

M. Sc. ENVIRONMENTAL SCIENCE & TECHNOLOGY

SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY,

C.S.J.M. UNIVERSITY, KANPUR NAGAR, U.P., INDIA

PREAMBLE

This M.Sc. Environmental Science and Technology (2 year) program for post graduate studies presented in this document follows the nationwide exercise undertaken by the **New Education Policy 2020** University Grants Commission as part of curriculum restructuring initiative. The course curriculum is interdisciplinary and draws content from different allied disciplines. Ideally, a post graduate programme should equally focus on theory and practical for the relevant subject and **skill development**. So that students enable necessary skills on **innovation, entrepreneurship** and also to get best employment in the national as well as global platform. Therefore, a number of skill-based papers have been identified and made a part of this curriculum. In this era of science and technology this course would be boon for the **sustainable development**.

This program and curriculum would help the students in future prospects and would open various new avenues in global market (Government/ Non Government Sector) like **Academician, Scientist, Environmental Officer, Environmental Manager, Environmentalist, Environmental Engineer, Disaster Management Expert, Remote Sensing and GIS Expert, Environmental Journalist, Researcher** etc. Now a days, most of the students with this degree getting lots of opportunities in various organizations like Ministries, Ministry of Environment Forest and Climate Change (**MoEFCC**), Ministry of Water Resources (**MoWR**), Ministry of Home Affairs (**MHA**), Ministry of Earth Science (**MoES**) Government of India etc., Research institutes (**CSIR, ICAR, ICMR** etc.), Academics, etc. This course is designed for the best learning outcomes from the students.

This popular course will lead to enhance the creativity and intellectual growth of a student. This is the best time because we are facing the impact of global climate change so that this course is on the demand for environmental sustainability and ecological balance. A latest demand for the subject exists not in India but globally due to climate change. It is also expected that Environmental Science postgraduates, in the long run, will also significantly contribute to the vision of **‘Zero liquid discharge’, ‘Zero Defect, Zero Effect’, Carbon Neutrality, Net Zero Carbon, Mission for LiFE (Life for Environment), Environmental Conservation, Water Conservation (As per Budget 2022) Disaster Management and Geospatial Technology, Earth and Environmental management** etc. and would become trainer various planning & policy initiative environmental issues and of Government of India.

SCOPE OF THE STUDY

This course provides ample job opportunities in **Industries, Ministries, Judiciary, Research Organizations, Universities, Colleges, Multinational Companies, Administration & NGOs, etc.** The present course is designed to meet the national and international requirements of Environmental sustainability, Environmental Monitoring and Management, Environmental Impact Assessment, ISO Certification, Environmental Legislations, Disaster, Hazards & Risk Management, Remote sensing and GIS, Air/Water/Soil Pollution/ Hazardous waste Management, Biodiversity Conservation, Natural Resource Management, Energy Resource Conservation, Recycling of plastic, Electronic waste etc. Waste Materials, Social Issues of the Environment, Environmental Protection and Policies for the sustainable development.

VISION:

The vision is to be a centre of excellence in environmental science education and research for the benefit of environment and humanity. To be a leading and renewed department for producing post graduates and researchers through value based quality education with innovative means and

collaborative interdisciplinary approaches who can address current and evolving environmental challenges for self –reliance, sustenance and betterment of society.

MISSION:

- ✓ To develop, nurture and empower the students to their full potential to cope with the environmental challenges for achieving the sustainable development.
- ✓ To adopt state-of-the-art technologies to optimize use of teaching and research for enhancing knowledge, skills and entrepreneurship amongst the young generations.
- ✓ To be recognised as an excellent centre in educating and training the students / teachers to provide solutions to environmental and climatic issues through innovative approaches.

Program Educational Objectives (PEOs)	
The M. Sc. Environmental Sciences and Technology program describe accomplishments that post graduates are expected to attain within five to seven years after graduation	
PEO1	The students could get employment opportunities in Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB), Research Institutions, Colleges, Universities and Non-governmental organizations.
PEO2	After successful completion of the course, the students could get job opportunities in urban and rural environmental mitigation and awareness including social forestry programs, bio-fertilizer and bio-pesticide industries, waste management and organic farming divisions funded by National, International and Regional agencies.
PEO3	The students could get employment perspectives in R & D laboratories of waste water treatment plants, metal, chemical and textile effluent treatment plants, municipal solid waste management units and waste management in biomedical industries and hospitals.
PEO4	The students could find employment opportunities in agro industries, forest departments, water harvesting and watershed management sectors, bioresources utilization and biodiversity conservation organizations, food and feed Industries, environment friendly and integrated livestock management sectors
PEO5	Students also having the immense opportunities to pursue higher studies in various research fields such as environmental

	pollution, environmental chemistry, waste management and bioremediation, environmental microbiology, waste water treatment, recycle, reuse and management, sustainable environmental food security, bio-resource utilization and biodiversity conservation, functional and ecosystem ecology, environmental toxicology, agro-waste ecosystem, non-biodegradable synthetic chemicals and polymers in environment, occupational health and industrial safety, environment analytical techniques, environmental impact assessment, remote sensing and geographical information system, environmental biotechnology, carbon sequestration, natural disaster management and mitigation, climate change, marine pollution and resources utilization, restoration of different ecosystems, renewable and green energy and environmental law, policies and auditing.
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Program Outcomes (POs)	
PO1	Acquired fundamental knowledge of different aspects of environment and local, regional, national and global environmental problems.Developed environmental monitoring skills, including conduct of experiments and data analysis.
PO2	Understand the physical and chemical and biological components of earth's environment, the ecological concepts, principles, processes including human and natural disturbances that impact the environment. Obtained exposure to the environmental pollution control technologies.
PO3	Acquired the knowledge and skills needed for the environmental design and management. Assess the potential environmental impact of developmental projects and design mitigation measures.
PO4	Acquired skills in the preparation, planning and implementation of environmental projects.
PO5	The students passing M.Sc. Degree in the subject Environmental Science and Technology subjects have the opportunity of job and services in the field of Teaching, Researches, Projects, Effluent Treatment Plants of various Industries/Companies/Factories, Municipal Councils/Corporations, Central Pollution Control Board, State Pollution Control Boards, National Research Institutes/Organizations/Laboratories, NEERI, EIA, GIS, Environmental Monitoring Projects,

	Environmental Consultants, Different Laboratories, NGO's, Forest department, Water Purification and Treatment Plants and Various Sectors related to the field of Environment.
Program Specific Outcomes (PSOs)	
PSO1	Understand the basic concepts of Environments and its components along with their interactions through study of Ecology, Biodiversity, Environmental Chemistry, and Environmental Microbiology, Biotechnology and Geology
PSO2	Understand the different kinds of technologies for pollution reduction air/ water/ soil etc.for their sources through study of Climate and also study the Hazardous Waste management, Toxicology environmental Laws and policies.
PSO3	Use of different tools/ Techniques for the management of Environment, Energy resources, solid wastes management, environmental and Biodiversity conservation like Remote Sensing & Geographical Information Systems Technology, Biostatistics and Computational Techniques, design and conduct experiments as well as to analyze and interpret data through laboratory and field exercises by using .
PSO4	Understand the disaster management and industrial safety. Determine the environmental impact due to different developmental projects and find solution to eliminate these impacts.
PSO5	Through Dissertation, student can identify a particular environmental problem, review the literature for finding the gaps, develop research methodology, collect data and carry out data analysis and interpretation for finding a suitable solution and acquire the ability to write the research findings in the form of structured thesis and communicate the research results through oral or poster presentations

