DEPARTMENT OF ENVIRONMENTAL SCIENCE

NAGALAND UNIVERSITY

Lumami- 798627

Revised M.Sc. Syllabus 2025

M.Sc. Course Scheme and Syllabus

Outcome Based Education System (OBES)/ Learning Outcomes based Curriculum Framework (LOCF)/ Choice Based Credit System (CBCS)

National Education Policy (NEP)-2020

(Revised 2025)

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

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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 80 credits for award of the degree of M.Sc. (Environmental Science). The credits earned shall have a minimum of 72 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 third semester has mandatory MOOCs and Internship of 2 credits each. 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 14 core courses out of which 12 are theoretical, and 2 are practical in nature. Each core course is of 4 credits (100 marks). The students shall be evaluated by way of continuous assessment (internal test, seminar and assignment) comprising 40% of the credit value (40 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 MOOCs of minimum 2 credits offered in the third semester. Students should complete an internship of 2 credits for at least 2 weeks to 4 weeks from the 1st to 3rd semester (at any time), but the credit will be added in the 3rd semester only. It would be completed in any industry/ research institute/university/ NGOs/ civil societies for upgrading skills.

Besides this in fourth semester student have 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 20 credits (500 marks) and the marks shall be awarded on the basis of the dissertation and presentation of the project report.

There will two(02) internal assessments (test/assignment/seminar) per paper (both theory and practical separately) and one must appear in at least one 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: 80, TOTAL MARKS: 2000

TOTAL CREDIT: 80							**TOTAL MARKS: 2000**
Sem.	**Course No.**	**Course Title**	**Credit**	**Nature**	**Internal**	**End-term**	**Total Marks**
I	ES-101	Basics of Environmental Science & Contemporary Environmental issues	4	T	40	60	100
	ES-102	Environmental Chemistry	4	T	40	60	100
	ES-103	Environmental Biology	4	T	40	60	100
	ES-104	Earth Surface Processes	4	T	40	60	100
	ES-105	Practical–I	4	P	40	60	100
II	ES-201	Environmental Pollution & its Control	4	T	40	60	100
	ES-202	Ecology &Environment	4	T	40	60	100
	ES-203	Remote Sensing & GIS	4	T	40	60	100
	ES-204	Environmental Management, Assessment and Legislation	4	T	40	60	100
	ES-205	Practical–II	4	P	40	60	100
STUDENT EXITING AFTER 2nd SEMESTER WILL BE AWARDED WITH P.G. DIPLOMA							
III	ES-301	Meteorology & Climatology	4	T	40	60	100
	ES-302	Biodiversity Conservation	4	T	40	60	100
	ES-303	Environmental Analytical Methods	4	T	40	60	100
	ES-304	*CBCP A. Disaster Management B. Eco Toxicology and Environmental Health C. Waste Management D. Green Technology	4	T	40	60	100
	ES-305	MOOCs	2	T	30	70	50
	ES-306	#Internship	2	P	-	-	50
	ES-401	Dissertation	20	P	-	-	500
			80				**2000**

* A student will choose any one of the CBCPs offered by the department in III[rd] Semester.

\# Students should complete an internship in any industry/ research institute/university/ NGOs/ civil societies for upgrading skills for at least 2 to 4 weeks from the 1st to 3rd semester (at any time), but the credit will be added in the 3rd semester only.

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: Basics of Environmental Science &Contemporary Environmental issues

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

CO4. Understanding of major global and national environmental issues will be developed

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-III: Contemporary Environmental Issues:

Major environmental issues of the world; 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-IV: 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

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.
9. Our Common Journey: A Transition towards Sustainability. National Academy Press, Washington D.C. Soubbotina, T. P. 2004.
10. Elliott, Jennifer. 2012. An Introduction to Sustainable Development. 4th Ed. Routledge, London.

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 P_{450}.

