M. Sc. Environmental Sciences

Syllabus

UNIVERSITY DEPARTMENT

Program Code: ENVA

2025– 2026 onwards

BHARATHIAR UNIVERSITY

(A State University, Accredited with "A++" Grade by NAAC,

Ranked 26th among Indian Universities by MHRD-NIRF)

Coimbatore - 641 046, Tamil Nadu, India

Program Educational Objectives (PEOs)	
The **M.Sc. Environmental Sciences** program describe accomplishments that 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, Industries and Non-governmental Organizations (NGOs).
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, biofertilizer and biopesticide 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, bioresource utilization and biodiversity conservation organizations, food and feed Industries, environment friendly and integrated livestock management sectors.
PEO5	Students have 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, bioresource utilization and biodiversity conservation, functional and ecosystem ecology, environmental toxicology, zero agrowaste 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.

Program Specific Outcomes (PSOs)	
After the successful completion of M.Sc. Environmental Sciences program, the students are expected to	
PSO1	Get practical knowledge about various physico-chemical parameters, mechanisms of chemical reactions and removal/reduction of air, soil and water pollutants from the environment through different techniques.
PSO2	Understand the importance and conservation perspectives of natural resources, impact of climate changes in environment, biological diversity and sustainable environmental management with restoration of functional ecosystem and ecology including environmental food security.
PSO3	Understand about the environmental toxicology, health issues and industrial safety perspectives in regional, national and global levels, environmental law, policies and importance and role of environmental impact assessment.
PSO4	Understand the basic and application of remote sensing and geographical information system in the studies and characterization of natural resources, geospatial, species distribution and mapping attributes in different environment and ecosystems.
PSO5	Understand about the wealth from waste, recycle, reuse, zero waste discharge, zero waste agroecosystem and environment through production of biocomposts and regenerating of useful byproducts from the waste and waste minimization aspects
PSO6	Understand the importance and role of microbial consortium along with biotechnological tools as nature based solution for effective implementation of bioremediation, waste management, green energy and sustainable environment.

Program Outcomes (POs)	
On successful completion of the M.Sc. Environmental Sciences program	
PO1	Students would acquire knowledge on the fundamental concepts of chemistry, atoms, molecules, bonding phenomenon, chemical reactivity and product outlet related to environmental chemistry. Students would also have more familiar with the classification of various pollutants such as air/ water/ soil and physical, chemical and biological control methods of above said pollutants in the environment.
PO2	Students could acquire knowledge with reference to designing of methods, way of data collection, analysis of data, interpretation of results to solve the environmental problems through the assessment of qualitative and quantitative characters, by using artificial intelligence, big data, data analysis and internet things.
PO3	Students will gets kill development on qualitative and quantitative analysis of environmental samples by using different analytical instruments techniques. Students also understand the work place hazards, mitigation by employing safety devices and also aware of environmental safety standards, certification, safety auditing and management perspectives.
PO4	Students gain knowledge about the importance of natural resources, distribution, utilization, conservation strategies, green energy sources and sustainable management perspectives. Further, students will also be able to understand the importance of environmental impact assessment, public participation in environmental impact assessment and EIA report preparation before implementing potential environmental projects in National, International, Regional and Local levels.
PO5	The students could understand the different type of natural disasters, causes, and impact on natural and man-made environments. Further, students gained knowledge will enable to become volunteers themselves in disaster management program for helping the affected community. Nonetheless, students will also acquire knowledge regarding the importance of preparedness in vulnerable areas. The students could understand the uses of sensors to collect spatial geographic data, generate geographical information by processing the digital data and application of RS, GIS and GPS tools to assess various environmental components such as distribution of forest area including Vegetation and wild animals, land and water resource area distribution and mapping etc.
PO6	Students will be able to acquired technical knowledge about the fundamentals of industrial effluent treatments, water and sewage wastewater treatments, environmental protection with pollutants free, zero waste discharge and operating of pollution control devices technology. Students will be able to understand the key features of environmental laws, acts and legal obligations, applying of green auditing tools and techniques, conducting of onsite assessment and preparation of audit reports be for implementing the potential public environmental projects.
PO7	Students will be able to gain technical skills and knowledge of the various environmental toxicants, toxicants in food, drugs, weedicides, heavy metals, pesticides, Organic and inorganic chemical molecules, exposure routes of toxicants, toxicological test methods and animal ethics to be followed in toxicological testing studies.
PO8	The students will be able to acquire and understand the management strategies of solid and liquid wastes from municipal and industrial sources, remediation measures of recycling, reuse and recovery from wastes, principles and mechanistic role of machines in the degradation of various pollutants. Students would have gained knowledge about

	the strategic phenomenon of environmental planning, life cycle assessment, material analysis, environmental impact assessment, risk assessment, environmental auditing, issues in various industrial sectors in cooperation with federal, state and local governing body and official work for mitigation strategies in issues pertaining to the environmental protection. Students will also be able to acquired knowledge about the role and importance of environmental education among the school children. Through obtaining the environmental awareness knowledge, students will be able to understand nature based mitigation efforts to save the sustainable environment and ecosystem for feature.
PO9	Students will be able to acquired practical knowledge about the need of agroforestry and biophysical process, role of agroforestry system in soil fertility and nutrient cycling, integrated livestock management, tree crops soil interaction, opportunities of employment and cash income through agroforestry.The students will be able to understand the importance and application of biofertilizers and biopesticides in soil fertility improvement and crop productivity and exploitation of their potential for sustainable agriculture. Students could also understand the integrated nutrient management and integrated pest management approaches through indigenous Knowledge based techniques.
PO10	Students will be able to understand and acquire knowledge about the recent approaches of industrial systems including sources and energy utilization, product generation and waste minimization to achieve zero pollution status. Further students will also be able to acquire practical knowledge on air quality monitoring attributes in urban and industrial environment, mitigation measures in industry, current national standards and guidelines for air quality assessment and maintaining the clean air environment.

BHARATHIAR UNIVERSITY: COIMBATORE 641046

M.Sc. Environmental Sciences Curriculum (University Department)

(For the students admitted during the academic year 2025-2026 onwards)

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
25ENVA13A	Environmental Chemistry	4	4		25	75	100
25ENVA13B	Environmental Microbiology and Biotechnology	4	4		25	75	100
25ENVA13C	Environmental Health, Industrial Safety and Sustainability	4	4		25	75	100
25ENVA13D	Instrumental Methods, Data Analytics and Research Methodology	4	4		25	75	100
25ENVA1EA-1 (or) 25ENVA1EA-2	Fundamentals of Ecology (or) Energy Resources and Conservation	4	4		25	75	100
25ENVGS18	Ecotourism	2	2		12	38	50
25ENVA13P1	Practical-I	4		6	40	60	100
	LIBRARY		**1**				
	SEMINAR		**1**				
	Total	**26**	**24**	**6**	**177**	**473**	**650**
SECOND SEMESTER							
25ENVA23A	Environmental Pollution	4	4		25	75	100
25ENVA23B	Environmental Toxicology	4	4		25	75	100
25ENVA23C	Environmental Impact Assessment and Green Auditing	4	4		25	75	100
25ENVA23D	Biodiversity and Conservation	4	4		25	75	100
25ENVA2EB-1 (or) 25ENVA2EB-2	Climate Change and Disaster Management (or) Environmental Geosciences	4	4		25	75	100
25ENVGS53	Natural Disaster Management	2	2		12	38	50
25ENVA23P1	Practical-II	4		6	40	60	100
	LIBRARY		**1**				
	SEMINAR		**1**				
	Total	**26**	**24**	**6**	**177**	**473**	**650**

THIRD SEMESTER							
25ENVA33A	Waste Management and Bioremediation	4	4		25	75	100
25ENVA33B	Environmental Law, Policy and Auditing	4	4		25	75	100
25ENVA33C	Remote sensing and Geographic Information System	4	4		25	75	100
25ENVA33D	Environmental Engineering	4	4		25	75	100
25ENVA3EC-1 (or) 25ENVA3EC-2	Introduction to Industry 4.0 (or) Industrial Ecology	4	4		25	75	100
25ENVGS03	Environmental Education and Awareness	2	2		12	38	50
25ENVA33P1	Practical-III	4		6	40	60	100
	Self-learning course - Health & wellness	1		1	100		100
	SEMINAR/ LIBRARY		1				
Total		**27**	**23**	**7**	**277**	**473**	**750**
FOURTH SEMESTER							
	Project Work and viva-voce Examination	8				200	200
	Industrial Visit and Summer Project	4				100	100
Total		**12**				300	**300**
Grand Total		**91**	**71**	**19**	**631**	**1719**	**2350**
CO-SCHOLASTIC COURSES							
ONLINE COURSES							
	Swayam, MOOC Course	2	-	-	-	-	-
VALUE ADDED COURSES							
Semester-1							
25ENVAVA01	Agroforestry	2	-	-	12	38	50
Semester-III							
25ENVAVA02	Bio-fertilizers and Bio-pesticides	2	-	-	12	38	50
JOB ORIENTED COURSES							
Semester-I							
25ENVAJO01	Ornamental Fish Farming	2	-	-	12	38	50
Semester-III							
25ENVAJO02	Air Quality Monitoring	2	-	-	12	38	50

The scholastic courses are only counted for the final grading and ranking. However, for the award of the degree, the completion of co-scholastic courses is also mandatory.

First Semester

Course code	25ENVA13A	ENVIRONMENTAL CHEMISTRY	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite	Basic knowledge on various chemical process	Syllabus Version	2025-2026			

Course Objectives:

The main objectives of this course are to:

1. Impart knowledge on the fundamentals of chemical process
2. Understand the environmental problems
3. Study for solving various environmental issues

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Have a basic understanding on the fundamental concepts of chemistry - atoms, bonding a chemical molecules	K2
2	Understand the sources, classification and formation of chemical pollutants and their impact on environment	K2
3	Have detailed knowledge on various physico-chemical parameters, chemical reactions and removal/reduction of air, soil and water pollutants from the environment	K2
4	Have the skill to design a field research on environmental problems for sustainable maintenance of the functional ecosystem	K3

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**- Analyze; **K5** - Evaluate; **K6** –Create

Unit:1	Fundamentals of Environmental Chemistry	14– hours

Definition - Concept and Scope - Preparation of Standard Solutions – Molarity, Molality, Normality, Percent and PPM (mg/l) Solutions. Stoichiometry, Gibbs energy, chemical potential, chemical kinetics, chemical equilibria, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes.

Unit:2	Atmospheric Chemistry	14– hours

Classification of Elements- Particles, ions and radicals in the atmosphere. Chemical speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog. Acid Rain; CFC and Ozone layer depletion.

Unit:3	Water Chemistry	14– hours

Structure and properties of water - Hydrological Cycle - Physical, chemical and biological parameters of Water – Phenomenon of Eutrophication - Concepts of color, odour, turbidity, pH, conductivity, DO, COD, BOD, alkalinity, Salinity, carbonates, redox potential, major cations & anions and heavy metals-Chemical composition of natural water types.

Unit:4	**Soil Chemistry**	**14– hours**
Physio-chemical composition of soil, Soil Structure, Texture, Inorganic and organic components of soil, Chemical properties of soil-saline. Acidic and alkaline soils, Macro and Micronutrients in soil, Humus and Organic Matter, Significance of C/N Ratio, Chemical reactions in soil, Soil pedogenic processes.		
Unit:5	**Global warming and green house gases**	**14– hours**
Green House Effect-Green house gases and its sources, impacts, consequences and remedial measures; Global warming, Carbon sequestration. Green technology Solution to Global Climate Change Mitigation, World and Indian scenario, Brown Haze, nuclear winter.		
Unit:6	**Contemporary Issues**	**2– hours**
Expert lectures, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72– hours**

Text Book(s)

1. Fundamental Concepts of Environmental Chemistry, Sodhi, G.S. (2009), Alpha Science International Ltd.
2. Environmental Chemistry, (5thEd.), De, A. K.(2002), New Age International (P)Ltd.
3. Fundamentals of Environmental Chemistry, 11th Edition, Manahan, E.S.(2022), CRC Press. Photochemistry & Spectroscopy, Simons ,J. P. (1971),Wiley Interscience.
4. Fundamentals of Photochemistry, Rohatgi-Mukherjee, K. K. (2006), New Age International (P) Ltd.
5. Elements of Environmental Chemistry, Jadhav, H.V.(1992), Himalya Publication House.
6. Environmental Chemistry, Sharma, B. K. andH.Kaur,H.(1994), Goel Publishing House
7. Environmental Chemistry, Moore, J.W. and Moore,E.A. (1976), Academic Press Inc.
8. Industrial Environmental Chemistry, Sawyer, D. T. and Martell, A. E. (1992). Springer-Verlog, New York.

Reference Books

1. Environmental Chemistry A global perspective, (4thEd.),Van Loon,G. W.and Duffy, S.J. (2017), Oxford University Press.
2. Chemistry of Atmospheres: An Introduction to the Chemistry of the Atmospheres of Earth, The Planets, and their Satellites (3rd Ed.), Wayne, R.P., (2000), Oxford University Press.
3. Basic Concepts of Environmental Chemistry (2nd Ed.), Connell, D.W.(2005), CRC Press.
4. Text book of Environmental Chemistry, Pani, B. (2007), IK International Publishing House.
5. Elements of Environmental Chemistry (2nd Ed.), Hites, R.A. (2012), Wiley & Sons.

6	Standard Methods for the Examination of Water and Waste Water, (23rdEd.), APHA,(2005), Washington, D.C.
7	Fundamentals of Soil Science, (8th Ed.), Futh, H. D.(2016),Wiley India.
8	Lehninger Principles of Biochemistry, (7th Ed.), Nelson, D. L. and Cox, M.M. (2017).W.H. Freeman & Co.
Related Online Contents [MOOC, SWAYAM, NPTEL,Websites etc.]	
1	https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ce57/
2	https://www.openlearning.com/courses/introduction-to-environmental-chemistry/
3	https://freevideolectures.com/course/2908/green-chemistry-an-interdisciplinary-approach-to-sustainability

Mapping with Programme Out comes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**
CO1	S	M	M	S	M	S	S	S	M	S
CO2	S	M	S	S	M	S	M	S	S	S
CO3	S	S	M	M	S	S	S	M	M	M
CO4	M	S	S	M	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	25ENVA13B	ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Knowledge in Basic Microbiology	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. Impart knowledge on microbial diversity and recent advancement methods in the analysis of microbial diversity.
2. Provide in-depth knowledge of role of beneficial and pathogenic microorganisms in environment.
3. Understand the application of microbes for production of different eco-friendly products.
4. Impart knowledge in molecular biotechnology and its applications in environmental management and conservation of biodiversity.
5. Make students aware about Bioethics, biosafety and IPR.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand and describe the type of microorganisms in the environment and the role of microorganisms in the cycling of nutrients in an ecosystem.	K2
2	Relate the role of micro-organisms in spread of human diseases and select the type of physical and chemical agents for microbial control.	K3
3	Understand the importance of plants and microbes in environmental remediation	K3
4	Know the ethical guidelines in use of GMOs, different biosafety levels and IPR.	K3
5	Know the importance of microbes and biotechnology for the synthesis of ecofriendly products.	K6

K1-Remember; **K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** -Create

Unit:1	Distribution / Diversity of Microorganisms	14-hours

Microflora in aquatic, terrestrial and air environment-bacteria, fungi and viruses, Extreme Environment – archae bacteria, acidophilic, alkalophilic, thermophilic, barophilic, osmophilic and radiodurant microbes. bioaerosols – sources, components, pathway and control methods; Role of Microorganism in Biogeochemical cycles - Nitrogen, Carbon, Phosphorus, Sulphur Cycle, Microbial corrosions.