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(YEAR WISE STRUCTURE OF POST GRADUATE PROGRAM (2 YEARS))

DISTRIBUTION OF PAPERS AND CREDITS IN ALL SEMESTERS

M.Sc. IST YEAR / SEM- IST						
COURSE CODE	TYPE	COURSE TITLE	MIN. CREDITS	CIA	ESE	MAX. MARKS
L060701T	CORE	FUNDAMENTAL OF ENVIRONMENTAL SCIENCE	4	25	75	100
L060702T	CORE	NATURAL RESOURCES AND THEIR MANAGEMENT	4	25	75	100
L060703T	CORE	ENVIRONMENTAL HAZARDS & DISASTERS	4	25	75	100
L060704T	CORE	REMOTE SENSING & GIS TECHNOLOGY	4	25	75	100
L060705P	PRACTICAL	PRACTICAL	4	25	75	100
		PROJECT WORK/ DISSERTATION CONTINUE	-	-	-	-
	MINOR ELECTIVE	MINOR ELECTIVE FROM OTHER FACULTY*	4	25	75	100
	TOTAL		24			600
Note: CIA – Continuous Internal Assessment, ESE- End Semester Examination						

M.Sc. IST YEAR / SEM- IIND						
COURSE CODE	TYPE	COURSE TITLE	MIN. CREDITS	CIA	ESE	MAX. MARKS
L060801T	CORE	ENVIRONMENTAL CHEMISTRY	4	25	75	100
L060802T	CORE	INSTRUMENTATION & BIOSTATISTICS	4	25	75	100
L060803T	CORE	ENVIRONMENTAL GEOSCIENCE	4	25	75	100
L060804T	ANY ONE ELECTIVES	CLIMATE CHANGE & METEOROLOGY	4	25	75	100
L060805T	TO BE CHOSEN	SOIL SCIENCE				
L060806P	PRACTICAL	PRACTICAL	4	25	75	100
L060807R	PROJECT	RESEARCH PROJECT	8			100
	TOTAL		28			600
Note: CIA – Continuous Internal Assessment, ESE- End Semester Examination						

M.Sc. IIND YEAR / SEM- IIIRD						
COURSE CODE	TYPE	COURSE TITLE	MIN. CREDITS	CIA	ESE	MAX. MARKS
L060901T	CORE	ENVIRONMENTAL IMPACT ASSESSMENT AND SUSTAINABLE DEVELOPMENT	4	25	75	100
L060902T	CORE	ENERGY RESOURCES & MANAGEMENT	4	25	75	100
L060903T	CORE	ENVIRONMENTAL TOXICOLOGY	4	25	75	100
L060904T	ANY TWO	BIODIVERSITY & WILDLIFE CONSERVATION	4	25	75	100
L060905T	ELECTIVES TO BE CHOSEN	ENVIRONMENTAL MICROBIOLOGY & BIOTECHNOLOGY	4	25	75	100
L060906T		IPR, BIOETHICS & BIOSAFETY	4	25	75	100
L060907P	PRACTICAL	PRACTICAL	4	25	75	100
	PROJECT	PROJECT WORK/DISSERTATION CONTINUE				-
	TOTAL		24			600
Note: CIA – Continuous Internal Assessment, ESE- End Semester Examination						

M.Sc. IIND YEAR / SEM - IVTH						
COURSE CODE	TYPE	COURSE TITLE	MIN. CREDITS	CIA	ESE	MAX. MARKS
L0601001T	CORE	ENVIRONMENTAL LEGISLATIONS	4	25	75	100
L0601002T	CORE	GREEN TECHNOLOGIES FOR POLLUTION CONTROL	4	25	75	100
L0601003T	ANY ONE	RESEARCH METHODOLOGY	4	25	75	100
L0601004T	ELECTIVES	AI & ML IN ENVIRONMENTAL MODELLING				
L0601005T	TO BE CHOSEN	MOOC COURSE FROM SWAYAM OR NPTEL WITH EQUIVALENT CREDITS				
L0601006R	PROJECT	SUMMER TRAINING/DISSERTATION/PROJECT WORK/ INTERNSHIP/ REVIEW PAPER	12	50	150	200
	TOTAL		24			500
	GRAND TOTAL					2300

SEMESTER –I

Programme	Year: First	Semester: First
Paper-1 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060701T	Course Title: Fundamental of Environmental Science	
Course Outcome (CO): After completing the course the student will be able to: ➤ Developing understanding about ecosystem dynamic and relationships between ecosystems and the natural environment, including land, air, and water. ➤ Learn basic element of ecology and environmental factor. Develop conceptual skills about biogeochemical cycles ➤ Learn the interaction between physical environment and organisms. ➤ Able to understand the relationship between man and environment. ➤ Understand the structure and composition of different earth 's atmosphere		
Unit/ Topic		
Unit-1: Principles and scope of Environmental Sciences; Man and environment, Multidisciplinary Nature of Environmental Education, Environmental Institutions, Role of Environmentalist in Environmental awareness, Ecotourism, Impact of COVID-19 on the Environment and vice versa, Ecosensibility.		
Unit-2: Structure and composition of Atmosphere, Hydrosphere, Lithosphere, Biosphere, Anthrosphere, Cryosphere.		
Unit-3: Ecology: Basic principles of Environment and Ecology, Ecosystem, Food Chain, Food Web, Ecological Pyramids (Number/ Biomass/ Energy), Environmental factors (Abiotic and Biotic), Biogeochemical cycles, Ecotone.		
Unit-4: Ecological Succession, Model of Succession, Climax Community and Type of climax, Environmental performance index, Environmental education and communication, Environmental Sustainability. Environmental Performance Index.		
Unit-5: Concept of Habitat, Functional role and Niche, Global distribution and Characteristics of Forest Lands, Grass Lands, Wetlands, Coral Reef, Mangrove, Arid Lands. Biome, Environmental Calendar, Ecological Footprints, Carbon Neutrality, Mission for LiFE (Life for Environment)		
SUGGESTED BOOKS: 📖 Environmental Science: Earth as a Living Planet by Botkin and Keller; JOHN WILEY & SONS, INC. 📖 A text Book of Environment Studies, Asthana, D. K. and Asthana, M. 2006, S. Chand & Co. 📖 Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p 📖 Atmosphere, Weather and Climate, Barry, R. G. 2003, Routledge Press, UK. 📖 Environmental Science: S. C. Santra, New Central Book Agency.		

