gene bank; pollen and spore bank; DNA bank; Biodiversity laws, legislation and treaties-CITES, TRAFFIC, CBD and Agenda 21; National Biodiversity Action Plan; National and State biodiversity conservation boards; People Biodiversity register.

Unit-III: Mega-diversity Zones and Biodiversity Hotspots:

Concepts; distribution and importance of megadiversity zones; Biodiversity hotspots; IUCN and other International NGO's helping in conservation; National and global red data lists; Categories of species and their management; Restoration of biodiversity; Acceleration of ecological succession; Reintroduction of biota; Methods for monitoring biodiversity trend; Threats to Biodiversity – Bio-invasions, and Bioterrorism.

Unit-IV: Bio-prospecting:

Concept of bioprospecting; biodiversity informatics; Eco-development committees and Eco-tourism; Wildlife distribution in India, problem in wildlife protection; Wildlife habitat management; Afforestation and Joint Forest Management-Social Forestry, Agro-Forestry and Urban forestry. IPRs; Patent protection and Biopiracy.

Suggested Readings:

1. Odum, E.P. and Barrett, G.W., Fundamentals of Ecology (5th Revised ed.), Brooks Cole, 2004.
2. Global Biodiversity strategy: WRI, IUCN & UNEP Reports.
3. Chapman, J.L. and Reiss, M.J., Ecology: Principles and Applications, Cambridge University Press, U.K., 1998.
4. Wilson, E.O., The diversity of life, Penguin Adult, 2001.
5. Pellens, R. and Grandcolas, P. (edition), Biodiversity conservation and phylogenetics systematics: preserving our evolutionary heritage in an extinction crisis (Vol. 14), Springer International, 2016.
6. Laladhas, K.P., Nilayangod, V.O., Oommen, P. (edition), Biodiversity for Sustainable Development, Springer International, 2017.

COURSE CODE: ES 303
COURSE TITLE: Environmental Analytical Methods

COURSE OUTCOME:

- CO1:** Understand the problem and identify suitable techniques to analyze the environmental samples.
- CO2:** Explain and use suitable sampling methods for collection of different samples to perform physical, chemical and biological characterization of environmental pollutants.
- CO3:** Appraise the principles, working and applications of the instrumental techniques used for analysis of physical, chemical and biological entities.
- CO4:** Differentiate between the various analytical methods and capable to design method required for quantitative and qualitative analysis of environmental components.

COURSE CONTENT

Unit-I: Analysis of Water, Soil and Air:

Sampling of water, soil and air; Sampling equipments; Sampling techniques; Physiochemical parameters (pH, DO, BOD and COD); Conductivity; Titrimetry; Gravimetry; Bomb Calorimetry.

Unit-II: Analysis of Metal Ions:

Working principal, instrumentation and application of Spectrophotometry (UV-Visible Spectrophotometry, Atomic Absorption Spectrophotometry, Flame photometry); Plasma emission spectroscopy (Induced Coupled Plasma Mass Spectrometer); X-Ray Spectroscopy (XRF and XRD); Scintillation counter; Refractometry.

Unit-III: Separation Techniques:

Principle and process of solvent extraction, Chromatography – principle and application of Paper chromatography, TLC and ion exchange chromatography; Gel permutation liquid chromatography (GPLC); Gas chromatography and Mass spectroscopy (GC-MS); High performance liquid chromatography (HPLC); Electrophoresis.

Unit-IV: Environmental Monitoring Techniques:

Anode Stripping Voltametry and Neutron activation analysis; Fluorescence techniques; Microscopic techniques; Instruments for nephelometry and turbidimetry and their applications, SEM; TEM; NMR, FT-IR.

Suggested Readings:

1. Banwell, C. N. and McCash, E. M., Fundamentals of Molecular Spectroscopy (5thed.), McGraw-Hill, 2013.
2. Hollas, J.M., Modern Spectroscopy (4thed.), John Wiley & Sons, Ltd., Chichester, 2004.
3. Drago, R.S., Physical Methods for Chemist, Saunders, 1992.
4. Williams, D. H. and Fleming, I., Spectroscopic methods in organic chemistry, Tata McGraw Hill, 1988.
5. Kemp, W., Organic Spectroscopy, ELBS Macmillan, 1991.