Unit:2	Ecological Relationships Among the Microorganisms	14-hours

Relationship among microbial population, microbial interactions in a biofilm, Host-Microbial interactions – positive interactions - mutualism, syntropism, proto cooperation and commensalism; negative interactions - amensalism, competition, parasitism and predation. Microbial pathogens and Parasites and their effects on Human, Animal and Plant health, Transmission of pathogens–Bacterial, Viral, Protozoan, and Helminths, Control of microorganisms. Indicator microorganisms in air, water and soil Environment.

Unit:3	Molecular Techniques in Microbial Ecology	14-hours

Understanding microbial diversity in the environment by culture-dependent approaches and their Limitations and culture-independent molecular approaches. BIOLOG, microtitre plates, analysis of

FAME profiles, quantitative PCR (qPCR), fluorescent in situ hybridization and pyro sequencing.		
Unit:4	**Role of Biotechnology in Environmental Protection**	**14-hours**
Role of microbes in production of Bioenergy, Biosurfactants, Enzymes and Biopolymers. Development of Genetically Engineered Microorganisms (GEMs), Role of GMOs in bioremediation, Advantages of Genetically engineered plants; Bt insecticide; Microbial enhanced oil recovery (MEOR), Biosensors, Bionanotechnology.		
Unit:5	**Bioethics, Biosafety and IPR**	**14-hours**
Ethics of Genetically modified plants, animals, microbes, GM food and Biowarfare. Biosafety guidelines in India; Containment, different biosafety levels. Intellectual Property Rights-Patents, Copyrights, Trademarks, Trade secrets, -Plant variety protection (PVP) - Plant breeders rights (PBRs) - Genetic Use Restriction Technology (GURT).		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)	
1	Text book of Environmental Microbiology, Mohapatra, P.K.(2008), I. K. International (P) Ltd.
2	Environmental Microbiology, Pepper, I. L., Gerba, C. P. and Gentry, T. J. (2015), 3rd edition, Academia Press, Elsevier
3	Basic Biotechnology, Ratledge,C. and Kristiansen,B.(2003), 2nd edition, Cambridge University Press
4	Bioethics and Biosafety in Biotechnology, Sree Krishna.V. (2007), New Age International Publishers.
Reference Books	
1	Topics in Ecological and Environmental Microbiology, Schmidt, T. M.and Schaechter, M. (2012), 3rd edition, Academia Press, Elsevier.
2	Environmental Microbiology: Fundamentals and Applications: Microbial Ecology, Bertrand, J.C., Caumette, P. and Lebaron, P.(2015), Springer
3	Environmental Microbiology –Theory and Application, Jjemba, P.K. (2004), Science Pub. Inc., USA.
4	Environmental Biotechnology-Theory and Application, Evano, G.H. and Furlong, J.C. (2004), John Wiley and Sons, USA
5	Environmental Biotechnology and Cleaner Bioprocesses, Olguin, C.J., Sanchez, G., Hernandez. E. (2000), Taylor & Francis
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.researchgate.net/publication/51905295_Culture-independent_methods_for_studying_environmental_microorganisms_Methods_application_and_perspective
2	https://www.hindawi.com/journals/ijps/2015/326745/
3	https://pubmed.ncbi.nlm.nih.gov/23190337/

4	https://www.sciencedirect.com/science/article/pii/S0960852418304310?via%3Dihub
5	https://www.sciencedirect.com/science/article/pii/S0734975010000728
6	https://www.sciencedirect.com/science/article/pii/S0167779917301051
7	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6100491/

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	L	M	L	M	M	M	M	L	S	L
CO3	L	M	S	L	L	M	S	M	M	M
CO3	L	S	S	S	M	S	S	S	S	S
CO4	M	S	M	S	M	S	S	S	S	S
CO5	M	M	S	S	L	S	M	S	S	S

Course code	25ENVA13C	ENVIRONMENTAL HEALTH, INDUSTRIAL SAFETY AND SUSTAINABILITY	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Basic Knowledge on Occupational Health and Safety issues	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To introduce students to occupational hazards and to impart knowledge to handle health, Safety and Environmental sustainability practices at workplaces.
2. To know about the environmental norms and standards
3. To understand how health ,safety and environment Sustainability at work interact with each other

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Know about the local and global occupational health and sustainability issues and their importance	K2
2	Recognize health hazards and understands relevant functions and responsibilities of a safety expert in the working environments involving hazardous wastes, chemicals and other harmful substances, which can pollute the immediate environment and cause health problems for people.	K1& K2
3	Know about the environmental norms and standards	K2
4	Recognize, assess and evaluate occupational health hazards and sustainability measures	K3
5	Develop skills in analyzing, sensitizing and managing the community about environmental health issues	K3& K4

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Introduction and Concepts of Environmental Health	14-hours

Environmental Health - World Health organization (WHO)-concepts of environmental and public health. Human-environment interaction. Exposome –food and chemical exposure - Industrial Hazards and Safety–Physical, Chemical and Biological hazards. Occupational Diseases associated with different types of industries – construction, textile, steel and food processing, pharmaceutical. Occupational Health and Safety considerations in Wastewater Treatment Plants. Prevention measures - - Health Education Medical First Aid and Management of Medical Emergencies. Epidemiological approaches. Ergonomics–Need, Task Analysis, Prevention of Ergonomic Hazards, Ergonomics Programme.

Unit:2	Industrial Safety Management and Occupational Safety Laws	14-hours

Industrial Accidents Metrics – Accident Frequency Rate; Prevention and Control. Dispersion of Radioactive material and release of toxic and inflammable materials. Work Study – Measurement of workers skills. Safety Management - Principles and Functions in Safety Management - Factors affecting industrial safety– Concept of safety organization and management – Safety Regulations –Supervisors and Safety department in motivation. Economic considerations in Industrial Safety-Cost of safety related expenses – cost-benefit analysis of pollution control, resource conservation and risk mitigation in industrial settings. Preparation of report on safety –remedial measures followed in Industry. Occupational Safety and Health Act and Health Administration, Right to know Laws- Indian Acts – Labour Act, Factories Act, OSHA. Industrial Safety Standards – ISO systems for Environmental Health and Safety (EHS)–ISO 45000 and 18001. Environmental Social Governance (ESG) - Basic concepts and principles of ESG in the context of Environmental health and Industrial Safety. Parameters of safety.

Unit:3	Hazards Exposure Evaluation Control Measure	14-hours
Sampling techniques, Personal monitoring, Biological monitoring; Threshold Limit Values (TLV), STEL; List of Industries under the First Schedule and Second Schedule of the Factories Act, 1948; Environmental health agencies of India, USA and Europe. Databases of hazardous chemicals. Causes of Accident-Accident statistics-Accident Reporting system, Safety Audit, Accident prevention, Disaster Planning, Safety Committee, Case studies on Bhopal, Chernobyl and similar disasters - Hazards Control: Control of Hazards Substitutions, Engineering control, Administrative control, Behaviour control, integrated control, Elimination, Control, Substitution, Isolation, Personal Protective Equipment (PPE).		

Unit:4	Principles of Risk Assessment and Environmental Management	14-hours
Types of Risk Assessment: Human Health Risk Assessments, Ecological Risk Assessment, Probabilistic Risk Assessments, Determination of acceptable risk based limits for Environmental chemicals and development of risk based remediation goals. The role of Risk Assessment in Environmental Management decisions: Evaluation of Human Health Risks Associated with airborne exposures to asbestos, a diagnostic human health risk assessment for a contaminated site problem and a risk based strategy for developing a corrective action, Response plan for petroleum – contaminated sites, Risk Management and Risk Communication.		

Unit:5	Sustainable Environmental Management and Environmental Economics	14-hours
Environmental Education and Communication, Environmental Conflict Management, Sustainable development-indicators of sustainability, Sustainable Management of Forests, Ecosystem Management: Coastal Environments, River and Inland Water Environments, Wetlands, Desert margins, Rural and Urban Environments .Environmental Sustainability in Industries–CER (Corporate Environmental Responsibility). Current environmental issues in India– Case studies: Narmada Dam, Tehri Dam, Almatti Dam. Basic concepts of Environmental Economics, International Trade and its Environmental Integrity, Eco-labeling, responsible care, design for the Environment and full-cost accounting for municipal solid waste management. Introduction to WHO SDGs (17)-SDG 6,7,13,14,15-climate action, Clean water, Renewable energy.		

Unit:6	Contemporary Issues	2-hours
Expert lectures, online seminars –webinars, Recent development and advances		

	Total Lecture hours	72-hours

Text Book(s)

1	ABC of Industrial Safety, Walsh, W. and Russell, L.(1984), Pitman Publishing Ltd., United Kingdom.
2	Environmental and Industrial Safety, Hommadi, A.H. (1989), I. B. B. Publication, New Delhi.
3	A Practical Guide to Understanding Management and Reviewing Environmental Risk Assessment Reports, Benjamin, S.L. and Bullock, D.A. (2001), Lewis Publishers, Washington D.C
4	Hand Book of Environmental Risk Assessment and Management, Calow ,P. (1998), Blackwell-Synergy, London.
5	Environmental Management in Practice, Volume – I to III Instruments for Environmental Management, Nath, B., Hens, L., Compton, P. and Devuyst, D. (1998), Routledge,

	London and NewYork.
Reference Books	
1	Environmental Strategies–Hand Book, Kolluru, R. V. (1994), McGraw Hill Inc., New York.
2	Occupational Safety and Health for Technologists, Engineers and Managers, Goetsch, D.L. (1999), Prentice Hall.
3	Safety and Environmental Management, Della-Giustina, D.E. (1996), Van Nostrand Reinhold International Thomson Publishing Inc. New York.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/110/105/110105094/
2	http://safety.ucanr.edu/Safety_Notes/
3	https://mscunisza.files.wordpress.com/2017/10/lecture-note-occupational-health-and-safety-management.pdf
4	http://www.ucen.ucsb.edu/sites/www.ucen.ucsb.edu/files/safety_training_iipp.pdf
5	https://www.ncbi.nlm.nih.gov/books/NBK55873/
6	https://nptel.ac.in/courses/120108004
7	http://cbs.teriin.org/pdf/Waste_Management_Handbook.pdf
8	https://www.eschooltoday.com/waste-recycling/what-is-recycling.html

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	S	L	S
CO2	S	M	S	S	M	S	S	S	L	M
CO3	S	L	S	S	L	S	S	S	L	M
CO4	S	L	S	S	M	S	S	S	L	S
CO5	M	S	S	M	S	S	S	S	L	S

Course code	25ENVA13D	INSTRUMENTAL METHODS, DATA ANALYTICS AND RESEARCH METHODOLOGY	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Basic knowledge on Environmental parameters	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To understand the principles, instrumentation and application of various spectroscopic techniques based equipment for evaluating the morphological, qualitative and quantitative characteristics of environmental samples and pollutants.
2. To understand the extraction, isolation and characterization of different environmental samples through chromatographic and electrophoretic techniques.
3. Impart understanding on the concepts of statistics
4. To understand the basic concepts of Big data analytics
5. To understand the research methodology

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand the basic principles, working phenomena and application of various sophisticated equipment	K2
2	Execute quantitative and qualitative analyses of various environmental samples through instrumentation techniques	K3
3	Extract information and draw scientific inference from ecology and environment related data	K3
4	Understand the basic concepts of Big data analytics	K4
5	Research methods for design and execute a well-planned field research	K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Instrumentation Techniques	14-hours

Properties of EMR–Basic Principles, Instrumentation and applications of: Ultraviolet – visible (UV-VIS) Spectroscopy, Flame Spectrometry, Atomic Absorption Spectroscopy (AAS), Mass spectrometry (MS), Inductively Coupled Plasma Emission Mass Spectroscopy (ICP-MS), Fourier transform infrared spectroscopy (FT-IR), Chromatography: High Performance Liquid Chromatography (HPLC), Gas Chromatography (GC), SEM, TEM, SDS-PAGE Electrophoresis, Agarose Gel Electrophoresis.

Unit:2	Environmental Monitoring Techniques	14-hours

Principle, interferences, instrumentation and applications of Turbidimetry, Nephelometry, Kjeldahl N analyzer, Elemental Analyzer, TOC Analyzer, Portable Gas Analyser, Particulate matter analyzer, O_3 analyzer, Beta-attenuation, Stack Monitoring, Meteorological Equipments. Portable water analyzer. Radiation detectors– Geiger Muller Counter, Scintillation Counters; Application of isotopes in biological and environmental studies. PCR techniques.

Unit:3	Basic Statistics	14-hours

Basic concept, Collection of Data–Classification and Tabulation–Diagrammatic Representation–Measures of Central Tendencies and Dispersion–Probability–Moments, Skewness and Kurtosis.

Sampling Methods: Probability sampling and Non-probability sampling methods. Mass and alternative hypothesis–t, z, x2 test, Analysis of variance–One way ANOVA–Two way ANOVA–Correlation and Regression. PCA , Introduction to environmental system analysis-Data Analysis using packages (SPSS).		
Unit:4	**Data Science**	**14-hours**
Data Science vs Statistics. Data Science Components – Data Engineering - Data analytics – Methods and Algorithm – Data Visualization. Big data - Characteristics of Big Data 6Vs - Types and Classifications- Sources -Technology Process – Big Data Exploration –Data Augmentation. Big Data Platforms – HADOOP-SPARK- NoSQL Databases. Big data analytics – R software environment. Big Data Applications in Industry-Healthcare- Environmental Sciences.		
Unit:5	**Research Methodology**	**14-hours**
Methods of literature collection, design, planning and execution of investigation, Preparation of scientific documents, general articles, research papers, review articles, editing of research papers, methods of citation, collection of literatures, including web based methods, bibliography, dissertation and thesis writing. Presentation techniques, effective communication skill. Importance of citation and indices, plagiarism.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, case studies, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)

1	Vogel'sText Book of Quantitative Inorganic Analysis, Barnes, J. D. J., Denney, R. C., Jeffery, G. H. and Mendham, J. (1999), 6th Edition, Pearson Education Ltd., U.K.
2	Instrumental Methods of Chemical Analysis, Sharma, B.K. (2005), Goel Publishing House, Meerut., India.
3	Instrumental methods of analysis, Malathi,S.,Patil,P.M.,Kumar,S.(2020).Thakur publications (pvt.) Ltd, Lucknow, India
4	Instrumental Methods of Analysis, Chatwal,G.R. and Anand,S.K. (2018). Himalaya Publishing House, Delhi.
5	Instrumental Methods of Analysis,7th edition, Hobart H.Willard, Lynne L.Merritt, John A. Dean and Frank A. Settle, Jr., (Eds.).(1986), CBS Publishers & Distributors, New Delhi
6	Statistical Methods 43rd Edition, Gupta,S.P., Sultan Chand & Sons Publications (Pvt) Ltd, New Delhi.
7	P. Kaliraj, T. Devi, Higher Education for Industry 4.0 and Transformation to Education 5.0,2020
8	Fundamentals of Bio-Statistics, Khan, I.A. and Kanum, A. (1994), Ukaaz Publication, Hyderabad.