Programme	Year: First	Semester: First
Paper-2 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060702T	Course Title: Natural Resource & their Management	
Course Outcome (CO) : After completing the course the student will be able to: ➤ Learn utilization of major natural resources and the future sustainability ➤ Understand the different functions played by ecosystem. ➤ Describe how the use, management and allocation of natural resources are affected by: laws, policies, economic factors (both market and non-market), and characteristics (including demographic, cultural, ethnic, and "values" differences) of private and public resource owners and users. ➤ Develop conceptual skills of management actions needed to achieve those objectives. ➤ Communicate effectively with colleagues, stakeholders, and the public about environmental and resource management issues.		
Unit/ Topic		
Unit-1: Classification of Natural Resources, Global distribution of Natural Resources, Geographical Indicators		
Unit-2: Water Resources: Global Distribution of Water Causes of Scarcity, Water Conservation and Management, Rainwater Harvesting, Watershed management, Traditional Practices for Water Conservation.		
Unit-3: Land Resources: Definition, Land Degradation, Classification, Land Used /Land cover Pattern, Desertification, Causes and Impacts of Infrastructure i.e. Road/ Railways/ Dam Building on the Environment, Land related Policy and Management.		
Unit-4: Mineral Resources: Geographical Distribution, Mineral Exploration, Impact of Mining on the Environment, Mineral Exploration for Sustainable Development, Energy Resources, Renewable and Non-Renewable, Development vs. Environment, Mineral Resource Management.		
Unit-5: Forest Resource: Classification, Causes of Degradation, Consequences, Conservation and Management, Forestry, Afforestation, Reforestation, Deforestation, Sacred Grooves, Social Forestry, Agro Forestry, Heritage tree, Urban Forest, Forest Restoration		
SUGGESTED BOOKS:		
 Moorthy V. V. N., Land and water management, Kalyani 2006		
 Gaston K.J. and Spicer: Biodiversity – An Introduction, Blackwell Publishing Krishnamurthy K. V. (2003)		
 Textbook of Biodiversity, CRC Press. 2004		
 Krishnamurthy K. V. An Advanced Textbook on Biodiversity: principles and Practice, Oxford & IBH Pub. Co. Pvt. Ltd. 2008		
 B.N. Pandey. Biodiversity Issues Threats and Conservation. Narendra Publishing Navjot S. Sodhi and Paul R. Ehrlich (Eds.) 2010. Conservation Biology for All.Oxford University Press 2012.		

Programme	Year: FIRST	Semester: FIRST
Paper-3 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060703T	Course Title: Natural Hazards and Disaster	
Course Outcome (CO): After completing the course the student will be able to: ➤ To discuss the various components of the disaster cycle. ➤ To evaluate the various methods used to manage environmental hazards and disasters. ➤ Identify, describe and discuss the physical and environmental systems of the Earth from macro to micro scales. ➤ Identify, describe and discuss the causes of primary and secondary impacts associated with particular natural environmental hazards ➤ Learning about the disaster management		
Unit/ Topic		
Unit-1: Hazards, Vulnerability, Risk, Disaster, Disaster Management Cycle, Nuclear Hazards, Biological Hazards & Chemical Hazards, Drought, Early Warning System.		
Unit-2: Masswasting: Definition, Landslides, Classification, Types, Role of Human Activity, Prevention and Control, Avalanche, Glacial Hazards, GLOF, Land Subsidence.		
Unit-3: Coastal Hazards: Tropical Cyclones, Tsunamis, Typhoon, Coastal Erosion, Sea Level Changes and It’s Impact on Coastal regions, Coastal Regulation Zones, Flood: Causes, Impacts, Flash flood, Urban Flooding, Flood Hazard Mapping & Management, Cold Wave, Heat Wave.		
Unit-4: Earthquakes: Nature of Earthquakes, Causes, Mercalli Intensity Scale, Richter Scale, Intensity and Magnitude of Earthquakes, Geographic Distribution of Earthquakes Zones in India, Seismic Waves and Seismicity.		
Unit-5: Volcanism: Definition, Types of Volcanoes, Geographic Distribution of Volcanoes, Causes of Volcanic eruption, Significance of Volcanic eruption, Forest Fire, Ring of Fire		
SUGGESTED BOOKS: 📖 Bell F.G., Geological Hazards: Their Assessment, Avoidance & Mitigation, Taylor and Francis, 2003. 📖 Alexander D., Natural Disasters, ULC press Ltd, London, 1993. 📖 E. Bryant, Natural Hazards, 2nd Edition, Cambridge University Press. 📖 National Policy on Disaster Management, NDMA, New Delhi, 2009. 📖 A Global Report - Reducing Disaster Risk, A Challenge for Development; UNDP— Publication, 2004		

Programme	Year: FIRST	Semester: FIRST
Paper-4 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060704T	Course Title: Remote Sensing & GIS Technology	
Course Outcome (CO) : After completing the course the student will be able to: ➤ Learning the Scales of meteorology, application of meteorological principles to transport and diffusion of pollutants, scavenging processes. ➤ Learning the Atmospheric disturbances ➤ Building a foundation for understanding Remote Sensing and Geographic Information System (RS-GIS) as a powerful tool for geospatial analysis. ➤ Build the foundation of understating of cartography, digital image, spatial and non-spatial data and geospatial terminology. ➤ Learn about data and sources (RS based and other sources, field data collection) and integrate those into GIS environment for analysis.		
Unit/ Topic		
Unit-1: Remote Sensing: History, Principles, Electromagnetic Spectrum (EMS), Resolution, Atmospheric Window, Visual Image Interpretation, Satellite Data, LIDAR, RADAR, Multispectral, Hyperspectral, Mars mission.		
Unit-2: Platforms and Sensors: Ground Based, Air Borne, Space Borne, Aerial Photography, and Image Interpretation. Digital Image Processing, Supervised, Unsupervised Classification, Accuracy assessment, Drone Technology, Mobile Mapping.		
Unit-3: Geographical Information System (GIS): Landuse /Land Cover Mapping, Change Detection Analysis, Agricultural Crop Mapping, Digital Terrain Model (DTM), Digital Surface Model (DSM), Digital Elevation Model (DEM) Population Dynamics, Urban sprawl, Geoinformatics, Spatial and Non Spatial data.		
Unit-4: Global Positioning System (GPS): DGPS, Application in Environmental Mapping. Map Composition		
Unit-5: Application of RS/ GIS/ GPS in Environmental Managements (Air/ Water/ Land/ Forest/ Disaster/ Geosciences/ EIA/ Pollution/Waste Management/ Biodiversity Conservation/ Wildlife Management/ Ecotourism and Global Climate Change)		
SUGGESTED BOOKS: ☞ Lillesand T. M., Remote Sensing and Image Interpretation. John Wiley, 7th Edition, 2015 ☞ Burrough P.A. and McDonnell R.A., Principles of Geographical Information Systems. 2nd Edition, Oxford University Press, 2006. ☞ Jense J. R., Remote Sensing of the Environment – An earth resource perspective. Pearson Education, 2nd Edition, 2013		

L060705P: PRACTICAL BASED ON THEORY PAPERS (1, 2, 3 & 4) / FIELD WORK. * PROJECT WORK/ DISSERTATION (CONTINUE..)