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.), BrooksCole, 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 (6^{th}ed.), Benjamin Cummings,SanFrancisco, 2001.
8. Ricklefs,R.E. and Miller, G.L., Ecology (4^{th}ed.), WH Freeman and Company England, 2000.
9. Bingro, H., Plants- Environment Interaction (3^{rd}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; Earth's structure; Isotasy and isostatic adjustments; Plate tectonics - theory of Plate tectonics, Major Tectonic Plates, Types of

Boundary, Plate tectonics and sea floor spreading; Concepts of stress and strain, Types of stress; Folds and faults; Types of folds and faults

Unit-II: Earth's Materials: Weathering of rocks; Controls on weathering, Rocks and rock types; Mass-wasting; Factors that influence mass wasting processes; Mass movements, Types of Slow movements, Types of Rapid movements, Major causes of mass movements; Soil formation process; Factors affecting soil formation; Soil profile; Soil types in India; 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 types; Types of stream; Stream ordering; Types of lakes found in India; Ground water; Abstraction of groundwater, Environmental influences on ground water,Ground water recharging, Artificial recharge; Rain water harvesting and its positive impact

Unit-IV: Geomorphology: Geomorphology, Endogenic and Exogenic forces; Fluvial processes and landforms; Glacial processes and landforms; 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
4. Systems and Man, Santa Barbara, California: Hamilton Publishing, 1973.
5. Bell F.G., Environmental Geology - Principles and Practice, Blackwell Science, 1998.
6. Valdiya, K. S., Environmental Geology, Tata McGraw-Hill, 1987.
7. Strahler, A.N. and Strahler, A.H., Environmental Geoscience - Interaction between Natural
8. Systems and Man, Santa Barbara, California: Hamilton Publishing, 1973.
9. Singh, V. P., Elementary Hydrology, Prentice-Hall, India, 1994.
10. Chow, V.T., Handbook of Applied Hydrology, McGraw-Hill, New York, 1964).
11. Sear, D.A., Newson, M.D., Thorne, C.R., Guidebook of applied fluvial geomorphology, Thomas Telford ltd., 2009.
12. 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. Physico-chemical Analysis of Soil.

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

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, (6^{th}ed.), Benjamin Cummings, San Francisco, 2001.
5. Ricklefs, R.E. and Miller, G.L., Ecology (4^{th} ed.), W H Freeman and Company England, 2000.
6. Grotzinger, J. and Jordan, T.H., Understanding Earth (7^{th} ed.), W.H. Freeman and company, 2014.
7. Fifield, F.W. and Haines,P.J., Environmental Analytical Chemistry, Blackwell,1998.
8. Keith, L.H., (edited) Principles of Environmental Sampling, American Chemical Society, 1988.
9. Clesceri, L.S., Standard Methods for Examination of Water and Waste Water (28^{th} ed.), American Public Health Association, 1998.
10. 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, PM_{10}& $PM_{2.5}$; 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 (4^{th}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, Chapparal, 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.), BrooksCole, 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 (6^{th} ed.), Benjamin Cummings, San Francisco, 2001.
5. Ricklefs, R.E. and Miller, G.L., Ecology (4^{th} ed.), W H Freeman and Company England, 2000.
6. Bingro, H., Plants-Environment Interaction (3^{rd} 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: 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 GIS softwares 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 of GIS and GPS in environmental management.

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.
5. 5. Joshi, D.C. Remote Sensing and Gis Applications: A Starter Guide, Scientific Publisher, India, 2019.

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 earn 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, eco-friendly 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; Environmental/Green tax; Total Environmental Quality Management (TQEM); Ecolabelling; Environmental Performance Index; Ecological and Carbon footprints.

Unit-II: Environmental Assessment Tools and Techniques:

Environmental Impact Assessment (EIA)- Definitions and Objectives; Scope and Advantages; The EIA Processes, Environmental Management Plan (EMP), Public consultation and participation, EIS; Assessment methodologies- Ad-hoc, Overlay, Network, Matrix, Checklist and Cost benefit analysis; The Indian EIA regime- Notifications, Guidelines, Project categories requiring Environmental Clearance, 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, Stockholm Conference, Rio Conference, Rio+10, Rio+20, Agenda 21, MAB programme and Paris Agreement; Global Environment Facility (GEF); Johannesburg Earth Summit; MDGs; SDGs, 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:

Constitutional provisions on environment in India; Wildlife Protection Act, 1972; Forest Conservation Act, 1980; 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; 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 MSW Management Rules, 2016; Noise Pollution (Regulation and Control) Rules, 2000; E-Waste Management Rules, 2022; CRZ Notification, 1991; National Green Tribunal Act, 2010

Suggested Readings:

1. Oberoi, N.K, Environmental Management, (2nd ed.), Excel Books, New Delhi, 2003.
2. Glasson, J., Therival, R., Chadwick, A., Introduction to Environmental Impact Assessment (4th ed.),Routledge, 2011.
3. Morgan, R.K., Environmental Impact Assessment – A Methodological Approach, Springer, 1998.
4. All guidelines and notifications of Government of Indiarelated to EIA rules.
5. Thomas, J.M. andCallan, S.J., Environmental Economics and management: Theory Policyand applications (5th ed.),South-Western CENGAGE Learning, Ohio, U.S.A.2009.