Reference Books

1	Standard Methods for the Examination of Water and Wastewater, (1998), 23rd, Edition, APHA, Washington, D.C.
2	Environmental Monitoring and Instrumentation, Bucholtz, F.(1997), Optical Society of America,Washington, D.C.
3	Environmental Sampling Analysis: A Practical Guide, Keith, L.H. (1991), 3rd Edition, Lewis Publication, Boca Raton, Florida.
4	Hand book of Analytical Instruments, Khandpur, R.S.(2015),3rd Edition, McGraw Hill Education (India) Pvt, New Delhi.

5	Fundamentals of Analytical Chemistry, Skoog,D. A. and West, D. M. (2004), Thomson Asia Pvt Ltd, Singapore.
6	Statistics for Advanced Level, Miller, J. (1989),Cambridge University Press.
7	Statistical Methods, Snedcor, G.W. and Cochran, W.G. (1982), Academic Press.
8	Practical Statistics for Experimental Biologists,Wardlaw, A.C. (1985), Wiley Chichester
9	Research Methodology –Methods and Techniques. Kothari, C.R.(1989), Wiley Eastern,
10	Introduction to Research Methodology in Agricultural and Biological Sciences,Venkata Subramanian, V. (1999), New Century Book House
11	Quantitative Techniques, Kothari, C.R. (1996), Vikas Publishing Housing Pvt Ltd, Hyderabad.
12	Environmental Science Methods, Haynes, R.(1982), Chapman & Hall, London.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/103/108/103108100/
2	https://onlinecourses.nptel.ac.in/noc20_ch02/preview
3	https://nptel.ac.in/courses/111/104/111104120/
4	https://nptel.ac.in/courses/111/106/111106112/

Mapping with ProgrammeOutcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	M	S	M	M	M	M
CO2	S	M	S	L	M	M	S	S	M	S
CO3	M	M	S	M	M	S	M	M	S	M
CO4	S	L	M	L	S	S	M	S	M	S
CO5	S	M	M	S	M	S	S	S	S	S

Course code	25ENVA1EA-1	FUNDAMENTALS OF ECOLOGY	L	T	P	C
Core/Elective/Supportive	Elective		4	0	0	4
Pre-requisite	Basic knowledge on plant and animal science	Syllabus Version	2025-2026			

Course Objectives:

The main objectives of this course are to:

1. Impart knowledge on the fundamentals of Ecology
2. Understand the natural environment
3. Study the relationship between organisms and their surroundings

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Have a basic understanding on the fundamentals of Ecology.	K2
2	Understand energy in the ecological systems.	K2
3	Have sound knowledge on population ecology, community ecology including landscape ecology.	K2
4	Have the skill to interpret the limiting and regulatory factors that influence functioning of the Ecosystem.	K3

K1-Remember; **K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** -Create

Unit:1	Introduction to Ecology	14-hours

Ecology: Definition and Scope, Concepts of the Ecosystem, Levels of Organization in Ecology, The Emergent Property Principle, Transcending Functions and Control Processes, Ecological Interfacing, Tropic Structure of the Ecosystem, Gradients and Ecotones, Techno ecosystems, Concept of the Ecological Footprint, Ecosystem Management.

Unit:2	Energy in Ecological Systems	14-hours

Fundamental Concepts Related to Energy, Solar Radiation and the Energy Environment, Concept of Productivity, Energy Partitioning in Food Chains and Food Webs, Metabolism and Size of Individuals, Net Energy Concept, Energy-Based Classification of Ecosystems, Energy Futures, Energy and Money.

Unit:3	Limiting and Regulatory Factors	14-hours

Concept of Limiting Factors, Factor Compensation and Ecotypes, Conditions of Existence as Regulatory Factors, Fire Ecology, Other Physical Limiting Factors, Biological Magnification of Toxic Substances, Anthropogenic Stress as a Limiting Factor for Industrial Societies.

Unit:4	Population Ecology	14-hours

Properties of the Population, Basic Concepts of Rate, Intrinsic Rate of Natural Increase, Concept of Carrying Capacity, Population Fluctuations and Cyclic Oscillations, Density-Independent and Density-Dependent Mechanisms of Population Regulation, Patterns of Dispersion, Home Range and Territoriality, Meta population Dynamics, *r*-and *K*-Selection. Lotka-Voltera models, Leslie's matrix.

Unit:5	**Community Ecology**	**14-hours**
Types of Interaction between Two Species, Coevolution, Evolution of Cooperation, Interspecific Competition and Coexistence. Interactions: Predation, Herbivory, Parasitism, Allelopathy, Commensalism, Cooperation, Mutualism, Symbiosis, Species Migration. Concepts of Habitat, Ecological Niche, and Guild. Ecosystem Development-Concept of the Climax. Landscape Ecology.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)	
1	Fundamentals of Ecology, Fifth Edition, Odum, E. P. and Barrett, G.W. (2004), Brooks Cole, Belmont, CA.
2	Ecology, Russell, P.J., Wolfe, S.L., Hertz, P.E., Starr, C. and McMillan, B. (2008), Brooks Cole, Course Technology, Cengage Learning India Private Limited, New Delhi.
3	Concepts of Ecology, Arumugam, N (2014), Saras Publications, Nagercoil, India.
Reference Books	
1	Essentials of Ecology and Environmental Science, Rana, S.V.S. (2005), 2nd Edition, Prentice Hall of India, New Delhi.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://shodhganga.inflibnet.ac.in/bitstream/10603/135902/7/07_chapter%20i.pdf
2	https://www.nature.com/scitable/knowledge/library/energy-economics-in-ecosystems-13254442/
3	https://biologydictionary.net/limiting-factor/
4	https://web.ma.utexas.edu/users/davis/375/popecol/lec1/whatis.html
5	https://openoregon.pressbooks.pub/envirobiology/chapter/4-4-community-ecology/

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	M	S	S	M	L	M	M	M	M
CO2	S	M	M	S	M	M	L	M	M	M
CO3	M	M	M	S	M	L	M	S	M	S
CO4	M	S	M	S	M	L	M	M	M	M

S-Strong; M-Medium; L-Low

Course code	25ENVA1EA-2	ENERGY RESOURCES AND CONSERVATION	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Basic knowledge on the energy resources and its related information	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To enrich the knowledge on energy resources and their significance and to know the strategies for sustainable management
2. To discuss the process of recognizing and defining ERC issues within an ecosystem management Frame work
3. To explains with an analysis of the role of ethics, social justice, and communication in the Sustainable management of energy resources.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Gain a thorough knowledge of energy resources, their distribution and factors affecting their availability.	K2
2	Understand how developmental activities will affect the energy resources of a nation.	K3
3	Understand the importance of energy resources, the need to conserve them and can attempt for alternative energy sources.	K4
4	Create awareness to incorporate best management plans in planning activities for nature conservation and sustainable environmental protection.	K6

K1-Remember; **K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create

Unit:1	Energy Sources: Concepts & uses	14-hours

Energy Sources: Conventional vs. renewable, examples, and pros/cons of renewable energy. Solar Energy: Working, applications, benefits, limitations, PV cells basics. Wind Energy: Principle, applications, advantages, system components. Tidal Energy: Basics, advantages, drawbacks. Geothermal Energy: Concept, resources, benefits, challenges. Biogas: Definition, composition, applications, plant types. Biomass: Definition and major renewable sources.

Unit:2	Energy Scenario & Management	14-hours

Energy Scenario: Global energy overview, reserves, India's energy use in sectors, environmental impacts, and solutions. Energy Management: Definition, objectives, techniques like self-awareness, reengineering, tech upgrades. Energy Efficiency: Concept, benefits, conservation elements. Star Labelling: Need, types (comparative, endorsement), BEE ratings, covered appliances.

Unit:3	Energy Use Across Sectors	14-hours

Domestic: Household needs (lighting, heating, cooking) based on climate. Agricultural: Energy for irrigation, machinery, transport, focusing on solar. Industrial: Energy for machinery, factory operations, varying by industry. Commercial: Energy for lighting, heating, equipment, influenced by business type. Service: Energy for operations like equipment and climate control in healthcare, hospitality.

Unit:4	**Energy Conservation: Principles & Importance**	**14-hours**
Energy Conservation: Definition, need, principles. Conservation in Buildings: Tips for energy-saving in homes and commercial sectors. HVAC System: Components, energy-saving opportunities, thermal insulation role. Lighting Systems: Energy conservation techniques.		
Unit:5	**Energy Audit of Electrical Systems**	**14-hours**
Energy Audit: Definition, need, BEE regulations, timing/intervals. Types of Audits: Preliminary, targeted, detailed audits. Instruments & Metering: Names and purposes of auditing instruments. Audit Stages: Team formation, audit forms, 10-step methodology (BIS). Audit Report: Format (over view). Energy Flow Diagram: Role and objective in analysis.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)	
1	Energy: Its Use and the Environment. Roger A. Hinrichs& Merlin H. Kleinbach (5th Edition, 2012).
2	Energy Resources: Occurrence, Production, Conversion, Use. Thomas W. DeGregori (1982)
3	Sustainable Energy – Without the Hot Air. David J.C. MacKay (2009)
4	Introduction to Energy: Resources, Technology, and Society. Edward S. Cassedy& Peter Z. Grossman (2nd Edition, 1998)
5	Energy for Future Presidents: The Science Behind the Headlines. Richard A. Muller (2012)
6	Fundamentals of Renewable Energy Processes. Aldo V. da Rosa (3rd Edition, 2017).
7	Energy and the Environment. James A. Fay & Dan S. Golomb (2nd Edition, 2012).
Reference Books	
1	Global Change and Natural Resource Management, Vitousek, P.M. (1994), Beyond global warming: Ecology and global change. Ecology 75,(7), 1861-1876.
2	Environmental Biology, Agarwal, K.C.(2001), Nidhi Publication Ltd., Bikaner.
3	Environmental Encyclopedia, Cunningham,W.P., Cooper, T.H., Gorhani, E.and Hepworth, M.T. (2001), Jaico Publishing House.
4	Global Biodiversity Assessment, Heywood, V.H. and Watson, R.T.(1995), Cambridge University Press.
5	Introduction to Environmental Science, Anjaneyulu, Y. (2004), BS. Publications, Hyderabad
6	Environmental Science, Miller T.G. Jr.(1989),Wads worth Publishing Co.(TB)
7	Essentials of Ecology, Townsend, C.R., Begon, M. and Harper, J. L. (2008), 3rd edition, Blackwell Science.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://onlinecourses.swayam2.ac.in/nou25_me02/preview
2	https://onlinecourses.nptel.ac.in/noc25_ge24/preview

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	M	M	S	S	S	S
CO3	S	M	M	M	S	S	M	S	M	M
CO3	M	S	S	M	S	S	M	S	S	M
CO4	M	S	M	M	S	M	M	M	S	M

Second Semester

Course code	25ENVA23A	ENVIRONMENTAL POLLUTION	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Knowledge in basic chemistry And biology	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. Educate the students on source, classification, impact and control measures of air, water and soil pollution
2. Make students aware of the industrial disasters and their consequences on environment and human and animal health.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand the sources and classification of Air pollutants and their impact on environment	K2
2	Know the properties of water, classification and the effects of water pollutants	K2
3	Understand the sources, sinks and broad classification, movement and sorption soil pollutants	K2
4	Gain detailed knowledge about physico-chemical and biological control methods of various air/soil/water pollutants.	K3
5	Gain more information about the causes, consequences and control measures of industrial disasters	K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Air Pollution	14-hours

Structure and composition of the atmosphere, Sources and Classification of Air Pollutants. Transport and Diffusion of Pollutants. Plume behavior and stack dispersion, Reactions of hydroxyl radical with Oxides of Nitrogen, Sulphur and Carbon. Sinks of Air pollutants – Acid rain: Ozone depletion–Montreal protocol; Global warming–Kyoto protocol; Gaseous pollution control measures; photo-chemical smog; Automobile pollution in India; Particulate matter pollution–PM10 and PM 2.5, Black carbon, clean energy and clean development mechanisms – online monitoring of pollution.

Unit:2	Water Pollution	14-hours

Water quality Parameters- DO, BOD, COD, acidity, alkalinity, salinity, hardness; drinking water quality standards; Water pollution; Classification of water pollutants, Groundwater pollution, Sources and sinks, Eutrophication, microbial pollution. Alternatives of end pipe treatments, online monitoring of industrial effluents–Sediment Pollution-Marine pollution (oil pollution) –sources & control, Emerging Contaminants –cleaning agents-soap, detergents, bleaching agents, anti knock compounds, lubricants, greases and antibiotics

Unit:3	Soil Pollution	14-hours

Sources, sinks and broad classification, movement and sorption mechanisms of organic and inorganic contaminants and their impacts on physico-chemical and biological properties of soil and plants, persistent organic pollutants and recalcitrant pollutants, Soil pollution control measures –*In situ* and *Ex situ* Physico-chemical and Biological methods.