***MINOR ELECTIVE FROM OTHER FACULTY.**

SEMESTER –II

Programme	Year: First	Semester: Second
Paper-1 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060801T	Course Title: Environmental Chemistry	
Course Outcome (CO) : After completion of the course, students will be able to:		
➤ Learn the basic and fundamental principles of environmental chemistry. ➤ Learn the chemical reactions in the atmosphere and water, including important chemical reactions in connection with SO_x, NO_x, photochemical smog, Ozone chemistry and acid rain chemistry. ➤ Demonstrate an understanding of major concepts, theoretical principles and experimental findings in chemistry. ➤ Use and application of laboratory methods and scientific instrumentation to investigate a scientific hypothesis, conduct experiments, analyze data and interpret results ➤ They will be able to apply previous knowledge on analytical chemistry to environmental processes and samples.		
Unit/ Topic		
Unit-1: Air Chemistry: Formation of Inorganic and Organic Particulate Matter, Thermo-Chemical Reaction in the Atmosphere. VOCs, Green Chemistry, Antigun, Air Purification Tower, Vertical Garden, Smart Tree, Atmospheric Science		
Unit-2: Oxygen and Ozone Chemistry, Chemistry of Air Pollutants, Smoke, Fog, Mist, Photochemical Smog.		
Unit-3: Water Chemistry: Properties of Marine Water, Surface Water, Ground Water, Chemical Composition, Eutrophication, Sedimentation, Coagulation, Filtration, Redox Potential, Waste Water Treatment Plant (WWTP), Effluent Treatment Plant (ETP), Sewage Treatment Plant (STP), Bio Water, Water ATM, Biomagnification, Heavy Metals (Hg, As, Pb etc.), Desalination, RO water, Mineral Water, Drinking water.		
Unit-4:Environmental Parameters: Physical, Chemical and Biological parameter of Water, pH Scale, Acidity, Hardness, Alkalinity, Nitrate, Nitrite, DO, BOD, COD, Eutrophication, Bioindicators, Environmental Standards for Air/Water/Soil (National/ International)		
Unit-5: Soil Chemistry: Chemical Composition of Soil, Soil Health, Bioremediation, Phytoremediation, Phytogrid Technology, Composting, Vermicomposting, Organic Farming, Natural farming, Green Manure, Soil Resistivity Meter, Silviculture.		
SUGGESTED BOOKS:		
 Environmental Chemistry: Anil K. De New Age International Publisher		
 A Text Book Environmental Chemistry, V. Subramanian, I K International Publishing House Pvt. Ltd.		
 Introduction of Environmental Chemistry 2nd Edition: Julian E. Andrews, Peter Brimblecombe, Tim D. Jickells , Peter S. Liss , Brian Reid, Publisher Wiley-Blackwell.		

	Textbook of Environmental Chemistry: Balram Pani, Second Edition, Publisher I K International Publishing House Pvt. Ltd	
	Advanced Environmental Chemistry: V. K Ahluwalia, Publisher The Energy and Resources Institute (TERI) Press New Delhi.	
	Environmental Chemistry: Colin Baird and Michael Cann, Fifth Edition, Publisher : WH Freeman	
	Principle of Environmental Chemistry: Third Edition, James E. Girard, RSC Publishing,	
Programme	Year: First	Semester: Second
Paper-2 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060802T	Course Title: Instrumentation and Biostatistics	
Course Outcome (CO): After completion of the course, students will be able to:		
➤ Learns the application of electron microscopy to structural biology, Gets acquainted with various types of dyes used for fluorescence microscopy. Understands the principle and application of chromatography, electrophoresis, photometry, spectrometers etc. ➤ Learns about methods to determine concentrations of biological macromolecules through use of UV absorption spectroscopy. ➤ Demonstrate extensive knowledge of the disciplinary foundation in the various areas of Instrumentation, as well as insight into contemporary research and development in environmental monitoring. ➤ Demonstrate specialized methodological knowledge in the specialized areas of Instrumentation and biostatistics about professional literature, statistical principles and reviewing scientific work. Know basic concepts of probability and biostatistics. ➤ Able to describe statistical methods and probability distributions relevant for environmental (Air/Water/Soil/Noise) monitoring.		
Unit/ Topic		
Unit-1: Microscopy: Compound, Phase Contrast, Florescent, Electron Microscope, Electrophoresis, BOD Incubator, COD Digester, Water Quality Analysis Kit, Soil Quality Analysis Kit.		
Unit-2: Spectrocolorimeter, Spectrofluorimetry, Atomic Absorption Spectrophotometer, ICPMS, Flame Photometer, Sound Level Meter, pH Meter, Stack Monitoring Kit, Electrophoresis, XRD, NMR, Piezometer.		
Unit-3: Chromatography: Paper Chromatography, Gas and High Pressure Liquid Chromatography (HPLC), Smoke Meter, Respirable Dust Sampler (RDS), High Volume Sampler (HVS), Fine particulate sampler (PM_{2.5}, Ultrafine), CO Analyzer, Ozone monitor, Continuous Air Quality Monitoring Index, Anemometer, VOCs meter.		
Unit-4: Application of Biostatics in Environmental science, Data Collection, Sampling Methods, Data Classification, Tabulation, Graphical and Diagrammatic Presentation, SPSS, Innovation in Environmental Instrumentation Technologies.		
Unit-5: Probability, Mean, Arithmetic Mean, Geometric Mean, Median, Mode, Central Tendency, Standard Deviation, T-Test, F-Test, Chi-Square Test, Analysis of Variance, ANOVA, Correlation and Regression.		

SUGGESTED BOOKS:

- Wilson, K and Walker J.: Principles and Technique of Biochemistry and molecular Biology, Cambridge.
- Seader, J.D. and Henley, E.J.: Separation Processes Principle, John Wiley and Sons, Inc. New York.
- Mark F. Vitha: Chromatography: Principles and Instrumentation., Wiley
- A.K. Sharma: Text Book of Biostatistics & Marcello Pagano and Kimberlee Gauvreau: Principles of Biostatistics.
- Veer Bala Rastogi: Biostatistics.

Programme	Year: First	Semester: Second
Paper-3 (Theory)	Subject: Environmental Sciences &Technology	
Course Code: L060803T	Course Title: Environmental Geoscience	
Course Outcome (CO): After completing the course the student will be able to:		
➤ Learn the basic principles of Environmental Geosciences. ➤ Learn the earth processes. ➤ Learning rock types and rock cycle. ➤ Learn the chemical properties of rock, geomorphology, structural geology ➤ Learning the engineering geology.		
Unit/ Topic		
Unit-1: The Earth: Composition of Crust, Mantle, Core, Discontinuities, Plate Tectonic Movement, Hardness Scale, Environmental Geology, Environmental Sustainability, Earth Science		
Unit-2: Rocks: Types of Rock (Igneous, Sedimentary, Metamorphic), Rock Cycle, Geology Vs. Development, Causes and Impacts of Mineral Exploration on the Environmental, Mining Projects (National/ International).		
Unit-3: Geomorphology, Lithology, Stratigraphy, Geological Time Scale, Aquifers, Aquitard, Aquiclude, Ground Water Potential Zones, Medical Geology, Petrology, Paleosciences, Schmidt Hammer		
Unit-4: Structural Geology, Fault, Fold, Lineament, Interlinking of Rivers, Drainage Patterns, Geology Compass, Geodesy Geophysical Resistivity meter.		
Unit-5:Engineering Geology, Geotourism (National/ International), Geoheritage Sites, Infrastructure Developmental Projects (Roads/ Railways/ Dam/Canal/ Tunnel/ Valley)		

SUGGESTED BOOKS:

- 📖 Bell F.G., Geological Hazards: Their Assessment, Avoidance & Mitigation, Taylor and Francis, 2003.
- 📖 Don L. Anderson, Theory of the Earth. Blackwell Scientific Publications, 1989.
- 📖 Smith K. and Ward R., Floods: Physical Process and Human Impacts, John Wiley and Sons, 1998
- 📖 Kale V.S., Flood studies in India, Geological Society of India, 1998
- 📖 Krauskopf K.B. and Bird D.K., Introduction to Geochemistry. McGraw-Hill, 1994
- 📖 Bell F.G., Environmental Geology - Principles and Practice, Blackwell Science, 1998