6. Marshall, G.R., Economics of Collaborative Environmental Management: Renegotiating the commons, Earthscan, U.K. and U.S.A., 2005.
7. Divan and Rosencranz., Environmental law & policy in India- cases and materials, 3e, 3rd edition; Oxford.

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. Analysis of Physicochemical parameters of Water and Wastewater Samples.
2. To familiarize with modules of ArcGIS Software.
3. To Georeference & Project a Satellite Imagery
4. To Digitize features from a given land use using ArcGIS software.
5. To study the community by quadrant method by determining frequency, density and abundance of different species present in the community
6. Study of Ecological adaptations – a) Hydrophytes and xerophytes, b)Rocky shore and sandy shore fauna.
7. Estimation of chlorophyll in terrestrial plants.
8. Estimation of biomass/standing crop of a terrestrial habitat.
9. Separation of mixture components using chromatographic Techniques
10. Extraction and separation of organic compounds from biological materials.

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: Earth's atmosphere, composition of the atmosphere, constant and variable gasses; Vertical structure of the atmosphere; Significance of Earth's atmosphere;Origin and Evolution of 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; Factors leading to air rising and cooling; Types of clouds

Unit-II: Earth-Atmosphere Heat Exchange: Insolation and heat budget;Reflection, absorption, Scattering; Terrestrial radiation; Electromagnetic radiation and its properties; atmospheric heating and cooling process; Adiabatic cooling and warming; Atmospheric scattering- Rayleigh, Mie and Nonselective scattering; Absorption; Earth's net flux, Earth-atmosphere energy balance

Unit-III: Movement of Air: Forces acting on horizontal movement of air; 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 UNFCC 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. Keith, L.H., (edited) Principles of Environmental Sampling, American Chemical Society, 1988.
7. Clesceri, L.S., Standard Methods for Examination of Water and Waste Water (28th ed.), American Public Health Association, 1998.
8. Lodge, J.P. Jr. (edition), Methods of Air Sampling and Analysis, Lewis, 1988.

9. 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 (A)
COURSE TITLE: Disaster Management

COURSE OUTCOMES:

CO1. Engaging students in critical thinking and pursue research and development activities to understand and manage disaster.

CO2. It will develop such learning which will induce professional skills to tackle complex problems during disaster and its preparedness.

COURSE CONTENT

Unit I: Basic concepts of disaster management

Definition and classification of disasters: natural and man-made, Characteristics and impacts of major disasters (earthquakes, floods, cyclones, industrial accidents), Hazard, vulnerability, risk, and capacity concepts, Historical perspectives and case studies, Disaster management cycle: prevention, preparedness, response, recovery, International frameworks: Sendai Framework, SDGs, Hyogo Framework

Unit II: 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); application of geoinformatics in hazard, risk and vulnerability assessment.

Unit III: Mitigation and preparedness

Concept of mitigation; types of mitigation: structural and non-structural mitigation, use of technologies in mitigations such as barrier, deflection and retention systems; concept of preparedness; importance of planning, exercise, and training in preparedness; role of public, education and media in hazard preparedness.

Unit IV: Disaster management in India

Lessons from the past considering the examples of Bhuj earthquake, tsunami disaster, and Bhopal tragedy; National Disaster Management Framework, national response mechanism, role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management; case study of efficient disaster management during cyclone 'Phailin' in 2013.

COURSE CODE: ES 304 (B)
COURSE TITLE: Ecotoxicology and Environmental Health

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; Does-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., Kjellstr"om, T., Kok, T.de., Guidotti, T., Basic Environmental Health,Oxford University Press, 2001.
3. Morgan, M.T., Environmental Health (2nded.), 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 304 (C)
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-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- Incineration, Co-combustion, Pyrolysis, Gasification, Refuse Derived Fuel; Biohydrogen and Biological Stabilization; Integrated SWM; Waste to Energy options; 3R &5R concepts