Unit:4	Noise, Thermal, Light And Hazardous Pollution	14-hours
Noise pollution–Sensing, Measurement, Abatement measures; Thermal pollution and control measures. Light pollution and control measures; Municipal solid wastes–hazardous and non-hazardous wastes, disposal and energy production, Biomedical Wastes- classification and treatment methods, Radio active Wastes- Sources, Transport, Disposal.		
Unit:5	**Industrial Pollution and Control**	**14-hours**
Pesticide, Tannery, Textile, Paper and Pulp Industries, Industrial disasters-Bhopal Disaster, Mayapuri Radiological Disaster, Chernobyl accident, Love canal Disaster, Oil Disasters-Exxon, British Petroleum-Gulf of Mexico; e-wastes, battery waste, Impact and Remedial Measures.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book (s)	
1	Chemistry for Environmental Engineering and Science, Sawyer, C.N., Mc Carty P. L., and Parkin, G. F. (2003), Tata McGraw-Hill Publishing Company Ltd., New Delhi.
2	A text book of environmental chemistry and pollution control, Dara, S. S.(1998), S. Chand & Company Ltd, New Delhi
3	Environmental Engineering, Howard S Peavy, H.S. (2003),Tata McGraw Hill Publishing Company Ltd., New Delhi
4	Environmental Chemistry, De, A.K. (2001), New Age International Publishers, New Delhi.
5	Ecology and Environment, Sharma, P.D. (2003). 7th Edition, Rastogi Publication,Meerut.
Reference Books	
1	Environmental Chemistry, Manahan, S. E. (2000),CRC Press, USA.
2	An Introduction to Soils and Plant Growth, 5th Edition, Donalue, R.I., Miller, R.W. and Shiekluna, J. C. (1987), Prentice Hall of India.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.who.int/ceh/capacity/Outdoor_air_pollution.pdf
2	https://ocw.mit.edu/courses/chemical-engineering/10-571j-atmospheric-physics-and-chemistry-spring-2006/
3	https://www.unenvironment.org/beatpollution/forms-pollution

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	M	S
CO5	M	M	S	M	S	S	S	S	M	M

Course code	25ENVA23B	ENVIRONMENTALTOXICOLOGY	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Basic knowledge on pollutants and its effects	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. Understand the occurrence and route of entry of various environmental toxicants and contaminants
2. Understand their fate and impact in environment
3. Understand their impact on the life of organism

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Gain knowledge on various environmental toxicants – toxicants in food, drugs, pesticides and PPCP's etc	K2
2	Improve understanding about the negative effects of organic and inorganic toxicants on life of organisms and on environment	K2
3	Gain knowledge on the exposure routes of toxicants, toxicological test methods, and determination of toxic levels of contaminants	K2
4	Understand the importance of toxicological regulations and will be able to explain the potential fate and effects of a contaminant in the environment	K3
5	Understood the importance of animal ethics to be followed in toxicological testing methods and option for alternative test methods	K4

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Toxicology	14-hours

Definitions, Major classes of environmental toxicants, Origin and Nature of Toxicants in Environment. Basic Probit analysis, concepts – Toxicants – Toxicity, Acute, sub-acute, chronic, dose effect, LD 50, LC 50, EC 50 and response safe limits. Dose response relationship, graphs, concentration response relationship, Safe Limits. Biological, chemical Factors that influence. Influence of route of administration abnormal response to chemicals; basis of selective toxicity; laboratory determination of toxicity of chemicals.

Unit:2	Chemical and Metal Toxicants	14-hours

Classification of pesticides–Pest surveillance, resistance, residual effects, toxic effects of insecticides on man and mammals. Heavy metals-Speciation, Metals- Toxicity, Properties, occurrence, Production, Industrial uses, Metabolism, Physiology, Toxicology, Prophylaxis and Therapy-Aluminium, arsenic, cadmium, chromium, lead and mercury. Mutagenesis and carcinogenesis - case studies. Emerging pollutants in environment-Endocrine disruptors-Pharmaceuticals and personal care products.

Unit:3	Xenobiotics in Environment	14-hours

Bioconcentrations–Volatilization–Biological and non-biological degradations, Detoxification. Chlorinated organics in environment and their fate. Short chained chlorinated hydrocarbons–Toxicity – Ecotoxicological relevants and degradation. PCB – Dioxins levels, fate, toxicity and their global distribution. Toxaphene –occurrence and degradation. Environmental risk assessments-Biomonitoring- Bioindicators- Environmental specimen banking.

Unit:4	**Mechanism of Toxicants**	**14-hours**
Bioaccumulation- Bioconcentration– Biomagnifications– mechanisms in biota–Significant influence, mechanisms and Kinetics of Bioconcentration. Cellular response to chemical stress– membrane process; intracellular fate of chemicals, cell receptors, cell injury and apoptosis. Long-term impact of chemicals in aquatic organisms, soil invertebrates and Avian species		
Unit:5	**Toxicology Models and Testing Methods**	**14-hours**
Biotransformation of xenobiotics– Molecular mode of action– Toxicity Testing Methods– Microbial, algal, invertebrates and alternative toxicity tests. Computational – QSAR modeling and Bioinformatics in toxicology. Multimedia mass balance models – fugacity – nonfugacity models –applications of multimedia models. Future test strategies in Ecotoxicology – Legislative perspectives. Animal management in Toxicological Evaluation: Animal extrapolation; Animal ethics. Environmental specimen banking.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)	
1	Environmental Risks and Hazards, Cutter, S.L. (1994), Prenctice -Hall of India, New Delhi
2	Hand book of Environmental Risk Assessment and Management, Callow, P. (1998), Blackwell Science, London
Reference Books	
1	Introduction to Environmental Toxicology- Landis, W. G. and Yu, M. H. (2003), 3rdedition, Lewis Publishers, CRC press, NY
2	Essentials of Toxicology–Klaassen,C.D, and Watkins III, J.B. (2003), 3rd Ed., McGrew Hill
3	Environmental Impact of Chemicals: Assessment and Control, Quint, M.D., Taylor, D., Purchase,R. (1996), The Royal Society of Chemistry, Cambridge
4	Environmental Risk Assessment Reports, Benjamin, S.L.and Belluck, D.A.(2001),CRCPress.
5	Casarett and Doull's Essentials of Toxicology. Klaassen, C. and Watkins III, J. B. (2010),2ndedition, McGraw Hill Education
6	Environmental Toxicology-Biological and Health effects of Pollutants. Yu, M.-H.,Tsunado, H. and Tsunoda, M.(2011), 3rd edition, CRC Press
7	Ecotoxicology, Schuurmann, G. and Market, G. (1998),John Wiley & Sons, Inc
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/120/108/120108002/
2	https://nptel.ac.in/courses/120/108/120108004/

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	M	S	L	S	S	S	L	M
CO2	S	M	M	S	S	S	S	M	L	M
CO3	S	S	S	M	L	M	S	L	L	L
CO4	S	M	S	M	L	L	S	L	L	L
CO5	M	S	S	M	L	L	S	L	L	L

Course code	25ENVA23C	ENVIRONMENTAL IMPACT ASSESSMENT AND GREEN AUDITING	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Basic knowledge in environmental impact assessment	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. Introduce students to the concept of Environmental Management
2. Develop skills in identifying and solving environmental problems
3. Teach the principles and practices of effective environmental management system audits

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain the concepts about Environmental Impact Assessment, develop skills in identifying and solving problems	K2
2	Locate, analyse and evaluate informations from various environmental matrices systematically	K4
3	Access and analyse different case studies/examples of EIA in practice for evaluation /assessment	K4
4	Explain the importance of environmental audits and other management tools in Business for social benefit by improving environmental performance	K3
5	Calculate the carbon foot print of any organization and identify suitable mitigation strategies for carbon reduction solutions.	K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Fundamentals of EIA	14-hours

Definition, Roles and Classification–Screening of Projects–Environmental Assessment Procedures–Project Alternatives - Environmental Impact Statement – Environmental Management Plan - EIA Notification 2006 and amendments - Public Participation - State and Central Clearance –Marine Based Monitoring-Limitations of EIA-Status of EIA in India.

Unit:2	EIA Methods	14-hours

Check list Methods–Matrix Methods–Network Methods – Overlay Method and Adhoc Method–. Prediction and Assessment of Impacts on Natural Resources–Biota, Surface Waters, Ground Water, Air, Noise, Hazards, Historic and Cultural Resources, Transportation, Socio-economic relationships.

Unit:3	Project based EIA	14-hours

Land Clearing Projects – Dam sites –Aquaculture– Mines–Steel– Hydel–Thermal–Nuclear– Thermal Power Plants – Airports - Highways projects – Industrial Projects. Inter linking of Rivers and River Basin Management.

Unit:4	Green Auditing	14-hours

Introduction, Necessity, Procedure for Environmental Auditing, Case Study. Environmental Management System- ISO 14000 series of standards and Methodologies. Green Entrepreneurship-Green Consumerism, Eco-labeling. Certification Process – Different Phases of Audit, Certification Audit, Certification Agencies. Green belt Designing and development, Green rating of industries.

Unit:5	EIA &GA case studies	14– hours

Narmada River Valley Project, Mumbai - Hyderabad High Speed Rail Project, Delhi Metro project, Hunan Xiangjang Inland watering(China), Airport terminal building for Guwahati International Airport, Sugar factory- Kumbhi Kasari Kolhapur, Municipal solid waste management (IISC Bangalore), Jagannath University Green Audit.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)	
1	Environmental Impact Assessment, Canter, L.W. (1996), McGraw Hill, New York.
2	Environmental Audit, Shrivastava, A.K. (2003), New Delhi, India
3	Environmental Impact Assessment-A Comprehensive Guide to Project and Strategic Planning, Eccleston, C. H. (2000), John Wiley and Sons.
4	Introduction to Carbon Capture and Sequestration, Smit, B., Reimer, J.A., Oldenburg, C.M. and Bourg,I. C. (2014), Imperial College Press, London.
Reference Books	
1	Environmental Impact Statements, Bregman, J. I. (1999), Lewis Publishers, London.
2	Environmental Assessment, Singleton R, Castle, P and Sort, D. (1999), Thomas Telford Publishing, London.
3	Effective Environmental Assessment, Eccleston, C.H. (2000), Lewis Publishers, London.
4	Environmental Auditing, Humphery, N. and Hadley. M.(2000), Boca Raton, USA.
5	Green Accounting, Bartelmus, P.and Seifert, E.K. (2017), Taylor & Francis Limited.
6	Perspectives in Environmental Studies, Kaushik, A. and Kaushik C. P. (2014). 4th Edition, New Age International Publishers, New Delhi.
7	Carbon Sequestration for Climate Change Mitigation and Adaptation, Ussiri, D.A.N. Lal, R. (2017), Springer International Publishing.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/120/108/120108004/
2	https://www.iisd.org/learning/eia/eia-essentials/timeline/
3	https://www.open.edu/openlearn/nature-environment/organisations-environmental-management-and-innovation/content-section-2.8

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	S	S	S	S	L	S
CO3	S	S	S	S	S	S	S	S	M	S
CO3	M	S	S	S	S	S	S	S	L	S
CO4	M	M	M	S	S	S	S	S	L	S
CO5	S	M	S	S	S	S	S	S	S	S

S-Strong; M-Medium; L-Low

Course code	25ENVA23D	BIODIVERSITY AND CONSERVATION	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Must have basic knowledge on Biology	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:
To impart understanding on the occurrence and distribution of various flora and fauna, their existence, interaction, Importance of biodiversity conservation and understand about Legislation related to conservation.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Will understand the basic principles of conservation is important in order to address the ecological challenges we face in the 21st century. Student will gain knowledge about the diversity distribution pattern of the enormous number of species and different kind of ecosystems in the natural world. This course will provide an introduction to the basic principles of conservation and biodiversity. Protecting our remaining biological diversity will involve all fields of science, from the humanities to natural sciences.	K1&K2
2	The interaction between the various speciesand environment and the impact of social development on biodiversity. Will gain knowledge in distribution of species in different ecosystem Will gain knowledge in threats to species,extinction and indicator species	K3
3	The importance of conservation of biodiversity which serving to the man kind and the ecosystem, and the major threats to biodiversity due to human developmental activities. The loss of biodiversity and the impact to the Human kind.	K4
4	Will gain knowledge about legislations regarding the conservation of biodiversity. Will gain knowledge in values of ethics, biodiversity Intellectual, Economics of Ecosystem, Food Plants, medicinal and ornamental plants.	K5
5	Will gain knowledge on legislation in Conservation and Management of biodiversity	K6

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** –Create

Unit:1	Scope of Biodiversity Science	14-hours

Composition and Scales of Biodiversity-Ecosystem- Ecological – Community - species and Genetic diversity; Origin of new species, Introduction to Taxonomy and Systematics, Basic Components of Taxonomy and Systematics: Identification, Description and Nomenclature, Phylogeny and Classification, The Hardy- Weinberg law; Gene flow-Genetic pollution and gene erosion; Species Concept–Biological and Phylogenic Concepts; Species Inventory–IUCN categories–Red data book.

Unit:2	Species Diversity	14-hours

Diversity- Global Distribution of Species-Tropical species diversity–Diversity in terrestrial, marine and fresh water –Micro-organisms -lower and higher plants–lower and higher invertebrates and vertebrates; Endemic and Endangered species; Monitoring indicator species and habitats;

Threats to biodiversity: Habitat Destruction, Fragmentation, Transformation, Degradation and Loss: Causes, Patterns and consequences on the Biodiversity of Major Land and Aquatic Systems; Species Extinction–Past rate of Extinction–Human Cause Extinctions; Man and animal conflicts. Biodiversity hotspot-Western Ghats-Eastern Ghats– Himalayas.		
Unit:3	**Western Ghats and Gulf of Mannar Hotspots**	**14-hours**
Geographical Overview: Location, extent, and climate of the Western Ghats and Gulf of Mannar. Biodiversity: Endemic species, unique ecosystems in both regions (forests, coral reefs, mangroves). Protected Areas & Conservation: Key conservation areas like Silent Valley and Gulf of Mannar, Marine Biosphere Reserve. Environmental Threats: Deforestation, overfishing, habitat destruction, and climate change. Conservation Efforts: Community involvement, sustainable development models, and case studies on successful initiatives.		
Unit:4	**Values of Biodiversity**	**14-hours**
Instrumental/Utilitarian value and their categories, Direct use value: Food, medicine, building material, fiber, fuel; Introduction to Ecological Economics; Indirect/Non-consumptive use value: Atmospheric and climate regulation, pollination, nutrient recycling, Monetizing the value of Biodiversity; Intrinsic Value; Ethical and aesthetic values, Anthropocentrism, Biocentrism, Ecocentrism and Religions; Intellectual Value; Economics of Ecosystem,Green Revolution, Food Plants, medicinal and ornamental plants, animal uses–livestock and fisheries.		
Unit:5	**Conservation and Management:**	**14-hours**
National Legislation –Protection of Wild flora and Fauna -Protection of National Habitats-National and International Protected Areas–Current Practices in Conservation-*in situ* Conservation and *ex situ* Conservation of Threatened Species– Biodiversity Act 2002– PatentAct– Agenda 21–Forest protection Act- Forest conservation Act 1980- Multilateral Treaties – Biodiversity Conventions. Environmental ethics – Biodiversity – a Socio – Political Perspective; Community conserved Areas (CCAs) –Ranges and significance of CCAs.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)

1	Global Biodiversity–Status of the Earths Living Resources, Groombridge, B. (1992), Chapman& Hall, London.
2	Ecology of Natural Resources ,Ramade, F. (1991), John Wiley and Sons Ltd.
3	Global Biodiversity and Strategy,WRI, IUCN,UNEP(1992).
4	Biodiversity, Science and Development, Younes, T and Castri, F. (1996), CAB International,UK.
5	The Biology of Biodiversity, Kato, M. (1999), Springer Verlag,Tokyo.
6	Biodiversity Conservation – In Managed forest and Protected areas, Kotwal, P.C. and Banerjee, S. (2002), Agrobios, India.
7	Global Biodiversity, Sinha, R.K.(1997), INA Shree Publishers, Jaipur.
8	Mega diversity Conservation, flora, Fauna and Medicinal Plants of India's hotspots, Chaudhuri, A.B. and Sarkar, D. D. (2003), Daya Publishing House, New Delhi.
9	Conservation of Biodiversity and Natural Resources. Singh, M.P., Singh B.S. and Dey, S.S.