ELECTIVE (ANY ONE)

Programme	Year: First	Semester: Second
Paper-4 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060804T	Course Title: Climate Change and Meteorology	
Course Outcome (CO): After completing the course the student will be able to: ➤ Learning the impacts of climate change ➤ Understand the climatic shifts due to climatology ➤ Learning the fundamental of meteorology ➤ Learning the Scales of meteorology, application of meteorological principles to transport and diffusion of pollutants, scavenging processes. ➤ Learning the Atmospheric disturbances over polar regions of the earth (arctic and Antarctica)		
Unit/Topic		
Unit-1: Climate Change: Theory of Climate Change, Climate and Society, Global Warming Potential (GWP), Ozone Depletion, Acid Rain, Earth Summit, Kyoto Protocol, Montreal Protocol, COP, IPCC, UNEP, UNESCO, UNDP		
Unit-2: Meteorology Fundamentals: Pressure, Temperature, Wind, Evaporation, Condensation, Fog and Effect of Meteorological Parameters on Pollutants and vice-versa, Wind Rose, Topographic Effects, Atmospheric Stability, Adiabatic Processes, Environmental Lapse Rate, Black Carbon, IMD, WMO		
Unit-3: Climatology, Clouds, Seasons Of India. Monsoon, Weather, Climate, El Nino, La Nina, Paleoclimatology, Environmental Isotopes, Atmospheric Science		

Unit-4: Oceanography, Greenhouse Gases, Impacts Of Sea Level Rise, Global Cooling, Impacts of Oil Spills, Marine Pollution, Diatoms, Carbon Sequestration, Economic Corridors, Ecosensitive Zones, Coral Bleaching, Marine Resource, Blue Economy, Marine Ecology.

Unit-5: Policies and Technologies to reduce impacts of Climate Change on Antarctic (South Pole), Arctic (North Pole), Southern Ocean and Indian Himalayas.

SUGGESTED BOOKS:

- 📖 Lillesand T. M., Remote Sensing and Image Interpretation. John Wiley, 7th Edition, 2015
- 📖 Burrough P.A. and McDonnell R.A., Principles of Geographical Information Systems. 2nd Edition, Oxford University Press, 2006.
- 📖 Jense J. R., Remote Sensing of the Environment – An earth resource perspective. Pearson Education, 2nd Edition, 2013

Programme	Year: First	Semester: Second
Paper-5 (Theory)	Subject: Environmental Sciences &Technology	
Course Code: L060805T	Course Title: Soil Science	
Course Outcome (CO): After completing the course the student will be able to: ➤ Learn the basic principles of Soil Science. ➤ Learn the soil forming factor, soil forming processes ➤ Learning Soil classification. ➤ Learn the chemical properties of soil colloids, ion exchange (cation and anion exchange phenomena) CEC, pH, SAR, ESP and buffering capacity. ➤ Learning the Soil biology related to soil fertility and soil enzymes.		
Unit/ Topic		

Unit-1: Soil Genesis: Weathering Processes (Physical/ Chemical/ Biological) and Soil Formation (Soil Forming Factor and Processes) Pedology.

Unit-2: Soil Classification: US Soil Classification (Taxonomy), Canadian Soil Classification, Indian Soil Classification.

Unit-3: Physico-Chemical Properties of Soils (Soil Colour, Structure, Texture, Particle Density, Bulk Density, Porosity, Moisture, Infiltration, Soil Aeration), Soil Colloids, CEC, pH, SAR, ESP, Buffering Capacity, Soil sampling

Unit-4: Soil Organic Matter: Sources, Composition, Microbial Decomposition of Organic Matter, Nature and Properties of Humus, Role of Microbes in Soil Fertility, Soil Profile.

Unit-5: Land Degradation, Sodic Soils, Soil Erosion, Types and Causes of Soil Erosion, Soil Conservation. Soil Museum, Types of Soil in India. Waste Land and It's Management.

SUGGESTED BOOKS:

- 📖 Brady, N.C. and Well, R.R.: The nature of properties of soil 14th Eds. Pearson Education Inc. Upper Saddle River New Jersey USA (2008).
- 📖 Boul, SW, Hole, FD., McCracken RJ. et al., 1997. Soil genesis and classification. 4th Eds. Ames. IA. Iowa state University Press.
- 📖 Boul,. SW., Southord,. P.J., Graham, R.C. and McDaniel, F.A.: Soil genesis and classification. 6th Edition John Wiley and Sons. New Yourk (2011).
- 📖 Soil Survey Division Staff.: Soil Survey Manual. USDA-NRCS Handbook No. 18, Washington, D.C. p. 437 (1993)
- 📖 Soil survey staff : Key to soil taxonomy USDA, NRCS (2010).

L060806P: PRACTICAL BASED ON THEORY PAPERS (1, 2, 3, 4 & 5)/ FIELD WORK.

L060807R: RESEARCH PROJECT/ DISSERTATION/ REVIEW PAPER/ INDUSTRIAL TRAINING.

SEMESTER –III

Programme	Year: Second	Semester: Third
Paper-1 (Theory)	Subject: Environmental Sciences &Technology	
Course Code: L060901T	Course Title: Environmental Impact Assessments and Sustainable development	
Course Outcome (CO): After completing the course the student will be able to: ➤ Explain the concepts about the environmental Impact assessment (EIA) and prepared EIA report. ➤ Identify and explore impact assessment fields and approaches. ➤ Develop skill to evaluate the issues and problems in environmental assessment from the perspective of process and methods, and the goals of EIA. ➤ Enable to practice EIA that examines the environmental consequences of development actions, in advance for environmental sustainability ➤ Lay foundation on the concept and components of environmental impact assessment and sustainable development ➤ Enable to practice EIA that examines the environmental consequences of development actions, in advance.		
Unit/ Topic		
Unit-1: Environmental Impact Assessment: Introduction, Concept, Significance, Comprehensive and Rapid EIA, Strategic Environmental Assessment (SEA), TOR, EAC & SEAC, Methods of EIA.		
Unit-2: Environmental Impact Assessment of Major and Minor Development Project: Industries, Mining, Thermal Power Plants, Atomic Power Station, Transport, Tourism and Bricks etc.		
Unit-3: Predictions and Assessment of Impact on Air, Water and Noise Pollution, Waste, Environmental Clearance.		
Unit-4: Life Cycle Assessment for Environmental Management, Environmental Management System Standard, EMS Standard: ISO 14000 Series		
Unit-5: Environmental Audit: Introduction, Concepts, Waste Audit, Cost Benefit Analysis, Environmental Design, Ecomark, Eco-Labeling		
SUGGESTED BOOKS: ➤ Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science. ➤ Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGrawHill, New York, USA.—N.S. ➤ Raman, A.R. Gajbhiye, S.R. Khandeshwar: Environmental Impact Assessment, Wiley.		