6. Fifield, F.W. and Haines, P.J., Environmental Analytical Chemistry, Blackwell, 1998.
7. Keith, L.H., (edited) Principles of Environmental Sampling, American Chemical Society, 1988.
8. Clesceri, L.S., Standard Methods for Examination of Water and Waste Water (28th ed.), American Public Health Association, 1998.
9. Lodge, J.P. Jr. (edition), Methods of Air Sampling and Analysis, Lewis, 1988.
10. Rump, H.H. and Krist, H., Laboratory Manual for the examination of water, waste water and soil (3rd ed.), VCH Publication, Weinheim, 1999.

COURSE CODE: ES 304

COURSE TITLE: Waste Management

COURSE OUTCOMES:

- CO1.** Engaging students in critical thinking and pursue research and development activities to solve waste management problems.
- CO2.** It will develop such learning which will induce professional skills to tackle multidisciplinary and complex problems of waste management.
- CO3.** Students will be able to design and develop feasible eco-friendly solutions various kinds of wastes.
- CO4.** It will develop entrepreneurial skills for waste management and to develop livelihood and economical options from waste to wealth ideas.

COURSE CONTENT

Unit-I: Solid Waste Management:

Types, Sources, Characteristics, generation rates; Components; Proximate and Ultimate analysis of Solid wastes; MSW management- Collection, Storage, Transportation and Disposal systems; Sanitary Landfills, Leachates and landfill gas management; Processing and recovery; Recycling; Biological and Thermal treatment of Solid wastes- Incineration, Co-combustion, Pyrolysis, Gasification, Refuse Derived Fuel; Biohydrogen and Biological Stabilization; National Action Plan on MSWM; Integrated SWM; Waste to Energy options; 3R and 5R concepts; Regulatory and legal frameworks for MSWM

Unit-II: Hazardous waste Management:

Definition, sources, classification and characteristics; Inventory; Health impacts; Collection, handling, storage and transport; Hazardous waste treatment technologies: Neutralization, Oxidation-Reduction, Precipitation; Solidification, Stabilization, Incineration; Disposal- TSDF concept; Recycling and reuse; Remediation of hazardous waste contaminated sites; Legacy wastes

Unit-III: Management of different Hazardous Wastes:

Characteristics, Types, Sources and Management and Health and environmental effects of Nuclear waste, Biomedical waste, E-waste and Plastic waste; Concept of CBWTF; Concept of EPR; Recycling; Energy production and other applications; Single Use Plastics (SUP)

Unit-IV: Liquid waste Management:

Definition and Classification of Waste water/Sewage; Sewage Characteristics; Sewage collection and disposal; Sewage/wastewater treatment- Primary, Secondary and Tertiary treatments; Physical, Chemical and Biological Treatments; Sewage Treatment Plants (STPs); Treatment Technologies- based on Attached growth process and Suspended growth process; Industrial waste water treatment with special reference to Sugar, Paper and Pulp and Textile industries; CETPs; Effluent treatment Standards.

Suggested readings:

1. LaGrega. 2004. Hazardous Waste Management. McGraw Hills
2. Mahajan 1985. Pollution control in process industries. Tata McGraw Hill
3. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel (2014)., 2nd Ed., CRC Press, USA.
4. Integrated Solid Waste Management, Engineering Principles and Management Issues, Tchobanoglous G, Theisen H and Vigil SA, McGraw Hill Education, 2014, Indian Edition
5. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition
6. Plastic Waste Management, 2024; Kalim Deshmukh, Jyotishkumar Parameswaranpillai, John Wiley & Sons
7. Handbook of electronic waste management: international best practices and case studies. Prasad, M. N. V., Vithanage, M., & Borthakur, A. (Eds.). (2019). Butterworth-Heinemann.
8. E-Waste Management: Challenges and Opportunities in India. Bhagat-Ganguly, V. (2021). Routledge India.
9. Biomedical waste management in hospitals. Latha, G., & Rajasekhar, M. (2021). Lulu Publication.
10. Wastewater treatment: advanced processes and technologies. Rao, D. G., Senthilkumar, R., Byrne, J. A., & Feroz, S. (Eds.). (2012). CRC Press.

COURSE CODE: ES 305

COURSE TITLE: Practical III

COURSE OUTCOMES:

- CO1:** Assess the noise pollution and possible measures to control the noise level for minimizing the impact.
- CO2:** Apply techniques for qualitative and quantitative sampling of plant diversity
- CO3:** Analyze the structural and functional components of a population as an ecological entity.
- CO4:** Explain the concept of the biological community as well as its alterations and interactions.
- CO5:** To Georeference & Project Satellite Imagery.
- CO6:** To gain skills in using statistical software.