	(2004), Daya Publishing House, New Delhi.
10	Biodiversity–Strategies for Conservation, Dadhich L.K. and Sharma, A.P. (2002), APH Publishing Corporation, New Delhi
11	Global Biodiversity – Conservation Measure, Khan, T. I and Al-Ajmi, D. N. (1999), Pointer Publishers, Jaipur.
12	An Advanced Text book on Biodiversity –Principles and Practice, Krishnamurthy, K.V. (2003), Oxford and IBH Publishing, NewDelhi.
13	An advanced Text book on biodiversity, Krishnamurthy, K.V.(2003), Oxford and IBH Book Publishing *Co* Pvt Ltd., New Delhi.
14	Evolution, Hall, B.K. and Hall grimsson, B. (2014), 5th Edition, Johnes and Bartlett India Pvt. Ltd. New Delhi.
15	Ridley, M.(2004), Evolution, 3rd Edition, Blackwell Science Ltd a Blackwell Publishing company, USA,
16	Curry, G.B. and. Humphries C.J. (2007), Biodiversity Databases Techniques, Politics, and Applications, CRC Press, Taylor & Francis Group.
17	The conservation of Plant Biodiversity, Frankel, O. H., Brown, A.H.D. and Burdon, J.J. (1995),1st edition, Cambridge University Press.
18	Encyclopedia of Biodiversity, Levin,S.A. (2000), Volume1, Academic Press.
19	Manual of patent Practice and procedure Patent office, India, 2005.
20	Evolution Understanding Evolution. http://evolution.berkeley.edu/evolibrary/article/evo_01accessed on 28.12.2014.
Reference Books	
1	Geologic Time and Earth's Biological History ftp://ftpdata.dnr.sc.gov /geology/Education/PDF/Geologic%20Time.pdf.
2	Center of origin -Wikipedia,the free encyclopediaen.wikipedia.org/wiki/Center of origin accessed on 28.12.2014
3	Biodiversity Hotspots- http://en.wikipedia.org/wiki/Biodiversity_hotspotaccessedon28.12.2014.
4	Plant Genetic Resources: Otto, H., Anthony, H.D., Brown and Burdon J.J. (1995).
5	The Conservation of Plant Biodiversity, 1stedition, Cambridge University Press
6	Mega diverse Countries; http://geography.about.com/od/physicalgeography /a/Megadiverse-Countries.htm accessedon28.12.2014.
7	Geo database Standards: www.data.gov.bc.ca/local/dbc/docs/geo/services/standardsprocedures/file_geobase_st andards.pdfaccessedon 31.12.2014.
8	Bar code Standards:barcoding.si.edu/pdf/dwg_data_standards-final.pdfaccessedon31.12.2014
9	UNESCO http://en.wikipedia.org/wiki/Biosphere_reserves_of_Indiaaccessedon31.12.2014
10	Biodiversity Databases Techniques, Politics, and Applications, Curry,G.B. and Humphries, C.J. (2007), CRC Press, Taylor & Francis Group. Frankel,
11	UNITV: Biodiversity Economics, Legislation and Intellectual Property Rights (IPR):
12	Environmental and Forest Acts, TRIPS, UPCOV, Suigeneris systems, Plant Breeders
13	Conservation, Management and use of Agrobiodiversity naasindia.org/Policy%20Papers /pp4.pdf
14	PPV & FRA http://www.plantauthority.in/accessedon31.12.2014
15	Patent office of India http://www.ipindia.nic.in/accessedon31.12.2014
Related Online Contents [MOOC, SWAYAM, NPTEL,Websites etc.]	
1	Wildlife Conservation-https://onlinecourses.nptel.ac.in/noc19_bt32/preview

2	Ecology and Wild life Conservation– https://www.mooc-list.com/course/ecology-and-wildlife-conservation-futurelearn
3	Biological Diversity (Theories, Measures and Data sampling techniques) https://www.mooc-list.com/tags/biodiversity

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	L	S	M	M	M	L	M	M	S	M
CO2	M	M	L	S	M	M	M	M	S	L
CO3	L	M	M	M	S	M	L	L	S	M
CO4	M	S	L	M	S	M	M	M	M	L
CO5	L	M	M	M	S	L	L	M	S	M

S-Strong; M-Medium; L-Low

Course code	25ENVA2EB-1	CLIMATE CHANGE AND DISASTER MANAGEMENT	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Basic Aptitude in Natural Hazards And Disaster	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To educate the students about the different types of natural hazards and understand approaches
2. To understand the disaster preparedness, mitigation and risk reduction.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand and differentiate the different types of disasters, analyse the causes and their potential impact on the natural and man-made environments.	K1& K2
2	Create awareness among the vulnerable population as a measure of disaster mitigation	K6
3	Educate people about the importance of preparedness in vulnerable areas.	K3
4	Know about the various national and international agencies that play a major role in disaster management	K2
5	Enable the students to volunteer themselves in disaster management programs thus helping affected community.	K4& K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Introduction to Climate Change	14-hours

Climate change – Global warming - Trends in climatology, meteorology and hydrology, Extreme weather events – Rising sea levels, Melting ice, super cell storms, Heat wave and droughts, changing ecosystem, pests and disease, Reduced food security–Global, national and regional scenario.

Unit:2	Climate change and Disaster risk	14-hours

Effects of climate change on disaster vulnerabilities – population exposure and vulnerability -people, health, livelihoods, ecosystems, environmental services, resources, infrastructure, and economic, social, and cultural assets, Disaster Concepts and Definitions – Hazard, Risk, Vulnerability, Disaster, Resilience, Mitigation, DRR, DRM, Emergency, Response, Relief; Resilience, Reconstruction, Recovery-Disaster Profile of India

Unit:3	Introduction to Disasters	14-hours

Types of Disasters: Nature and characteristics: Cyclone– Tornadoes–Avalanches–Flood–Drought–Volcanic eruptions– Earthquakes –Seismic zonation -Tsunamis-Wild Fire–Landslides–Causes and effects-Impact on Environment-Forecasting and Early Warning System

Disaster Management**:** Predisaster Planning-Toning of Disaster–prone areas–prioritization–regulations–protection measures during disaster and Post disaster. Relief Camp Organization–Survey

Disaster Management Cycle–Vulnerability Analysis—Legal Aspects–case studies for disasters And management. Technology for Disaster Management–Role of Information and communication technology, Remote sensing and Geographic Information System in Disaster Management.		
Unit:4	**Disaster Preparedness and Training**	**14-hours**
Community Preparedness and public participation in Natural Disasters-Disaster Training –Role of information, education, communication and training- Roles and responsibilities of different national and international agencies and government - NGO, Armed forces, Paramilitary forces, Community based organizations (CBO)-Army Training for Disaster Reduction–Role of team and co-ordination-Training needs.		
Unit:5	**Mitigation and Management Strategies**	**14-hours**
Disaster Mitigation–Trends in disaster management-UN resolution on Strengthening of Coordination of Humanitarian Emergency Assistance, International Decade for Natural Disaster Reduction (IDNDR), Policy for disaster reduction, problems of financing and insurance. Training for emergency, Regulation /guidelines for disaster tolerance building structures.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars, case studies – webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)	
1	Natural Disaster, Sharma, R.K. & Sharma, G. (2005), APH Publishing Corporation, New Delhi.
2	Ross Prizzia (2015). Climate Change and Disaster Management. Sentia Publishing, USA.
3	Natural Hazards and Disaster Management -Vulnerability and Mitigation, Singh. R. B, (2006), Rawat Publications, New Delhi.
Reference Books	
1	Natural Hazards, Edwards, B. (2005), Cambridge University Press, U.K.
2	Early warning Systems for Natural Disaster Reduction, Zschau,J. and Kuppers, N. (2003), Springer-Verlag, Berlin.
3	Space Technology for Disaster management: A Remote Sensing & GIS Perspective, Roy, P.S. (2000), Indian Institute of Remote Sensing (NRSA), Dehradun.
4	A Manual on Disaster Management, Diwan, P. (2010), Pentagon Earth, New Delhi.
5	Disaster Management: A disaster Manager's Handbook, Carter, N.W. (1992), Asian Development Bank, Manila.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	www.iirs.nrsa.org
2	www.GIS.Development.net
3	http://quake.usgs.gov
4	https://www.un.org/en/climatechange/climate-adaptation?gclid=EAIaIQobChMIpqyWvqDV9wIVVJJmAh26oQ0iEAAYBCAAEgJNd_D_BwE
5	https://www.econstor.eu/bitstream/10419/191561/1/978-1-138-56735-1.pdf
6	https://www.usgs.gov/faqs/how-can-climate-change-affect-natural-disasters
7	https://onlinecourses.swayam2.ac.in/nou21_ge37/preview

8	https://onlinecourses.swayam2.ac.in/cec20_ge35/preview
9	NIDMhttp://nidm.gov.in/default.asp
10	NDMAhttp://www.ndma.gov.in/en/

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	S	S	M	L	S	L	S
CO2	M	M	S	M	S	S	M	S	M	M
CO3	M	M	M	M	S	S	M	S	L	M
CO4	L	M	S	S	S	M	M	S	L	M
CO5	M	M	S	S	S	M	M	M	M	M

Course code	25ENVA2EB-2	ENVIRONMENTAL GEOSCIENCES	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Basic knowledge on Earth Resources	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. Impart knowledge on the fundamentals of natural environment
2. Understand the Earth, Geochemistry, Mineral and Water resources of the environment
3. Study about the Earth Systems and Biosphere

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Have a basic understanding on the Earth resources	K1
2	Have sound knowledge on the earth's structure, natural resources and the environment	K2
3	Understanding the Earth system of interacting rock, water, air and life and how these elements have shaped Earth's surface	K2
4	Have the skill to identify the geologic features of the earth and use them to understand the geologic history of a region.	K2

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	The Earth Systems and Biosphere	14-hours

Conservation of matter in various geospheres – lithosphere, hydrosphere, atmosphere and biosphere. Energy budget of the earth. Earth's thermal environment and seasons. Ecosystems flow of energy and matter. Coexistence in communities-food webs, ecosystems terrestrial and aquatic. General relationship between landscape, biomes and climate. Climates of India, Indian Monsoon, El Nino, Droughts. Tropical cyclones and Western Disturbances.

Unit:2	Earth's Processes and Geological Hazards	14-hours

Earths processes; concept of residence, time and rates of natural cycles. Catastrophic geological hazards. Study of floods, landslides, earthquakes, volcanism and avalanche. Prediction and perception of the hazards and adjustments to hazardous activities.

Unit:3	Mineral Resources and Environment	14-hours

Resources and Reserves, Minerals and Population. Oceans as new areas for exploration of mineral resources. Ocean ore and recycling of resources. Environmental impact of exploitation, processing and smelting of minerals.

Unit:4	Water Resources and Environment	14-hours

Global Water Balance. Ice sheets and fluctuations of sea levels. Origin and composition of sea water. Hydrological cycle - piper diagram with hydrological cycle. Factors influencing the surface water. Types of water. Resources of oceans. Ocean pollution by toxic wastes. Human use of surface and ground waters. Ground water pollution.

Land use Planning: The land use plan. Soil surveys in relation to land use planning. Methods of site selection and evaluation.		
Unit:5	**Environmental Geochemistry**	**14-hours**
Concept of major, trace and Rare Earth Elements (REE). Classification of trace elements, Mobility of trace elements, Geochemical cycles. Biogeochemical factors in environmental health. Human use, trace elements and health. Possible effects of imbalance of some trace elements.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars- webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)	
1	Geoenvironment- An introduction, Aswathanarayana, U., (1995), Capital Books.
2	A text book of environment, Agrawal, K.M, Sikdar, P.K., and Deb, S.C.,(2002), 1st Edition, Macmillan India.
3	Ground water assessment, development and management, Karanth, K.R., (1987), Tata McGraw Hill.
4	Engineering and General Geology, Singh, P. (1999), S.K. Kataria & Sons, New Delhi.
5	Environmental Geology- Indian Context,Valdiya, K.S.(1987), Tata McGraw Hill Publication. Co., Bombay.
Reference Books	
1	Natural Hazard, Bryant, E. A. (1991), Cambridge University Press.
2	Geology and Society, Coates, D. R. (1985), Chapman & Hall, NewYork.
3	Environmental Geology, Keller, E. A. (1999), 8th editon, Pearson.
4	Geology, Environment and Society, Valdiya, K. S. (2004), Universities Press.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/105/105/105105170/
2	https://serc.carleton.edu/teachearth/teach_geo_online/index.html
3	https://www.edx.org/learn/geosciences

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	M	M	M	M	M	M	M	M
CO2	M	M	L	M	S	M	M	M	L	S
CO3	M	M	M	L	M	L	L	M	M	M
CO4	M	M	M	M	M	M	M	M	L	L

*S-Strong; M-Medium; L-Low

Third Semester

Course code	25ENVA33A	WASTEMANAGEMENT AND BIOREMEDIATION	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Basic knowledge on different types of waste and Its management	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to:

1. Impart knowledge on the management of solid and liquid wastes from municipal and industrial sources
2. Study the principles behind remedial measures for waste management, recycling of wastes
3. Understand the concept of bioremediation

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	Understanding of the management of solid and liquid wastes from municipal and industrial sources.	K2
2	Apply the principles of remedial measures of recycling, reuse and recovery from the wastes.	K3
3	Understand and describe the principle and mechanistic role of microbes in the degradation of various pollutants.	K2

K1-Remember; **K2** -Understand; **K3**-Apply;**K4**-Analyze;**K5** -Evaluate;**K6** -Create

Unit:1	Waste Management	14-hours

Different Types of waste and sources – Waste Management and Disposal: Sanitary landfills, Sources and Generation of Solid Waste–classification. Waste Minimization approaches–Monitoring and Management strategies. Hazardous waste management- Hospital waste disposal strategies, Radioactive Waste management. Waste Disposal Methods– incineration, coincineration, pyrolysis, Biomining of legacy waste.

Unit:2	Recycling of Wastes	14-hours

Strategy for waste management- Recycling of waste for Industrial, Agricultural and Domestic Purposes; Recycling of Metals, Reuse, recovery and reduction of paper and plastics; Fly Ash utilization, Recycling of waste in industries, Recycling of waste in cement, paper, pulp, textile industries, Strategies for conversion of biodegradable waste into organic fertilizers and fuels and biomethanization. Energy recovery from waste. Circular economy in waste management, EPR

Unit:3	Smart Waste Management Technologies	14-hours

Smart Waste Management Technologies - Principle, necessity, limitation and prospects; Pneumatic Waste Collection, E-Waste Kiosks, AI & robots - powered waste monitoring and sorting, Smart Waste Bins and Sensors, Solar-Powered Trash Compactors, Plasma Gasification, Automated Recycling Centers, Enhanced Garbage Truck Technology, Recycling Apps.

Unit:4	Principles of Bioremediation	14-hours

Microbial growth and Metabolism- Geneticplasticity–Metabolic pathways for the degradation of xenobiotics, Principles and mechanisms of biodeterioration - Microbial leaching of metal ores, Biosurfactant based bioremediation, Molecular techniques in bioremediation**,** Phytoremediation–Phytodegradation, phytovolatilization, phytoextraction, plant - microbe interaction in organic and inorganic polluted soils – Genetic engineering approaches.