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: Different categories of Hazardous Wastes and its management:
Characteristics, Types, Sources, 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 form wastes; 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. Integrated Solid Waste Management, Engineering Principles and Management Issues,Tchobanoglous G, Theisen H and Vigil SA, McGraw Hill Education, 2014, Indian Edition
4. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-HillEducation, 2002, 2nd Edition
5. Plastic Waste Management, 2024; Kalim Deshmukh, Jyotish Kumar Parameswaran Pillai, John Wiley & Sons
6. Handbook of electronic waste management: international best practices and case studies.Prasad, M. N. V., Vithanage, M., & Borthakur, A. (Eds.). (2019). Butterworth-Heinemann.
7. E-Waste Management: Challenges and Opportunities in India. Bhagat-Ganguly, V. (2021). Routledge India.
8. Biomedical waste management in hospitals. Latha, G., & Rajasekhar, M. (2021). Lulu Publication.
9. Wastewater treatment: advanced processes and technologies.Rao, D. G., Senthilkumar, R., Byrne, J. A., & Feroz, S. (Eds.). (2012). CRC Press.

COURSE CODE: ES 304 (D)
COURSE TITLE: Green Technology

CO1: Students will be able to understand the principles and objectives of green technology, including sustainability, pollution prevention, and life cycle thinking.

CO2: Students will analyze various green technologies across sectors (e.g., renewable energy, green buildings, eco-friendly materials) and evaluate their environmental and economic impacts.

CO3: They can apply knowledge of green design and innovation to propose sustainable solutions for real-world environmental problems.

Unit I: Introduction

Definition and concepts: green technology, green energy, green infrastructure, green economy,green chemistry; sustainable consumption of resources; individual and community level participationsuch as small-scale composting pits for biodegradable waste, energy conservation; principles and recognition of green criteria in chemistry; biodegradableand bio-accumulative products in environment; green nanotechnology; reagents, reactionsand technologies that should be and realistically could be replaced by green alternatives;photodegradable plastic bags.

Unit II: **Green infrastructure, planning and economy**

Green buildings; history of green buildings, need and relevance of green buildings over conventionalbuildings, construction of green buildings; associated costs and benefits; outlined examples of greenbuildings; LEED certified building; Eco-mark certification, establishment of Eco-mark in India, itsimportance and implementation; Green planning: role of governmental bodies, land use planning,concept of green cities, waste reduction and recycling in cities, role of informal sector in wastemanagement, public transportation for sustainable development, green belts. ; Introduction to UNEP'sgreen economy initiative, inclusive economic growth of the society, REDD+ initiative, and cap and trade concept; green banking.

Unit III: Applications of green technologies

Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermal melting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats). Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets, promotion and/or subsidy of alternative forms of transportation for employees, such as carpools, fuel efficient vehicles, and mass transit, methane emissions reduction and/or reuse.

Unit IV: Green future

Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; major challenges and their resolution for implementation of green technologies; green practices to conserve natural resources (organic agriculture, agro forestry, reducing paper usage and consumption, etc.); emphasis on waste reduction instead of recycling, emphasis on innovation for green future; role of advancement in science in developing environmental friendly technologies.

COURSE CODE: ES 305
MOOCs

COURSE OUTCOMES:

CO1. MOOCs courses will foster self-directed learning by allowing students to access high-quality educational resources anytime and anywhere, promoting lifelong learning and adaptability.

CO2. Learners will gain in-depth theoretical understanding and practical skills in a specific subject area, which enhances their academic competence and professional readiness.

- Student will opt for one MOOCs of minimum 2 credits from online platforms like SWAYAM.
- Student can earn credits from SWAYAM and credits could be transferred in lieu of core paper.
- Credits earned from SWAYAM not related to syllabus will be considered as value added courses.

COURSE CODE: ES 306
INTERNSHIP

COURSE OUTCOMES:

CO1. Students will be able to apply classroom-acquired concepts to real-world environmental challenges through fieldwork, lab work, or organizational assignments, enhancing problem-solving and analytical skills.

CO2. Internship will provide exposure to environmental organizations, research institutions, or government agencies, helping students develop industry-relevant competencies, communication skills, and professional networks for future career opportunities.

- Students should complete an internship in any industry/ research institute/university/ NGOs/civil societies for upgrading skills for at least 2 to 4 weeks from the 1st to 3rd semester (at anytime), but the credit will be added in the 3rd semester only.

COURSE CODE: ES 401
COURSE TITLE: Dissertation

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

Student will undergo six monthly dissertation in the 4^{th} Semester. At the end, the evaluation will be done on the basis of dissertation report and presentation/viva.