COURSE CONTENT

1. Practical related to use of statistical software.

2. To Georeference & Project a Satellite Imagery
3. To Digitize features from a given land use using ArcGIS software.
4. Extraction and separation of organic compounds from biological materials.
5. Separation of mixture components using chromatographic Techniques
6. To determine the minimum size of the quadrant by 'Species-Area-Curve' method.
7. To study the community by quadrant method by determining frequency, density and abundance of different species present in the community.
8. To estimate Noise Pollution Level by using Noise Level Meter.

Suggested Reading:

1. Date, C. J., An Introduction to database system, Addison Wesley, U.K., 1986.
2. Jensen, J.R., Remote Sensing of the Environment-An earth resource perspective (2nd ed.), Pearson Education, India, 2013.
3. Chipman, J.W., Kiefer, R.W., Lillesand, T.M., Remote sensing and Image interpretation, Wiley, 2011.
4. Burrough, P.A., Mcdonell, R.A., Lloyd, C.D., Principles of Geographical Information System (International 3rd ed.), Oxford University Press, U.K., 2016.
5. Barnett, V., Environmental Statistics: Methods and Applications, John Wiley and Sons, New Delhi, 2006.
6. Sawyer, N., McCarty, P.L., Parkin, G.F., Chemistry for Environmental Engineering and Science (5th ed.), McGraw Hill, 2003.

COURSE CODE: ES 306

COURSE TITLE: Industrial/Study tour and submission of report

COURSE OUTCOMES:

- CO1:** Field based learning of industrial processes, pollution and its control will be developed in the students.
- CO2:** Students will get acquainted with different treatment technologies, design and operation adopted to treat different kinds of effluents.
- CO3:** A study or excursion tour will develop broad thinking in the students about real world problems and their solutions.

COURSE CODE: ES 401

COURSE TITLE: Energy & Environment

COURSE OUTCOME:

- CO1.** Ability to understand the basics of renewable and non-renewable energy resources and associated environmental issues.
- CO2.** Ability to understand the global, regional and local initiatives for energy conservation and sustainable development
- CO3.** Ability to understand about various non-convention sources of energy
- CO4.** Ability to understand possible ways for conservation of energy resources.

COURSE CONTENT

Unit-I: Energy Resources and Conservation:

Energy forms; Laws of Conservation of Energy; Energy resources classification; solar energy and its spectral characteristics; Energy flow patterns, effects of energy use on the environment and analyses of current energy related problems; Energy consumption patterns-India and world; Problems and Solutions in energy conservation.

Unit-II: Conventional Energy Sources:

Classification, composition and physiochemical characteristics of fossil fuels (Coal, Oil and Natural gas); Gross-calorific value and Net calorific value; Environmental problems associated with fossil fuels; Nuclear energy: Fission and fusion; Nuclear fuels; Nuclear reactors and radioactive waste; Environmental implications of nuclear energy; Hydroelectricity: Principles of generation of hydroelectric power and environmental problems.

Unit-III: Non-Conventional Energy Sources:

Solar Energy; Solar collectors and concentrators, Solar electricity generation; Photovoltaic modules; solar ponds; Wind energy-harnessing and its potential; Geothermal and Hydrothermal energy-concepts and prospect in India; Tidal and wave energy, problems and prospects.

Unit-IV: Bio-Energy:

Biomass composition and types; Conversion processes – pyrolysis, charcoal production, compression, gasification and liquefaction; Energy plantation; Biogas – production and uses, anaerobic digestion; Energy from solid Wastes – Sources, types, energy production; Microbial fuel cell –principle, types and challenges; Biodiesel, bioethanol, biogas, biohydrogen – importance, production technologies and applications.

Suggested Readings:

1. Devins, D.W., Energy: Its Physical Impact on the Environment, John Wiley and Sons, 1982.
2. Fowler, J.M., Energy and Environment, McGraw Hill, 1984.
3. Ristinen, R.A. and Kraushaar, J.J., Energy and the Environment, John Wiley and Sons, 1998.
4. Energy and the Challenge of Sustainability, World Energy Assessment, UNDP, 2000.
5. Ravigranath, N.H., Usha, R.K., Nataranjan, B., Monga, P., Renewable Energy and Environment-A Policy Analysis for India, Tata- McGraw Hill, 2000.
6. Nakicenovic, N., (edition) Global Energy Perspectives, Cambridge University Press, 1998.
7. Boyle, G., (edition), Renewable Energy: Power for a sustainable future, Oxford University Press, U.K., 1996.