Unit:5	**Bioremediation of Soil and Water Pollutants**	**14-hours**

Degradation of xenobiotics –bioremediation of hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAH), Heterocyclic Compounds, Phenols and Chlorophenolic compounds, Cyanide, dyes and Plastics, *In situ* and *ex situ* bioremediation methods, Bioremediation of Surface Soils, Fate and transport of contaminants in the Vadose zone, Types of soil treatment systems–Bioreactors. Biotreatments of harbor Sediments. Bioremediation of fresh water and marine ecosystems

Unit:6	**Contemporary Issues**	**2-hours**

Expert lectures, online seminars –webinars, Recent development and advances

	Total Lecture hours	**72-hours**

Text Book(s)

1	Hazardous Wastes and Solid Wastes, Liu, D. H. Fand Liptak, B.G.(2000), Lewis Publishers, New York.
2	Geomicrobiology, Ehrlich, H. L. (1996), Marcel Dekker Inc., New York.
3	Bioremediation, Baker, K.H. and Herson, D.S.(1994), Mc Graw–Hill Inc, New York

Reference Books

1	Microbial Ecology, IV Ed., Atlast, R. M and Bartha, R, (2000), Addison Wesley Longman Inc.
2	Biodegradation and Bioremediation, Alexander, A.(1999), Academic Press
3	Recycling of Crop, Animal and Human Waste in Agriculture, Tandon, H.L.S. (1995), Mc Graw Hill Publishing Co.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	http://cbs.teriin.org/pdf/Waste_Management_Handbook.pdf
2	https://www.eschooltoday.com/waste-recycling/what-is-recycling.html
3	https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/geomicrobiology
4	https://www.mdeq.ms.gov/wp-content/uploads/2017/06/Bioremediation
5	https://clu-in.org/techfocus/default.focus/sec/Bioremediation/cat/Aerobic_Bioremediation_(Direct)/
6	Fang et al. (2023) Artificial intelligence for waste management in smart cities: a review. Environmental Chemistry Letters. 21:1959–1989.
7	Idoko et al (2024) Development of Smart Waste Management Technologies Using IoT Solutions for Environmental Sustainability in Urban Infrastructure Planning. International Journal of Innovative Science and Research Technology, 9(12), December – 2024

Mapping with Programme Outcomes

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	M	S	S	M	S	S	M	M	M
CO2	M	S	M	S	M	S	S	M	M	S
CO3	S	M	M	S	M	S	S	S	M	S

Course code	25ENVA33B	ENVIRONMENTAL LAW, POLICY AND AUDITING	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Fundamental knowledge on environmental law and policy	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are:

1. To understand statutory and regulatory frame work in India with regard to Environmental affairs
2. To understand significant development in national and international environmental laws
3. To impart knowledge about environmental auditing, regulations and policies of India and international perspectives

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand Environmental issues and response of judiciary system to environmental issues.	K1
2	Exercise his rights like right to information, and know about legal remedies Available for environmental protection–national and international environmental laws	K3
3	Know about fundamental rights of human beings to live in healthy environment – Clean air, water and soil	K3
4	Plan an environmental management system for societal benefits by improving environmental performance of organizations	K4
5	Conduct on –site assessments and prepare audit reports.	K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Global Environmental Policies	14-hours

Necessity for International Environmental Court – United Nations Environment Programme [UNEP] role on international environment laws. International environmental policy–environmental problems and their impact on international system, the instruments of international environmental policy–international law-soft law - (treaties, conventions and protocols) scientific cooperation - fund support, sanction, dispute settlement procedures, non-state actors and international environmental policy–Transnational Environmental Policies –the Indus river basin, the Ganga– Brahmaputra river basin system. Hazardous Wastes- Basal convention.

Unit:2	Environmental Legislation in India	14-hours

Environmental law –Constitutional and legislative provisions in India: Article 41A and 51 A; Institutional Framework - Nodal Agencies – Ministry of Environment, Forest and Climate Change - Functions of the Central and State Pollution Control Boards. State Level Environmental Assessment Authority -Policy and Planning Framework - Land use policy for India–Urban planning.
Environmental protection and fundamental rights, judicial remedies and procedures–Tort law, public nuisance, the writ jurisdiction, statutory remedies, Public Interest Litigation, Class Action, Freedom of Information and the Right to Know.

Unit:3	Key Environmental Legislations in India	14-hours

The Factories Act, 1948 - The Mines and Minerals Act, 1957 (Development and Regulations) –The Atomic Energy Act, 1962 - The Wildlife Protection Act 1972, The Water (prevention and control of pollution) Act of 1974, The Water Cess act of 1977, The forest conservation act 1980 - The Air (prevention and control of pollution) act of 1981,The Environmental Protection Act, 1986, The Public Liability Insurance act of 1991, The National Environment Tribunal Act, 1995, The National Environment Appellate Authority act, 1997, National Green Tribunal Act 2010,Plastics Waste management Rules 2016, E-waste Rules, 2016 - Hazardous Waste Rules, 2016 – Recent Amendments.		
Unit:4	**Environmental Auditing**	**14-hours**
Organizations and the environment- Objectives and Scope–Types of EA–Objective based (Liability, management and functional audits); Client driven – Elements of audit process (What, who, why and how)– Environmental issues: Identification of problems.		
Unit:5	**Benefits And Costs Of Environmental Audit**	**14-hours**
Contents of EA reports -Tools for EA (EMSs) –International standards for environment quality – ISO14001, 19011 - EA in India – Gazette Notification, 1992- Case studies: South India Viscose rayon unit case, Public Participation –A case study approach.		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars -webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)	
1	Environmental law in India, Singh, G. (2005), McMillan, New Delhi.
2	Environmental law and policy in India, Diwan, S. And Rosencrany, A. (2001), Oxford University Press, New Delhi.
Reference Books	
1	Environmental Management in Practice, Nath, B., Hens, L., Compton, P. and Devuyst, D. (1998), VolI, Routledge, London and New York.
2	The ISO 14000 Hand book: The New International Environmental Management Standards, Cascio. J. (1996), McGraw Hill Professional.
3	ISO14004–Environmental management systems: General guidelines on principles, systems And supporting techniques (ISO 14004: 1996 (E).
4	ISO14001: Environmental management systems: Specification with guidance for use (ISO14001: 1996b (E)), International organization for standardization– Switzerland.
5	Pollution Control Legislations, (1999), Vol. I and II, Tamil Nadu Pollution Control Board, Chennai
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.coursera.org/learn/environmental-law
2	https://onlinecourses.nptel.ac.in/noc20_lw02/preview
3	https://onlinecourses.swayam2.ac.in/cec20_ge12/preview
4	https://shodhganga.inflibnet.ac.in/bitstream/10603/145973/12/m.chapter-v%20evolution%20of%20the%20law%20relating%20to%20environmental%20p.pdf

5	https://www.soas.ac.uk/cedep-demos/000_P508_EAEMS_K3736-Demo/module/pdfs/p508_unit_01.pdf
6	https://www.iloencyclopaedia.org/part-vii-86401/environmental-policy/item/748-environmental-auditing-definition-and-methodology

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	L	M	S	L	S	M	S	L	M
CO2	S	L	M	S	L	S	S	S	M	S
CO3	S	S	M	S	S	S	S	S	M	S
CO4	M	S	S	S	M	S	S	S	M	S
CO5	S	S	S	S	M	S	S	S	S	S

Course code	25ENVA33C	REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Basic knowledge on remote sensing And geographic data	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are:

1. To teach the principles and applications of spatial information technologies viz RS, GPS and GIS about the distribution of resources.
2. To give hands-on training on the uses of Remote sensing and GIS software in environmental studies

Expected Course Outcomes:

On the successful completion of the course, student will be able:

1	To learn how sensors collect spatial geographic data
2	To generate geographical information by processing digital data by remote sensing and assess its environmental applications.
3	To apply RS, GIS and GPS tools in various dimensions of the environment.

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit1	Concepts and Foundations of Remote Sensing	14-hours

History of remote sensing - Electro-magnetic energy – Properties and interaction with the earth and atmosphere. Atmospheric windows. Black, white and grey bodies, Keys of Image interpretations. Aerialphoto-classification based on attitude of cameralens, distortions caused due to flight irregularities, overlaps, scale, relief displacement and its effects. Photo recognition elements, Different types of photographs.

Unit2	Introduction to GIS and GIS Software	14-hours

Fundamentals of GIS: Concepts of components Layers and features, Raster /Vector data sets-Geo referencing and projection, Spatial and attributes and GIS basics; Data attributes and spatial topology, Digitization and data attributes- map data representation, GPS., Software-Arc GIS; Open Sources GIS consorception-QGIS, Google earth engine, OSM (Open Series Map).

Unit:3	Elements of Photographic Systems and Computer Applications	14-hours

Landsat IRS and other satellite systems- satellite data. Principals involved in thermal IR image and microwave image interpretation. Image restoration methods, Image processing, Image resolution, filtering techniques, Classification-supervised and unsupervised NDVI, Open sources satellite systems, BUVAN Geos GLFC, Planet

Unit:4	Remote Sensing Applications	14–hours

Impact Assessment– Pollution Monitoring– Water– Air– Ocean Pollution– Land Degradation– Desertification– Industry– Mining– Ground Water Modeling– Damage Assessment– Coastal and Marine Applications – Future Sensors – Satellite System – ENVISAT – Megha Tropiques – TRMM – EOS Missions– Integral Earth Observation Studies– Global Change- Case studies. Applications of Different types of images in Earth Sciences, Environmental Sciences, Archaeology, Marine Studies, Forestry, Soils, Hazard Management, Climate Projections etc.

Unit:5	GIS Applications	14–hours

Resources mapping, Inventory and monitoring natural resources, Land cover mapping, Wetland mapping– Applications to Agriculture– Water Management, Specific Applications– Infrastructure– Ground Water. GPS applications– Principles of Accuracy –Data base Creation– Networking of Data.		
Unit:6	**Contemporary Issues**	**2–hours**
Expert lectures, online seminars– webinars, Recent development and advances		
	Total Lecture hours	**72– hours**
Text Book(s)		
1	Remote Sensing and GIS for Environmental Planning, Muralikrishna, I.V. (1995), Tata-McGraw Hill.	
2	Environmental Monitoring: Applications of Remote Sensing and GIS, Singh, R.B. (1992), Geocartho International Centre, Honk Hong.	
3	Environmental Remote Sensing from Regional and Global Scales, Foody, G.M. and Curran, P.J. (1994),1st edition, Wiley.	
4	Introduction to Environmental Remote Sensing, Barrett, E.C and Curtis, L.F. (1982), Chapmanand Hall.	
5	Fundamentals of Remote Sensing, Joseph, G. (2003), Universities Press (India) Ltd., Hyderguda, Hyderabad.	
6	PRINCIPLES OF REMOTE SENSING PAULJ. CURRAN, RAWAT Publishing, 2020 edition	
7	Basics of Remote Sensing and GIS by Dr.S.Kumar Laxmi Publications2005	
Reference Books		
1	Remote Sensing and image interpretation, Lillesand, T., Keifer, R.W. and Chipman, J.W. (2004), 5thedition, John Wiley and sons, NewYork.	
2	Remote Sensing Techniques for Environmental Analysis, Estes J.E. and Senger, L.W. (1973), John Wiley and Sons, New York.	
3	Remote Sensing of Environment, Lintz, J. and Simonett, D.S. (1976), Reading, Massachusetts, Addition – Wesley Publishing Co.	
4	Geographic Information Systems –Spatial Modeling and Policy Evaluation, Fischer, M.M. and Nijkamp, P. (1993), Springer – Verlag.	
5	Advances in Environmental Remote Sensing, Danson, F.M. and Plummer, S.E.(1995), John Wiley & Sons.	
6	Space Remote Sensing Systems – An Introduction, Chen, H.S. (1985), 2nd edition, Academic Press.	
7	Digital Image Processing, Pratt,W.K. (2001),John Wiley & Sons.	
8	Observation of Earth and its Environment–Survey of Missions and Sensors, Herbert, K.J. (2002), Springer-Verlag.	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	https://onlinecourses.nptel.ac.in/noc19_ce41/preview	
2	https://www.classcentral.com/course/swayam-remote-sensing-and-gis-14272	
3	https://www.classcentral.com/report/swayam-moocs-course-list/	
4	https://www.mooc-list.com/course/introduction-urban-geo-informatics-edx	

Course code	25ENVA33D	ENVIRONMENTAL ENGINEERING	L	T	P	C
Core/Elective/Supportive		Core	4	0	2	4
Pre-requisite		Basic knowledge about the Wastewater Treatment plants and Air pollution abatement	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To educate the students about the designing of primary, secondary and tertiary treatment systems of wastewater.
2. To gain knowledge about disinfection methods, chlorine dosage and ETP for different industries
3. To educate about air pollution monitoring and control methods

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand the engineering concepts of wastewater treatment	K1
2	Understand the various parameters influencing the wastewater retreatment	K2
3	Attempt to design a water treatment method for real time effluents	K3
4	Know the different analytical methods of wastewater treatment and Disinfection methods	K4
5	Gain knowledge about environment protection and operation of pollution Control devices	K5

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**–Evaluate; **K6-**Create

Unit:1	ETP, Wastewater Characteristics and Primary Wastewater Treatment	14-hours

Criteria for Effluent Treatment plant (ETP), Physico-chemical and biological characteristics of wastewater, Preliminary treatment-screens, grit removal-Designing of primary treatment of wastewater, equalization, mixing, sedimentation, flocculation, neutralization, floatation, clariflocculator, sedimentation tanks.

Unit:2	Secondary Wastewater Treatment- Aerobic Methods	14-hours

Designing of Secondary treatment of wastewater- Types- Aerobic wastewater treatment-Designing of Aeration Tanks, Diffusers, mechanical aerators, Trickling Filters, Waste Stabilization Ponds, Rotating Biological contactor (RBC), Fluidized Bed Reactor (FBR), Activated sludge process (ASP), modifications, Advanced activated sludge process (AASP), Advantages of aerobic wastewater treatment.

Unit:3	Secondary Wastewater Treatment– Anaerobic Methods	14-hours

Anaerobic wastewater treatment- Designing of anaerobic digester- Up flow Anaerobic Sludge Blanket Reactor (UASB), Sewage anaerobic system for WWT- Advantages of anaerobic wastewater treatment, importance of microorganisms in biological treatment. Disinfection methods- chlorination-chlorine dosage, chlorine demand and residual chlorine.