 Benard A Omoyeni , Principles and Application of Environmental Impact Assessment (EIA) Publisher: Benard a Omoyeni.  Andrew Chadwick, John Glasson, Riki Therivel, Introduction to Environmental Impact Assessment, publisher Routledge.  Environmental Impact training manual https://www.iisd.org/learning/eia/wp-content/uploads/2016/06/EIA-Manual.pdf  Peter Wathern, Environmental Impact Assessment - Theory and Practice, Publisher: Taylor & Francis Ltd		
Programme	Year: Second	Semester: Third
Paper-2 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060902T	Course Title: Energy Resources & Management	
Course Outcome (CO): After completing the course the student will be able to: ➤ Gain skill on conventional and non-conventional sources of energy, Acquire the knowledge on biomass and geothermal energy. ➤ Concept of solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation. ➤ Understand the present scenario of state on different energy issue. ➤ Explore the concepts involved in wind energy conversion system by studying its components, types and performance. ➤ Illustrate ocean energy and explain the operational methods of their utilization.		
Unit/Topic		
Unit-1: Conventional and Nonconventional Energy Resources: Scope, Application of CNCE, Application of Alternative Energy Resources, Green Hydrogen. Net Zero Carbon Emission		
Unit-2: Green Energy: Solar Energy, Application of Solar Energy, Fossil Fuels, Coal, Petroleum, Natural Gas, CNG, PNG. Innovation in Green Technologies, Concept of 3 ‘R’ and 5 ‘R’, Environmental Economics.		
Unit-3: Bioenergy: Energy From Biomass, Conversion Technology, Biogas and Biogas Plant, Wind Energy, Chemical Energy, Magneto Hydro Dynamic (MHD) Power Generation, Biofuels, Concept of waste to wealth.		
Unit-4: Ocean Energy: OTEC, Tides and Wave Energy, Geothermal Energy, Policy and Planning		
Unit-5: Nuclear Energy: Fission and Fusion, Cryogenics, Space Pollution: Causes, Impacts and Management.		
SUGGESTED BOOKS: • John Twidell and Tony Weir: Renewable Energy Resources • N. K. Bansal : Non-Conventional Energy Resources • K.C. Kothari, D.P.Ranjan: Renewable energy sources and emerging Technology • G.D. Rai: Non-Conventional Energy sources, Khanna Publisher		

Programme	Year: Second	Semester: Third
Paper-3 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060903T	Course Title: Environmental Toxicology	
Course Outcome (CO): After completing the course the student will be able to: ➤ Understand toxicology and associated terms. Learn chemical properties of different group of compound and biological effects. ➤ The applied knowledge in biology and/or chemistry with specialization in the field of environmental toxicology. ➤ Gain skill of exposure assessment, dose response relationship and understanding of the mechanisms of action and effect of xenobiotics at multiple levels of biological organization. ➤ Understand the principles of environmental toxicology and how to assess toxicity. ➤ Use technical and analytical skills to quantify the level and effect of xenobiotics in environmental components (air, water, soil and biota).		
Unit/ Topic		
Unit-1: Toxicology: Principles, Importance of Toxicology, Classification of Environmental Toxicants, Animal Toxicity Test, Statistical Concept of LC₅₀/ LD₅₀, Frequency and Cumulative Responses, Responses of toxicants to Crop/ Animal/ Human, Dose Effect & Response relationship. Unit-2: Translocation & Toxic Effect of Xenobiotic, Mutagenic and Carcinogenic Compound, Influence of Ecological Biological and Chemical Factors, Environmental Pollution (Air/ Water/ Soil) by various Paint/ Leather/ Sugar/ Food/ Nuclear Industries etc. Unit-3: Biotransformation: Site, Enzymes and Reaction, Aquatic Toxicity Test (Acute, Sub-Acute Chronic and Sub-Chronic Test) Statistical Test of LC₅₀, Epidemiology. Unit-4: Basics Principles of Environmental Health, Industrial Toxicology, Principles and Methods of Occupational Health, Relationship of Occupational Health & Hygiene, Safety Measures. Unit-5: Health Maintenance: Health Survey and Analysis, Environmental legislations for Health and Safety, Health issues in the Working Environment, Environmental Hazards: Physical/ Chemical/ Biological and Ergonomics, Vital Statistic and Epidemiological Data for Demography, Hazard Evaluation in Environment pollution zone with specific emphasis on Radiological data. Role of technology in Occupational Health and Safety Management.		
SUGGESTED BOOKS:		
 Encyclopedia of Toxicology, 3 rd Edition, Elsevier		
 Karen E Brown, Thomas M Brown: Principle of Toxicology 3 rd Edition, CRC Press		

- 📖 Casarett & Doull's Toxicology: The Basic Science of Poisons, 9th edition.
- 📖 Spiegel M, Stephens LJ, Schaum's Outline of Statistics, McGraw Hill Forsyth D, Probability and Statistics for Computer Science, Springer
- 📖 R.K.Jain and Sunil S.Rao , Industrial Safety, Health and Environment Management Systems, Khanna publishers , New Delhi (2006)
- 📖 Industrial Safety -National Safety Council of India. Grimaldi and Simonds , Safety Management, AITBS Publishers , New Delhi (2001)

ELECTIVE (ANY ONE)

Programme	Year: Second	Semester: Third
Paper-4 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060904T	Course Title: Biodiversity Conservation & Wildlife Management	
Course Outcome (CO): After completing the course the student will be able to: ➤ Learn basic elements of ecology and environmental factors ➤ Developing understanding about ecosystem dynamics. ➤ Understand the different functions played by ecosystem. ➤ Learn the positive and negative interaction of the organism. ➤ Develop conceptual skills about biogeochemical cycles		
Unit/Topic		
Unit-1: Biodiversity: types, Hotspots, Biogeographic Zones in India, Agro climatic Zones, Natural and Anthropogenic Causes of Depletion, Red Data Book, Rare, Endangered, Threatened and Extinct species, Environmental Ethics.		
Unit-2: Biodiversity conservation: In-Situ And Ex-Situ Conservation, Biodiversity Park, Green Corridors, Green Belt, Green Muffler, Environmental Movements-Chipko, Silent Valley, Bisnois of Rajasthan		
Unit-3: Wildlife: Ecological balance, Importance and Impacts of Human wildlife conflicts, Wildlife Management, Agenda-21, Cartagena protocol, Nagoya protocol, Aichi biodiversity targets, CBD, Aquaculture, Watershed.		
Unit-4: Geographical distribution of wildlife, causes of depletion and extinction of wildlife, UNESCO World Heritage (Natural/ Cultural) Sites, Criteria-10, Environmental Psychology		
Unit-5: Ecosensitive Zones, Biosphere Reserves and Protected Area, National Parks, Tiger Reserves, Wildlife Sanctuaries, Butterfly Park, Botanical Garden, Zoological Garden, Bird Sanctuaries.		

SUGGESTED BOOKS:

- 📖 Ecology and Environment: P.D. Sharma., Rastogi Publication.
- 📖 Fundamental of Ecology: E. P. Odum,W. B. Saunders Company, USA 8. Ecology, 2nd Edition by Paul Colinvaux, Wiley.
- 📖 Ecology: From Individuals to Ecosystems by Michael Begon & Colin R. Townsend & John L. Harper; Blackwell publishing.
- 📖 Ecology: Theories and Applications (4th Edition) by Peter Stiling; Prentice Hall. Text Book of Environmental Studies, Erach Bharucha, Orient longman Pvt. Ltd., Ernakulam.