COURSE CODE: ES 402

COURSE TITLE: Research Aptitude and Biostatistics

COURSE OUTCOMES:

- CO1.** Students will be able to explain key research concepts and complex issues inherent in selecting a research problem to a specific research project.
- CO2.** Students will learn various research designs, data collection techniques, developed skill to select an appropriate research design, methodology and implementing a research plan.

CO3. It will enable students to apply suitable statistical approaches to research studies and its limitations.

CO4. Student will be able to write research proposal/thesis and manuscript preparation, and to communicate effectively in the scientific community of their academic discipline. And will recognize research integrity and ethical norms

COURSE CONTENT:

Unit-I: Introduction to Research:

Research- Meaning, Classification, and characteristics, positivism and post-positivistic approach to research; Methods of research- Experimental, descriptive, historical, qualitative and quantitative methods; Steps of research; Data and its types Methods of data collection and analysis, interpretation and presentation; Thesis and article writing: Format and styles of referencing; Research communication; Application of ICT in research; Research ethics

Unit-II: Sampling Techniques:

Population and sample; Sample size and Sampling frame; Advantages of sampling and its limitations; Different Sampling Techniques- Probability and Non-probability sampling, their types, differences and use, relative advantages and disadvantages

Unit-III: Biostatistics for Environment:

Measures of Central Tendency and Tests of Significance: Mean, Median, Mode in discrete and continuous data series; Measure of dispersion-Range, Interquartile range and Standard deviation; Variance; Probability distributions; Correlation and Regression; Null hypothesis; Test of significance of small and large samples- t- test; F-test; Z-test; Analysis of Variance (ANOVA); X^2 -tests

Unit-IV: Basic Computer Knowledge:

Windows, Unix and Linux; Word processing, Spreadsheets, Graphics and Data base; Introduction to web browsing software and Search engines with special reference to online environmental resources; Use of common application software in Environmental research

Suggested Readings

1. Creswell, J.W., Qualitative inquiry and research design: choosing among five approaches, SAGE, 2007.
2. Walliman, N., Research Methods, Routledge, 2010.
3. Bowker, A.H. and Liberman, G.J., Engineering Statistics, Prentice-Hall, 1972.
4. Berthouex, P.U., Statistics for Environmental Engineers, Lewis Publ., 1994.
5. Ott, W.R., Environmental Statistics and Data Analysis, CRC Press, 1995.
6. Date, C. J., An Introduction to database system, Addison Wesley, U.K., 1986.

COURSE CODE: ES 403

COURSE TITLE: Contemporary Environmental Issues & Sustainability

COURSE OUTCOMES:

CO1. Understanding of major global and national environmental issues will be developed.

- CO2.** Students will be informed about various national environmental conservation plans, policies, programs and projects.
- CO3.** Students will develop understanding about functions of different government and non-government organizations involved in environmental conservation.
- CO4.** Learning of how sustainability considerations can actually be embedded within an individual's and community's day to day activities

COURSE CONTENT:

Unit-I: Contemporary Environmental Issues:

Issues in India: Environmental issues related to water resource, hydropower projects: in J & K, Himachal Pradesh and North East, Narmada dam, Tehri dam, Almatti dam, Interstate conflicts on river waters; River linking program and its environmental impact; Polluted River stretches in India, Desertification; Fluoride, Arsenic and Nitrate in ground water; Environmental disasters- Bhopal gas tragedy, Chernobyl disaster, Fukushima nuclear disaster

Unit-II: National Missions, Action Plans and Conservation Projects:

National Action Plan on Climate Change; National Solar Mission; National Water Mission; National Mission for Green India; National River Conservation Plan- Namami Gange, Yamuna Action Plan; National Water and Air Quality Monitoring program (NWMP & NAMP); National Mission for Sustainable Agriculture; Project Tiger, Project Elephant, Project Dolphin, Crocodile conservation project, GoI-UNDP Sea Turtle project, Indo-Rhino vision

Unit-III: Environmental movements and Organizations:

Chipko movement; Appiko movement; Silent Valley movement, Bishnoi movement, Narmada Bachao Andolan, Gandhamardan movement; Powers and functions of- MoEFCC-India, Central and State pollution Control Boards and NGT; International and national organizations of repute: IPCC, UNEP, IGBP, Greenpeace, Conservation International, WHO, WWF, TERI, CSE, CEE; Role of NGOs in environmental conservation