Unit:4	Tertiary Wastewater Treatment	14-hours

Designing of Tertiary wastewater treatment- Advanced oxidation processes, Membrane filtration- Reverse osmosis- Ion exchange method, Adsorption, Multiple Evaporators, Sludge Drying Bed-Grey water management, zero liquid discharge, Eco- friendly reuse of wastewater		
Unit:5	**Air Pollution monitoring & Abatement**	**14-hours**
Air Pollution Monitoring, ambient sampling, latest techniques- Designing of Settling Chamber, stack height, flue gas recirculation, biobeds, Cyclones, Fabric filters, wet scrubbers and Electrostatic Precipitators		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars, case studies- webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Books	
1	Wastewater Engineering: Treatment and Reuse, Metcalf and Eddy. (2003), Tata McGraw Hill Publishing Company Ltd. ,New Delhi.
2	Hand book of Water and Wastewater Treatment Plant Operations, Spellman, F.R. (2003), Lewis Publishers, London.
Reference Books	
1	Water and Wastewater Technology, Hammer, M.J. and Hammer, Jr.M.J. (2001), Prentice Hall of India Pvt. Ltd., NewDelhi.
2	Environmental Engineering: A Design Approach, Sincero, A.P. and Sincero, G.A. (1999), Prentice-Hall of India Pvt. Ltd., NewDelhi.
3	Introduction to Environmental Engineering and Science, Masters, G.M. (2004), Prentice- Hall of India Pvt. Ltd., NewDelhi.
4	Environmental Engineering, Peavy, H.S. (2003), Tata McGraw Hill Publishing Company Ltd., New Delhi.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://sswm.info/sites/default/files/reference_attachments/SPERLING%202007%20Wastewater%20Characteristics,%20Treatment%20and%20Disposal.pdf

Mapping with Programme Outcomes										
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO10**
CO1	M	S	S	M	M	S	L	M	L	S
CO2	M	M	M	L	L	S	M	S	M	S
CO3	M	S	S	M	L	S	M	M	L	S
CO4	L	S	M	S	L	S	S	S	L	S
CO5	L	M	S	M	M	S	M	S	M	S

Course Code	25ENVA3EC-1	INTRODUCTION TO INDUSTRY 4.0	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Basic knowledge on computational methods	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. Educate the students about industry 4.0 tools
2. Impart knowledge on Big data analysis
3. Impart knowledge on Artificial Intelligence and Internet of Things with Environmental Sciences perspectives

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand the need for adopting Industry4.0 tools	K2
2	Understand the basics of Artificial Intelligence and associated technologies	K2
3	Understand the basics of Big data analytics	K2
4	Understand the basics of Internet of Things	K2
5	Apply the tools of Industry 4.0 in various disciplines	K3

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Industry4.0	14-hours

Need– Reason for Adopting Industry 4.0- Definition– Goals and Design Principles –Technologies of Industry 4.0 – Big Data – Artificial Intelligence (AI) – Industrial Internet of Things - Cyber Security – Cloud –Augmented Reality.

Unit:2	Artificial Intelligence	14-hours

Artificial Intelligence: Artificial Intelligence (AI)–What &Why?- History of AI- Foundations of AI -The AI - Environment - Societal Influences of AI – Application Domains and Tools – Associated Technologies of AI- Future Prospects of AI- Challenges of AI

Unit:3	Big Data and IOT	14-hours

Big Data : Evolution - Data Evolution - Data : Terminologies - Big Data Definitions – Essential of Big Data in Industry 4.0 - Big Data Merits and Advantages - Big Data Components : Big Data Characteristics - Big Data Processing Frameworks - Big Data Applications - Big Data Tools – Big Data Domain Stack : Big Data in Data Science – Big Data in IoT - Big Data in Machine Learning -Big Data in Databases - Big Data Use cases: Big Data in Social Causes - Big Data for Industry –Big Data Roles and Skills -Big Data Roles - Learning Platforms; Internet of Things (IoT) : Introduction to IoT– Architecture of IoT- Technologies for IoT- Developing IoT Applications- Applications of IoT- Security in IoT

Unit:4	Applications and Tools of Industry 4.0	14-hours

Applications of IoT– Manufacturing– Healthcare– Education– Aerospace and Defense– Agriculture– Transportation and Logistics– Impact of Industry 4.0 on Society: Impact on Business, Government, People. Tools for Artificial Intelligence, Big Data and Data Analytics, Virtual Reality, Augmented Reality, IoT, Robotics

Unit:5	**Jobs 2030**	**14-hours**
Industry4.0– Education4.0 – Curriculum 4.0 – Faculty 4.0– Skills required for Future – Tools for Education– Artificial Intelligence Jobs in 2030 – Jobs 2030-Frame work for aligning Education with Industry 4.0		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars, case studies - webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Book(s)	
1	P. Kaliraj, T. Devi, Higher Education for Industry 4.0 and Transformation to Education 5.0, 2020

Reference Books	
1	Data Analytics and Big Data. Soraya Sedkaoui (2018). Wiley Press
2	Big Data: A Very Short Introduction, Dawn E. Holmes (2017). Oxford Press

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/106/104/106104189/
2	https://nptel.ac.in/courses/106/102/106102220/
3	https://onlinecourses.nptel.ac.in/noc20_cs92/preview

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	L	S	S	M	L	L	M	L	L	M
CO2	L	S	S	M	L	L	S	L	L	M
CO3	L	S	S	M	L	L	S	L	L	S
CO4	L	S	S	M	S	S	S	L	S	S
CO5	L	S	S	S	L	L	M	M	L	S

*S-Strong; M-Medium; L-Low

Course code	25ENVA3EC-2	INDUSTRIAL ECOLOGY	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Basic knowledge on environment & industrial process	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are:

1. To define and describe industrial ecology;
2. To demonstrate the relationships among production, consumption, sustainability, and industrial ecology
3. To show how industrial ecology serves as a frame work for consideration of environmental and sustainability- related aspects of science and technology

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand the philosophy and principles of Industrial ecology.	K2
2	Identify the benefits and limitations of tools like materials flow analysis, design for environment, environmentally extended input-output analysis, and process-based life cycle assessment.	K1& K2
3	Identify appropriate tools for measuring environmental impacts of industrial systems.	K2
4	To design solutions for sustainability problems in the industrial system.	K3
5	Conduct a comparative environmental life cycle assessment (LCA) in support of a decisions with respect to design, operations, or policy making for products, products systems, or infrastructure in the industrial system.	K3

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Introduction to Industrial Ecology	14-hours

The anthrosphere and industrial ecology, Industrial metabolism and biological analogies, material and energy flows and transformations, internalization of materials cycle, system integration and industrial metabolism, Eco-efficiency

Unit:2	Industrial Ecosystems and Energy Link	14-hours

Components of the industrial ecosystem, industrial symbiosis, examples of symbiotic industrial ecosystems, designing and developing symbiotic industrial ecosystem. Industrial Ecology and Energy Energy considerations in (i) Material Choice (ii) Product manufacture (iii) Product use (iv) remanufacturing and recycling

Unit:3	**Tools of Industrial Ecology**	**14-hours**
Life Cycle Assessment (LCA) – Products, Processes and Facilities -Materials and Product Budgets, Design for Environment, Eco-efficiency, Design for Recycling, Dematerialization and Decarbonization –Industrial metabolism- IPAT equation.		
Unit:4	**Status of Resources**	**14-hours**
Depletion Times, under abundant Resources, Hitchhiker Resources, Energy Resources, Energetically Limited Mineral Resources, Geographically Influenced Resource Availability, Environmentally Limited Resources, Cumulative Supply Curves, Water Resources		
Unit:5	**Industrial Product and Process Design**	**14-hours**
The Product and Process Challenge, Conceptual Tools for Product Designers, Design of X, Product Design Teams, The Product Realization Process, The Process Life Cycle, Approach to Process Analysis, Guidelines for Process Design and Operation, Implications for Corporation		
Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars –webinars, Recent development and advances		
	Total Lecture hours	**72-hours**

Text Books	
1	Graedel, T.E., and Allenby, B.R. 2010. Industrial Ecology and Sustainable Engineering. Upper Saddle River, New Jersey: Pearson Education.
2	Industrial Ecology: Environmental Chemistry and Hazardous Wastes, Stanley E Manahan, (1999). Lewis, New York, USA.
Reference Books	
1	Industrial Ecology. T.E. Graedel and B.R. Allenby, (2003). Printice Hall, New Jersey, USA.
2	Edward Cohen- Rosenthal E. and Musnikow J.(edited) (2003) Eco-industrial Strategies, Sheffield, UK: Greenleaf Publishing
3	Thomas E.G. and Brad R.A., Industrial Ecology and Sustainable Engineering , 3rd edition.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://is4ie.org/announcements/360
2	https://ocw.mit.edu/courses/esd-123j-systems-perspectives-on-industrial-ecology-spring-2006/pages/lecture-notes/
3	http://pustaka.unp.ac.id/file/abstrak_kki/EBOOKS/A%20Handbook%20of%20Industrial%20Ecology.pdf
4	https://ocw.mit.edu/courses/esd-123j-systems-perspectives-on-industrial-ecology-spring-2006/b1d357790bdb0cfb3223661472a8bc9d_lec1.pdf
5	http://www.blog.industrialecology.uni-freiburg.de/index.php/2018/01/31/launching-the-industrial-ecology-open-online-course-ieooc/

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	M	S	S	S	L	S
CO2	S	M	S	S	M	S	S	S	L	M
CO3	S	L	S	S	L	S	S	S	L	M
CO4	S	L	S	S	M	S	S	S	L	S
CO5	M	S	S	M	S	S	S	S	L	S

S-Strong; M-Medium; L-Low

Course code		TITLE OF THE COURSE	L	T	P	C
Self-Learning Course		HEALTH & WELLNESS	-	-	1	1
Prerequisite		Basic understanding about wellbeing	Syllabus Version	2025-2026		

Course Objectives:

The main objectives of this course are:

- The Health & Wellness course focuses on teaching the elements of physical, mental, emotional, social, intellectual, environmental well-being which are essential for overall development of an individual.
- The course also addresses the dangers of substance abuse and online risks to promote emotional and mental health.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Demonstrate proficiency in sports training and physical fitness practices.	K1
2	Develop competence and commitment as professionals in the field of health and wellness.	K2
3	Awareness on drug addiction and its ill effects	K3

K1 – Understand; **K2** – Deliberate; **K3 –** Application

Unit: I	Introduction to Holistic Well-being	6 hours

Introduce the core components of Health & Well-being namely Physical, mental and emotional well-being- Provide worksheets on all the four components individually and explain the interconnectedness to give an overall understanding.

Unit: II	Wellness Wheel Exercise (Overall Analysis)	7 hours

Guide students to assess their well-being in various life dimensions If tcugh exercises on vai ious aspects of well — being, and explain the benefits of applying wellness wheel-Introduce Tech Tools: Explore the use of technology to support well-being.-Introduce students to apps for meditation, sleep tracking, or healthy recipe inspiration.

Unit: III	Breaking Bad Habits (Overall Analysis)	6 hours

Open a discussion on bad habits and their harmful effects-Provide a worksheet to the students to identify their personal bad habits-Discuss the trigger, cause, consequence and solution with examples.-Guide them to replace the bad habits with good ones through worksheets.

Unit: IV	Physical Well-being	6 hours

Fitness: Introduce the different types of fitness activities such as basic exercises, cardiovascular exercises, strength training exercises, flexibility exercises, so on and so forth.

Nutrition: Facilitate students to reflect on their eating habits, their body lype, and to test their knowledge on nulrition, its sources and the benefits.

Yoga & Meditation: Discusś the benefits of -Yóga and Meditation for one's overall health

Brain Health: Discuss the importance of brain health for daily life.-Habits that affect brain health (irregular sleep, eating, screen time). Habits that help for healthy brains (reading, proper sleep, exercises).
Benefits of breathing exercises and meditation for healthy lungs.

Healthy *lungs:* Discuss the importance of lung health for daily life-Habits that affect lung health (smoking, lack of exercises)-Benefits of breathing exercises for healthy lungs.

Hygiene and Grooming: Discuss the importance of hygienic habits for good oral, vision, hearing and skin health.- Discuss the positive effects of grooming on *one's* confidence level and professional growth.

Unit: V	**Emotional Well-being**	**7 hours**

Stress Management: Trigger a conversation or provide self-reflective worksheets to identify the stress factors in daily life and their impact on students' performance-Introduce different relaxation techniques like deep breathing, progressive muscle relaxation, or guided imagery.

Importance of saying 'NO': Explain the students that saying 'NO' is important for their Physical and mental well-being, Academic Performance, Growth and Future, Confidence, Self-respect, *Strong* and Healthy Relationships, building reputation for self and their family (avoid earning a bad name)-Factors that prevent them from saying 'NO'. How to practice saying 'NO".

Body Positivity and self-acceptance -Why is it important?,, Be kind to yourself- Understand that everyone's unique

Unit: VI	**Social Well-Being: Practicing Gratitude**	**2 hours**

Cultivating Kindness and Compassion: Define and differentiate between kindness and compassion. Explore practices that cultivate these positive emotions.

Self-Compassion as the Foundation.-The power of small gestures. Understanding another's perspective. The fruits of compassion.

Practising Forgiveness: Discuss the concept of forgiveness and its benefits. Forgiveness: What is it? and What it isn't?-Benefits of forgiveness. Finding forgiveness practices.

Celebrating Differences: Appreciate the value of individual differences and foster inclusivity. The World: A Tapestry of Differences (cultures, backgrounds, beliefs, abilities, and appearances)-Finding strength in differences (diverse perspectives and experiences lead to better problem-solving and innovation)-Celebrating differences, not ignoring them (respecting and appreciating the unique qualities)

Digital Detox- Introduce the students to: The concept of a digital detox and its benefits for social well-being. How to disconnect from devices more often to strengthen real- world connections.

Unit: VII	**Intellectual Well-being**	

Being a lifelong Learner: Give students an understanding on: The relevance of intellectual well-being in this 21st century to meet the expectations in personal and professional well-being- The Importance of enhancing problem-solving skills- Cultivating habits to enhance the intellectual well-being (using the library extensively, participating in extra-curricular activities, reading newspaper etc.)

Digital Literacy Discuss: The key aspects of digital literacy and its importance in today's World-It is more than just liking and sharing on social media-The four major components of digital literacy (critical thinking, communication, problem-solving, digital citizenship). Why is digital literacy important? Boosting one's digital skills.

Transfer of Learning: Connections between different subjects — How knowledge gained in one area can be applied to others.

Unit: VIII	**Environmental Well-being**	

The Importance of initiating a change in the envionment. The session could be around: Defining Environmental well-being (physical, chemical, biological, social, and psychosocial factors) — People's behaviour, crime, pollution, political activities, infra-structure, family situation etc.Suggesting different ways of initiating changes in the environment (taking responsibility, .creating awareness, volunteering, approaching administration.		
Unit: IX	**Mental Wellbeing**	
Importanct of self-reflection: Steps involved in achieving mental wellbeing (self-reflection, self-awareness, applying actions, achieving mental wellbeing)-Difference ways to achieve mental well-being (finding purpose, coping with stress, moral compass, connecting for a common cause). The role of journalizing in mental wellbeing. Mindfulness and Meditation Practices: Benefits of practicing mindful habits and meditation for overall well-being-Connecting with nature: Practising to be in the present moment — Nature walk, feeling the sun, listening to the natural sound- Exploring with intention — Hiking, gardening to observe the nature. Reflecting on the emotions, and feeling kindled by nature-Serving people Identifying the needs of others. Helping other:Volunteering your time, skills and listening ear-Finding joy in giving Creative Expressions: Indulging in writing poems, stories, music making/listening, creating visual arts to connect with inner selves.		
Unit: X	**Situational Awareness (Developing Life skills)**	
Being street smart: Who are street smart? Why is it important to be street *smart?* Characteristics of a street *sm*art person: Importance of acquiring life skills to become street smart — (General First-aid procedure, CPR Procedure, Handling emergency situations like fire, flood etc).-Digital Awareness Discuss: Cyber Security Information Literacy Digital Privacy Fraud Detection		
Unit: XI	**Understanding Addiction Plan**	
Identifying the environmental cues, triggers that lead to picking up this habit. Knowing the impact of substance abuse — Adverse health conditions, social isolation, ruined future, hidden financial loss and damaging the family reputation-Seeking help to get out of this addiction.		