Programme	Year: Second	Semester: Third
Paper-5(Theory)	Subject: Environmental Sciences &Technology	
Course Code: L060905T	Course Title: Environmental Microbiology and Biotechnology	
Course Outcome (CO): After completing the course the student will be able to: ➤ Impart knowledge on microbial diversity and recent advancement. ➤ Gain in depth knowledge of role of beneficial and pathogenic microorganism in environment. ➤ Understand the application of microbes for production of different eco-friendly products. • Understand biotechnology and its application in Environment management. ➤ Understands the role of microbes in management of waste plant biomass and can apply knowledge in designing microbe-based processes for pulp, textile, biofuel and animal feed production industries. ➤ Will have gained insight on industrially important microbes, recent developments in fermentation processes and various optimization strategies at fermenter level.		
Unit/ Topic		
Unit-1: Microbes: Definition, Characters, Types and Importance, Xenobiotics.		
Unit-2: Fermentation Technology, Vermiculture Technology, Biofertilizer Technology, Significance of Biofertilizer in Agriculture, Role of Microbes in Degradation of waste, Bioaccumulation, Biomagnifications. Biodegradation of Leather, Fiber, Food, Paper and Wood		
Unit-3: Micro-Flora of Atmosphere, Air, Water and Soil Sampling Techniques, Identification of Aeroallergens, Air Borne Diseases and Allergies, Soil Borne Diseases, Environmental Impacts on Food Technology, Entrepreneurial Microbiology.		
Unit-4: GEMs, Effect of Environmental Factors on Microorganism, Control of Air Pollution by Plants, Responses of Plants		

and Animals to Change in Physiochemical Characteristics and Distribution of Plants in relation to Pollution (Microphytes, Phytoplanktons, Periferons and Macrophytes). Nanotechnology, Sugar technology, Leather Technology, Role of Biomedical Sciences in environmental Management, Significance of Pharmaceutical Sciences in ecological balance.

Unit-5:Environmental Biotechnology: Concept, Technique, Transgenic Plants and Animals, Vaccines, Production of Vaccines, Culturing of Microbes, Animal Cells and Plant Cells, Plant Tissue Culture.

SUGGESTED BOOKS:

- 📖 Prescott, L.M., Hurley J.P.Klein, J.P.: Prescott's Microbiology, 11th Edition, McGraw Hill Publication, New York.
- 📖 Jacquelyn G Black, Laura J. Black Microbiology: Principles and Explorations 11th Edition, Wiley R.C. Dubey.
- 📖 Text book of Biotechnology, S. Chand publication.

Programme	Year: Second	Semester: Third
Paper-6(Theory)	Subject: Environmental Sciences & Technology	
Course Code: L060906T	Course Title: IPR, Bioethics & Biosafety	
Course Outcome (CO): After completing the course the student will be able to: ➤ To become familiar with India’s and global biosafety and bioethics policies. ➤ To provide basic knowledge on biosafety and bioethics and their implications in Environmental Science and Technological research. ➤ Will be able to differentiate the change detection of different acute and chronic diseases caused due to environmental pollution. ➤ To learn biosafety and risk assessment of products derived from innovative ideas of environmental conservation and management and regulation of such products. ➤ Learning of intellectual property rights and their significance.		
Unit/ Topic		

Unit-1: Intellectual Property Rights: Types of IP, Patents, Trademarks, Copy Rights and Related Rights, Industrial Design, Traditional Knowledge, Geographical Indication, IPs of relevant to Environmental Science & Technology.

Unit-2: Introduction to Indian Patent Law. World Trade Organization and Its related Intellectual Property provisions. Patenting in Research, Economic, Ethical and Depository Considerations.

Unit-3: Bioethics–Necessity of Bioethics, Different Paradigms of Bioethics – National & International. Ethical Issues against the Environmental Science & Technologies.

Unit-4: Bioethics in Research – Biodiversity conservation, Wildlife management, Waste management, Environmental Conservation and Management, Environmental Pollution, Disaster Management, Green technology

Unit-5: Patents and secret process: History of patenting, composition, subject matter and characteristics of a patent, inventor, infringement, cost of patent. Patents in India and other countries. Fermentation economics, Advances and trends, ethical issues, quality control, legislation, FDA & FPO, (India), safety and security at workplace.

SUGGESTED BOOKS:

- 📖 Indian Patent Law. Kalyan C Kankanala ; Arun K. Narasani ; Vinita Radhakrishnan. Oxford University Press, New Delhi
- 📖 Karen F. Greif and Jon F. Merz, Current Controversies in the Biological Sciences - Case
- 📖 Studies of Policy Challenges from New Technologies, MIT Press
- 📖 Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.
- 📖 National Biodiversity Authority. <http://www.nbaindia.org>

L060906T: PRACTICAL BASED ON THEORY PAPERS (1, 2, 3, 4, 5 & 6)/ FIELD WORK.

*** PROJECT WORK/ DISSERTATION (CONTINUE..)**

SEMESTER –IV

Programme	Year: Second	Semester: Fourth
Paper-1 (Theory)	Subject: Environmental Sciences &Technology	
Course Code: L0601001T	Course Title: Environmental Legislation	
Course Outcome (CO): After completing the course the student will be able to: ➤ Understand, develop & apply insights into the role of environmental laws for environmental protection and its people from activities that upset the earth and its life-sustaining capacities. ➤ Demonstrate the strengths and weaknesses in environmental law and its enforcement for developing strategies to overcome the same. ➤ Gain insights into the politics of environmental issues at globally. ➤ Debate on environmental policies and regulations and various movements in India. ➤ Develop perspective on important environmental issues that have become a matter of global policy making, international negotiations and trade disputes.		
Unit/ Topic		
Unit-1:Environmental Law: Significance, Indian Constitution, Article 48A, Article 51A(g), National and International Organizations dealing with Global Environmental Issues and Sustainable Development.		
Unit-2:Water (Prevention and Control of Pollution) Act-1974, The Water (Prevention and Control of Pollution) Cess Act, 1977, Water (Prevention and Control of Pollution) Cess Rules, 1978, Environmental Protection Act-1986.		
Unit-3:Hazardous Waste (Management and Handling) Rule 1989, Biomedical Waste (Management and Handling) Rule-1998, E-Waste (Management and Handling Rules-2011, Batteries (Management and Handling) Rules, 2001, Recycled Plastics, Plastics Manufacture and Usage Rules 1999, Basel Convention on Control of Trans boundary Movements on Hazardous Wastes and Their Disposal 1989, Hazardous Wastes (Management and Handling) Amendment Rules, 2003		
Unit-4:Wild Life Protection Act-1972, Biodiversity Act-2002, The Prevention of Cruelty to Animals Act-1960, Indian Forest Act-1972, Forest Conservation Act-1980, Disaster Management Act 2005, The Public Liability Insurance Act, 1991 National Green Tribunal Act-2010.		
Unit-5:Coastal Regulation zone notification 2018, The Energy Conservation Act, 2001, Compensatory Afforestation Fund Act, 2016, The Ozone-Depleting Substances (Regulation and Control) rules 2000, Air (Prevention and Control of Pollution) Act-1981, Air (Prevention and Control of Pollution) (Union Territories) Rules, 1983, Noise Pollution (Regulation and Control Rules-2000.		

SUGGESTED BOOK

- Abraham, C.M. 1999. Environmental Jurisprudence in India. Kluwer Law International.
- Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. Bulletin of the National Institute of Ecology 15: 227-238.
- Divan, S. & Rosencranz, A. 2002. Environmental Law and Policy in India: Cases, Materials and Statutes (2nd edition). Oxford University Press.
- Leelakrishnan, P. 2008. Environmental Law in India (3rd edition). LexisNexis India.
- Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International.