Unit-IV: Sustainable development:

Concept and growth of the idea of sustainability; Indicators of sustainability, Models of Sustainable Development; Sustainable Development Scenario- Global and National; Sustainable Development Goals (SDGs); Sustainable habitat- Green Building and GRIHA rating norms; Rural sustainable development- Challenges and opportunities, Livelihood generation, rural Socio-economical development prospects

Suggested readings:

1. Our Common Journey: A Transition towards Sustainability. National Academy Press, Washington D.C. Soubbotina, T. P. 2004.
2. Elliott, Jennifer. 2012. An Introduction to Sustainable Development. 4th Ed. Routledge, London.
3. Sachs, J. D. 2015. The Age of Sustainable Development. Columbia University Press, New York.
4. Dent, David, Olivier Dubois, and Barry Dalal-Clayton. Rural planning in developing countries: supporting natural resource management and sustainable livelihoods. Routledge, 2013

5. Rogers, P. P., Jalal, K. F., & Boyd, J. A. (2012). An introduction to sustainable development. Routledge.
6. Callen, M. T., & Cashin, M. P. (1999). Assessing external sustainability in India. International Monetary Fund.

COURSE CODE: ES 404. A

COURSE TITLE: Remote Sensing & GIS

COURSE OUTCOMES:

- CO1.** Building the foundation for understanding Remote Sensing and Geographic Information System (RS-GIS) as a powerful tool for geospatial analysis
- CO2.** Learn about data and sources (RS based and other sources, field data) and GIS software.
- CO3.** Develop capability to handle at least one GIS software with understanding.
- CO4.** Obtain basic capability in skills and functional knowledge to carry out GIS (RS-GIS) based projects.

COURSE CONTENT

Unit-I: Principles of Remote Sensing:

Concepts of Remote Sensing; Types of orbits, swaths; Different types of resolution: spatial, radiometric, spectral and temporal, types of sensor; Satellites and their sensors; Data products; Applications of remote sensing in environmental monitoring and management.

Unit-II: Physics of Remote Sensing:

Energy sources and radiation principles; Electromagnetic spectrum and its properties; Laws governing the properties of radiation and its implication for remote sensing; Electromagnetic radiation and its interaction with the atmosphere and Earth surface features; Concept of spectral signature.

Unit-III: Digital Image Processing & Image interpretation:

Principles, Image rectification, Image enhancement and mosaicing; Image classification- Supervised, Unsupervised, Ground truth data and training set manipulation; Classification accuracy assessment; Elements of image interpretation, interpretation keys.

Unit-IV: Geographical Information System (GIS) & Global Positioning System (GPS):

Basic principles; Raster and vector data; Map projection; Topology creation; Overlay analysis; Data structure and Digital cartography; Basic principles of GPS; Applications to environmental studies.

Suggested Readings

1. Jensen, J.R., Remote Sensing of the Environment-An earth resource perspective (2nd ed.), Pearson Education, India, 2013.
2. Chipman, J.W., Kiefer, R.W., Lillesand, T.M., Remote sensing and Image interpretation, Wiley, 2011.
3. Burrough, P.A., Mcdonell, R.A., Lloyd, C.D., Principles of Geographical Information System (International 3rd ed.), Oxford University Press, U.K., 2016.

4. Hofmann-Wellenhof, B., Lichtenegger, H., Collins, J., Global Positioning System: Theory and Practice, Springer-Verlag, 1997.

COURSE CODE: ES 404. B

COURSE TITLE: Wildlife & Conservation Biology

COURSE OUTCOMES:

- CO1.** Ability to apply the knowledge for biodiversity conservation
- CO2.** Ability to comprehend the principles of ecosystems and evaluate them against actual life activities.
- CO3.** Ability to develop innovative conservation strategies for newly discovered or endangered species in a specific area, and interpreting ecological and social events from the perspective of biodiversity

COURSE CONTENT

Unit-I: Behavioural Ecology: An understanding of proximate and ultimate mechanisms in animal behaviour; Group living: costs, benefits and optimal group size; Selfishness and altruism; Evolutionary stable strategies; Predator prey relationships and evolutionary arms race; Competition for resources; Sexual selection; parental care and mating systems; Cooperation and help; communication pathways.

Unit-II: Man & Wildlife:

Eco-development; Community participation in wildlife management; Conservation and development linkage; Man animal conflict; Wildlife Trade; Trans-boundary problems; Special management programme with special to Project tiger; Operation rhino; Project Elephant; Case studies of captive – Red panda and Snow leopard.

Unit-III: Wild Life Management:

Management of rare and endangered species; Control of weed species; Control and management of overabundant wildlife populations; Management of small populations; Ecological monitoring of animal species and restoration programmes.

Unit-IV: Wildlife Health:

Introduction to disease; Determinants of disease and disease transmission; Review of major microbial and parasitic diseases of Indian wild life; Importance of wildlife health management; Behavioural patterns in captivity and animal welfare issues.

Suggested Readings

1. Bailey, J.A., Principles of Wildlife Management, John Wiley & Sons Ltd, 1984.
2. Dasmann, R.F., Wildlife Biology (2nd ed.), Wiley, 1981.
3. Krausman, P.R. and Leopold, B.D., Essential Readings in Wildlife Management and Conservation, Johns Hopkins University Press, 2013.
4. Morrison, M.L. and Mathewson, H.A. (edition), Wildlife Habitat Conservation: Concepts, Challenges, and Solutions, Johns Hopkins University Press, 2015.
5. Krausman, P.R. and Cain III, J.W., Wildlife Management and Conservation: contemporary Principles and Practices, Johns Hopkins University Press, 2013.

COURSE CODE: ES 404. C

COURSE TITLE: Environmental Health and Toxicology

COURSE OUTCOME:

- CO1.** Ability to demonstrate sound understanding of the concept of Environmental Chemistry and Environmental Toxicology
- CO2.** Ability to Summarize the most relevant terms, principles, and methods in environmental toxicology
- CO3.** Ability to recognize the importance of environmental changes and understand various aspects of environmental pollutants and its implications on human health.

COURSE CONTENT

Unit-I: Overview of Environmental Health:

Concept and scope of Environmental Health; Environmental health criteria; Historical review of human impact on the environment; Basic requirements for healthy environment; Risk verses benefits; Dose-Response relationships: Graded response, quantal response, time action curves threshold limit value (TLV); margin of safety, toxicity curves; Environmental toxicity testing: scope, process and limitation; Introduction to environmental contaminants monitoring.

Unit-II: Occupational Safety:

Major chemical contaminants at workplace; The relationship of occupational hygiene/ safety and disease; occupational diseases: respiratory, skin, liver, kidney, nervous system; Chemical carcinogenicity; Mechanism of carcinogenicity, Environmental carcinogenicity testing; Industrial environmental accidents.

Unit-III: Environmental Health Hazard:

Biological, chemical, physical and psychological health hazard; Asbestosis, Silicosis, Sinusitis, Asthma, Fluorosis and Allergies; Bio-transformation, bio-accumulation and bio-magnification: Principles, receptor sites absorption and storage of xenobiotics; Types of bio- transformations, toxico-genomics and pharmacogenomics; Influence of ecological factors on the effects of toxicity.

Unit-IV: Eco-toxicology & Human health:

Toxicity testing: Bioassay – Definition, purpose, criteria for selection of test organism methodology, estimation of LC50, limitation and importance of bioassay, acute toxicity (single), Sub acute toxicity, chronic toxicity, teratogenicity, and mutagenicity; Assessment of risks to human; Bioactive substances and their significance in the ecosystem; Food as source of toxicity to environmental pollutants; Transport through food chain - bio-transformation and bio-magnification; Clinical toxicology; Detoxification in human body.

Suggested Readings

1. Shaw, I.C. and Chadwick, J., Principles of Environmental Toxicology, CRC Press, 1998.
2. Yassi, A., Kjellström, T., Kok, T.de., Guidotti, T., Basic Environmental Health, Oxford University Press, 2001.
3. Morgan, M.T., Environmental Health (2nd ed.), McGraw-Hill Ryerson Limited, 2003.

4. Koren, H., Handbook of Environmental Health and Safety—principle and practices (Vol. 2), Lewis Publishers, Chelsea, U.K., (1991).

COURSE CODE: ES 405

COURSE TITLE: Submission of dissertation and presentation/viva-voce.

COURSE OUTCOMES:

- CO1.** Students will be able to identify and synthesis the relevant information from various sources and explaining topics under discussion
- CO2.** Enhance capability to interacting intellectually in a seminar through informal and formal speaking.
- CO3.** Students will be able to face the challenge and offer substantive replies to others' arguments, comments, and questions
- CO4.** Students will get refine, and expand their abilities to get employability