Programme	Year: Second	Semester: Fourth
Paper-2 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L0601002T	Course Title: Green Technologies for Pollution Control	
Course Outcome (CO): After completing the course the student will be able to:		
➤ Able to understand the green chemistry. Familiarise with different technologies for green technology. ➤ Develop understanding about different types of monitoring techniques available for solid, liquid and gaseous environmental pollutants. ➤ Ability to apply recycling vis-à-vis resource recovery technologies for useful conversion of specific waste type to eco-friendly products ➤ Examine the critical linkage between various environmental pollution (like air/ water/soil etc.) and their impacts on human health. ➤ Will develop understanding on the mode of various source, causes of diseases as triggered by the spread of contaminants in soil, water and air. Understand and analyze different types of pollution and the guidelines for their control in the context of public health.		
Unit/Topic		
Unit-1: Green Technology: Definition and Concepts, Major Challenges and Opportunities, Green Planning: Role of Governmental Bodies, Land Use Planning, Concept of Green Cities, Waste Reduction and Recycling in cities and urban/rural sector.		
Unit-2: Green Infrastructure: Green Buildings; History of Green Buildings, Need of Green Buildings over Conventional Buildings, Construction of Green Buildings, Wind Turbines, Solar Panels, Applications of Green Technologies: Green House Gases, Emissions Reduction, Carbon Capture and Storage (CCS) Technologies, Global Warming Potential, Locust attack, Stubble burning and management, Carbon Credit, Green Tax		
Unit-3: Air Pollution, Air Borne Diseases, Technologies for Air Pollution Monitoring, Vehicular Pollution, Air Quality Index, Water Pollution: Types, Sources and Effects, Water Borne Diseases, Technologies for Water Pollution Management, Water Quality Index.		
Unit-4: Soil Pollution, Causes, Sources and Effects, Technologies for Soil Pollution Management, Flyash, Noise Pollution, Sources & Effects on human and animal health. Innovative Technologies for Noise pollution control, Plastic pollution,		

waste management

Unit-5: Thermal Pollution, Radioactive Pollution, Space Pollution, Nuclear Pollution, Types, Sources and effects of Pollutants, Technologies for Environmental Pollution Management, Light pollution, Radioactive pollution

SUGGESTED BOOKS:

- 📖 Environmental and Pollution Science. Elsevier Academic Press. 5. Purohit, S.S. & Ranjan, R. 2007.
- 📖 Ecology, Environment & Pollution. Agrobios Publications. 6. Vesilind, P.J., Peirce, J.J., & Weiner R.F. 1990.
- 📖 Air Pollution and Health. The Royal Society of Chemistry, UK. 3. Park, K. 2015.
- 📖 Textbook of Preventive and Social Medicine (23rd edition). Banarsidas Bhanot Publishers. 4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006.
- 📖 Text book of preventive and social medicine, Banarsi Das & Bhanot, Jabalpur. Smith, K.R. 2013.
- 📖 Biofuels, air pollution and health: a global review. Springer Science & Business Media.

ELECTIVE (ANY ONE)

Programme	Year: Second	Semester: Fourth
Paper-3 (Theory)	Subject: Environmental Sciences &Technology	
Course Code: L0601003T	Course Title: Research Methodology	
Course Outcome (CO): After completing the course the student will be able to: ➤ To become familiar with recent research methodologies in the field of environmental science and technology. ➤ To provide basic knowledge of global research on environmental science and technology. ➤ Will be able to know about various research concepts methods on environment related issues. ➤ Will be able to upgrade the knowledge on the recent advancement on the issues of environmental pollution. ➤ To learn the research methodologies for creation of innovative ideas on environmental conservation and management.		
Unit/ Topic		

Unit-1: Introduction to Research Methodology: Objectives and Motivation in Research and Innovation in Environmental Science and Technology.		
Unit-2: Defining The Research Problem: Selecting and Defining a Research Problem, Reviewing And Conducting Literature Search, Developing a Research Plan, Project Proposal.		
Unit-3: Types and Methods of Research: Classification of Research, Pure and Applied Research, Exploring or Formulative Research, Descriptive Research, Diagnostic Research/ Study, Evaluation of Research/ Studies, Action Research, Experimental Research.		
Unit-4: Designing of Experiment: Different Experimental Designs – Single and Multifactorial Design, Making Measurements and Sources of Error in Measurements, Methods of Data Collection and Record Keeping.		
Unit-5: Data Processing and Statistical Analysis: Processing Operations, Tabulation, Graphical Representation, Statistics in Research: Concepts of Sample and Population, Report Writing, Writing a Research Paper - Abstract, Acknowledgement, Introduction, Methodology, Results and Discussion, References, Poster presentation, Oral presentation, Review paper, White paper, writing, Journal Research Paper Writing, Book Writing, Book chapter writing, Scientific article writing, Documentary making, Software used in the academic writing.		
SUGGESTED BOOKS:		
📖 Research Methodology: Methods & Techniques by C.R. Kothari, New Age International Publishers.		
📖 Statistical Methods for Research Workers by Fisher R.A., Cosmo Publications, New Delhi.		
📖 Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.		
📖 Research Methodology: A step by step for beginners by Ramjet Kumar, Sage Publication		

Programme	Year: Second	Semester: Third
Paper-4 (Theory)	Subject: Environmental Sciences & Technology	
Course Code: L0601004T	Course Title: Artificial Intelligence and Machine learning in environmental modelling	
Course Outcome (CO): After completing the course the student will be able to: ➤ Able to understand the Artificial intelligence and machine learning. ➤ Understand the Big Data science		

- Familiarise with different technologies for application in environmental modelling.
- Develop understanding about different types of monitoring techniques available for solid, liquid and gaseous environmental pollutants by artificial intelligence.
- Ability to apply recycling vis-à-vis resource recovery technologies for useful conversion of specific waste type to eco-friendly products with latest technologies

Unit/Topic

Unit-1: Modern Programming Methods, Computational Mathematics.

Unit-2: Applying Computational/Data Science in Climate change, Global Warming, Population dynamics, Air, Water, Land, Disaster Management, Biodiversity conservation, Wildlife management, Smart City, Eco-Villages

Unit-3: Environmental Data Management, AI/ ML Application in Environmental Pollution, conservation and management, Hazardous Waste, Biomedical Waste, Solid Waste, Plastic Waste, E-Waste Management.

Unit-4: Big Data Analytics for Environmental Modelling, Space Pollution, Nuclear War, Chemical War and Biological War.

Unit-5: Artificial Intelligence, Machine Learning, Application of AI/ ML in Environmental Management.

SUGGESTED BOOKS:

- 📖 Allegrini I, De Santis F. (Ed), Urban Air Pollution: Monitoring and Control Strategies, Springer
- 📖 Environmental and Pollution Science. Elsevier Academic Press.
- 📖 Clarke A.G. , Industrial Air Pollution Monitoring, Springer
- 📖 Air Pollution: Health and Environmental Impacts. CRC Press, Taylor & Francis.
- 📖 Ecology, Environment & Pollution. Agrobios Publications.

L0601005T: MOOC COURSE FROM SWAYAM OR NPTEL WITH EQUIVALENT CREDITS

L0601006R: SUMMER TRAINING/DISSERTATION/PROJECT WORK/ INTERNSHIP/ REVIEW PAPER

Proposed seats-20

Fees: 45,200/- Ist year 46,600-IIInd year