Supportive Courses

Course Code	25ENVGS18	ECOTOURISM	L	T	P	C
Core/Elective/Supportive		Supportive	2	0	0	2
Pre-requisite		Knowledge on the importance of environment and natural tourism	Syllabus Version	2025-2026		

Course Objectives:

The main objectives of this course are to:

1. Impart knowledge on the fundamentals of ecotourism activities
2. Study about the concepts of ecotourism
3. Understanding the conservation of natural resources

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand the role of ecotourism for sustainable development	K2
2	Have a basic understanding on the use of business frame work to plan and implement sustainable tourism	K2
3	Have detailed knowledge on the Impact of Ecotourism	K2
4	Have the knowledge for creating awareness of protecting the environment as well as consider the needs of local people	K6

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Conceptsof Tourism	8-hours

Classification–Religious Tourism–CulturalTourism–HeritageTourism–MonumentalTourism–AdventureTourism–MassTourism–SustainableTourism–Consumptiveand Non-Consumptive Tourism. Principles of Ecotourism – Types of Ecotourism – Concepts of Ecotourism – Origin of Ecotourism–Objectives of Ecotourism –Benefits of Ecotourism –Trends affecting Ecotourism

Unit:2	Places of Interests of Ecotourism	8-hours

Ecocircuit of the Western Ghats– Infrastructural Facilities for Ecotourism– Maintenance of Ecological Centers – Important Biosphere Reserves. Target group of Ecotourism – Ecotourism and Conservation – Study of different Ecosystem – Rain forest Ecotourism – Mountain Ecotourism –Polar, Islands and Coasts Ecotourism– Wilderness– Marine Ecosystem- Sanctuaries and National Parks- TQM of Ecotourism Resorts, Knowledge, skills, attitude and commitment of ecotourism service providers.

Unit:3	Impact of Ecotourism	8-hours

Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities– Socio- cultural Impacts– Ecotourism related organization–Ecotourism Research- Disasters and Ecotourism- Role of ethics in ecotourism- Advantages and Disadvantages of Ecotourism- Eco-branding and Eco-labeling of Ecotourism Products - Marketing of Ecotourism, Ecotourism and Sustainable Development- Management Issues in Ecotourism, Ecotourism- based / related employment: Scope and areas of employment.

Unit:6	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars - webinars, Recent development and advances		
	Total Lecture hours	**26-hours**

Text Book(s)

1	The Encyclopedia of Ecotourism, Weaver, D. B.(2001), CABI Publishing, U.K.
2	Encyclopedia of Ecotourism Volume I, II and III, Sinha, P.C. (2003), Anmol Publications (P) Ltd., New Delhi.
3	Ecotourism and sustainable Development, Mukherjee, N. (2008), Cybetech Publications, New Delhi.
4	Global Ecotourism, Chandra, P. (2003), Kaniskha Publishers, New Delhi.
5	Ecotourism, Weaver, D. (2001), John Wiley & Sons, Milton.

Reference Books

1	Ecotourism. An Introduction, David, F.A. (2003), Routledge, London and New York.
2	Ecotourism Impacts, Potentials and Possibilities,Wearing,S. and Neil, J. (2009), 2nd edition, Butterworth & Heinemann, Amsterdam.
3	Case studies in ecotourism, Buckley, R. (2003), CAB International, Cambridge.
4	Environmental impacts of ecotourism, Buckley, R. (2004), CAB International, Oxfordshire.
5	Facing the wild: ecotourism, conservation, and animal encounters, Bulbeck, C.(2005), Earth scan, London.
6	Tourism, ecotourism,and protected areas.Ceballos-Lascurain, H.(1996), Gland: IUCN
7	Ecotourism: Management and Assessment, Diamantis, D. (2004), London: Thomson.
8	Ecotourism: aguide for planners and managers, Lindberg, K. and Hawkins. D.E.(eds). (1993), The Ecotourism Society, NorthBenninton.
9	Ecotourism, Page, S.J. and Dowling, R.K. (2002), Prentice Hall, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.acseduonline.com/courses/ecotourism-14/certificate-in-ecotourism-ctecotour-184.aspx
2	https://www.classcentral.com/course/edx-sustainable-tourism-society-environmental-aspects-10356
3	https://www.openlearning.com/csu/courses/introduction-to-ecotourism/

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	L	L	M	M	L	L	L	L	L
CO2	L	L	L	L	L	S	L	L	L	M
CO3	L	S	M	L	M	L	L	M	L	L
CO4	L	S	L	L	L	L	L	L	S	L

*S-Strong; M-Medium; L-Low

Course Code	25ENVGS53	NATURAL DISASTER MANAGEMENT	L	T	P	C
Core/Elective/Supportive		Supportive	2	0	0	2
Pre-requisite		Basic knowledge on natural disasters and their consequences	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To impart knowledge on the management, disaster preparedness and training and mitigation strategies during the natural disasters.
2. To acquaint the Students with the concepts, terminologies and developments in the field of Disaster Management and to inform them about the prospects of a Natural Disaster Manager.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Differentiate the different types of disasters, analyses the causes and their potential impact on the natural and man -made environments.	K2
2	Educate people about the importance of preparedness invulnerable areas.	K3
3	Will know about the various national and international agencies that play a major role in disaster management	K4
4	The knowledge gained will enable the students to volunteer themselves in disaster management programs thus helping affected community.	K5

K1-Remember; **K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5** -Evaluate; **K6** –Create

Unit:1	Natural Disasters	8-hours

Nature and Extent and Educative– Disasters, Cyclone, Tornadoes, Avalanches, Flood, Drought, Volcanic, Earthquakes, Fire and Landslides. Forecasting and Warning System: Cyclone Disaster Education- Cyclone Safety, Earthquake and Avalanche Safety, Flood Safety and Impact on Environment.

Unit:2	Disaster Management	8-hours

Pre-disaster Planning-Toning of Disaster – prone areas – prioritization –regulations – protection measures during disaster- Post disaster. Relief Camp Organization–Survey and Assessment. Disaster Management Cycle– Vulnerability Analysis–Warning system– Legal Aspects–case studies for disasters and management, Safety Measures–Disaster Management plans.

Unit:3	Disaster Preparedness and Training	8-hours

Community Preparedness in Natural Disasters- Roles and responsibilities of different national and international agencies and government - NGO, Armed forces, Paramilitary forces, Community based organizations (CBO) - Army Training for Disaster Reduction –Role of team and co-ordination – Training needs–Target Groups– Local Condition. Mitigation Strategies: Disaster Mitigation– Training for emergency.

Unit:4	Contemporary Issues	2– hours

Expert lectures, online seminars –webinars, Recent development and advances

	Total Lecture hours	**26-hours**
Text Book(s)		
1	Natural Disaster, Sharma, R.K. and Sharma, G. (2005), APH Publishing Corporation, New Delhi	
2	Disaster Management: A disaster Manager's Handbook, Nick, C.W. (1992), Asian Development Bank, Manila.	
3	Earthquake: A Natural Disaster, Ashutosh, G. (1994), Ashok Publishing House. New Delhi	
4	Disaster Management approaches and strategies, Singh, T. (2006). Akansha Publishing House, New Delhi.	
5	Towards Basics of Natural Disaster Reduction, Sinha, D.K. (2006), Research Book Centre, New Delhi.	
6	Disaster Planning: The Preservation of Life and Property, Foster, H. D. (1980), Springer Verlay, New York.	
7	Disaster Management, Singh, S. K., Kundu, S. C. and Singh, S. (1998), Mittal Publications, New Delhi.	
Reference Books		
1	www. GIS. Development. net	
2	www. GIS. Development. net	
3	Disaster Management, Prakash, I. (1994), Rashtra Prahari Prakasan, Gaziabad Publishing House, New Delhi.	
4	Natural Disaster Reduction, Misra, G.K. and Mathur, G.C. (1993), Reliance	
5	www.iirs.nrsa.org	
6	http://quake.usgs.gov	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	https://onlinecourses.swayam2.ac.in/cec19_hs20/preview	
2	https://www.mooc-list.com/tags/disaster-management.	

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	M	M	S	S	M	S
CO2	M	S	M	M	S	S	S	M	M	S
CO3	M	M	M	S	S	M	S	S	S	M
CO4	M	M	M	S	M	M	M	M	M	S

*S-Strong; M-Medium; L-Low

Course Code	25ENVGS03	ENVIRONMENTAL EDUCATION AND AWARENESS	L	T	P	C
Core/Elective/Supportive		Supportive	2	0	0	2
Pre-requisite		Basic Knowledge on the environmental issues and its related information	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To impart understanding on the environmental education and environmental awareness
2. To undertaking case studies and surveys in the field of environmental Education

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Students will be able to understand the role and importance of Environmental Education for school children.	K2
2	Through obtained the environmental awareness knowledge, students will be able to understand the eco-friendly mitigation efforts to save the sustainable nature for Future generation.	K5
3.	Observe values like love for nature, respect for rights of animals, care of plants and other living beings and protection of the environment.	K4

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**–Create

Unit:1	Environmental Education	8-hours

Concept, scope and importance of Environmental Education - Objectives of Environmental Education at secondary school level. Values and ethics related to environment, Approaches of Environmental Education, Salient features of environmental awareness through education: programs of environmental education for secondary school children-Programs of environmental education for attitude Changes among the children.

Unit:2	Environmental Hazards	8-hours

Causes and effects of environmental hazards, effect of human activities on environment-environmental pollution- global and local (Soil pollution, water pollution, air pollution, noise pollution) - Green House effect –Ozone layer depletion –acid rain, pillar melting, rise of sea level and their implications-Mitigation efforts.

Unit:3	Environmental Awareness	8-hours

Learning to live in harmony with nature - environmental education for development, conservation of soil, water, forests, wild life, energy resources, movement to save environment, eco-friendly technology -Alternate sources of energy– Waste management- Population and environment.

Unit:4	Contemporary Issues	2-hours

Expert lectures, online seminars–webinars, Recent development and advances

		Total Lecture hours	**26-hours**
Text Book(s)			
1	Environmental Impact Assessment, Canter, E.W. (1977), McGraw Hill Co., New York.		
2	Man and Nature, Fedron, E. (1980), Progress Publishers, Moscow.		
3	Concept of Ecology, Kormondy, E. (1991), Prentice Hall of India, New Delhi.		
4	Ecology, Odem, E.P. (1975), Oxford and IBH Publishing Co., New Delhi.		
5	Environmental Science, Purdom, P.W. and Anderson, S.H. (1983), Charles E. Merril Publishing Co.		
Reference Books			
1	Education for the Environmental Concerns, Implications and Practices, Saxena, A.B. (1996), Radha Publication, New Delhi.		
2	Environmental Biology, Sharma, P.D. (1993), Rastogi and Co. Meerut.		
3	Environmental Education,Gupta,V.K. (1998), New Academic Publishing House, Mai Hiran Gate, Jallandhar.		
4	The Hand book of Environmental Education, Palmer, J. and Philips, N. (1994), Routledge, London.		
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]			
1	https://www.mooc-list.com/categories/sci-environment		
2	https://swayam.gov.in/explorer?category=Environmental_Sciences		

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	M	S	S	M	S	M	S	M	S
CO2	M	S	M	S	M	M	M	M	S	M
CO3	S	S	M	M	S	M	S	S	S	S

*S-Strong; M-Medium; L-Low

Value Added Courses

Course code	25ENVAVA01	AGROFORESTRY	L	T	P	C
Core/Elective/Supportive		Value Added Course-1	2	0	0	2
Pre-requisite		Basic Knowledge on Agroforestry	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are:

1. To gain insights on the concept of agroforestry as a sustainable land use activity and agroforestry intervention methods including diagnosis &design methodologies.
2. To impart knowledge on soil and water management in agroforestry including biogeochemical cycling of nutrients.
3. To impart knowledge on interactions between tree and livestock including their management, principles of crops and fodder production in agroforestry.
4. To make familiar and grow of trees and shrubs (fruit, fodder and small timber) more suitable for agroforestry.
5. To educate the role and multiple use of agroforestry system in integrated and sustainable Agroecosystem

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Understand the need of agroforestry and the involved biophysical processes	K1
2	Gain knowledge on the role of agroforestry systems in soil fertility and nutrient cycling	K2
3	Understand the positive and negative tree-crops- soil interactions (for light, water and nutrients).	K2
4	Acquire knowledge about the familiar of environmental conservation and International conventions, in particular the Convention on Climate Change and the Convention on Biological Diversity, and how they relate to agroforestry systems.	K3
5	Understand the opportunities for employment and cash income through agroforestry systems and also understand how agroforestry innovations can make positive impact on economy and environment	K4

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Agroforestry and Types	8-hours

Definition, objectives and principles. Introduction and Agroforestry Research in India, Traditional Agroforestry system in India, Structural Classification of agroforestry systems: Agrisilviculture, Silvipastoral, Agrosilvipastoral, Riparian buffer strips, Wind breaks, Shelterbelts, Contour strips, Fertility plantings, Vegetative lie Hedges/Fences, Importance and benefits of agroforestry in context of climate change and hazards, carbon sequestration potential of agroforestry systems, managing component interaction in agroforestry for higher yield, enhancing adaptive capacity.

Unit:2	Ecosystem Services of Agroforestry	8-hours

Potential species for edible oil, industrial oil and biofuel sources, agroforestry for soil conservation and amelioration, water conservation measures of tree based agroforestry systems- pitting system, earth basins, earthen bunds, staggered trenches /water absorption trench, agroforestry and ecosystem services, food and nutrition security, agroforestry for fuel wood and fodder production, energy security and biofuel production, agroforestry based systems of animal production, Role of N_2 fixing trees in agroforestry, management of problem soil through agroforestry, waste land development

through agroforestry, reclamation of mine soils, controlling seepage- canal and water storage, agroforestry interaction, effective insect and pest control.		
Unit:3	**Role of Multipurpose Plants to Agroforestry**	**8-hours**
Nutrient cycling through agroforestry, role of multipurpose trees and shrubs to agroforestry system- *Leucaena leucocephala*, *Pongamia pinnata, Tamarindus indica*, *Acacia nilotica, Pithecellobium dulce, Jatropha curcas, Ziziphus marutinana, Gliricidia sepium*, *Mangifera indica*, *Ailanthus excels, Ceiba pentandra, Moringa oleifera, Prosopis cineraria* and grasses. Home garden development through agroforestry, advantages and disadvantages and future thrust of agroforestry systems, ecosystem services and environmental benefits- clean air, clean water, pollination/seed dispersal, flood mitigation, biodiversity mitigation, livelihood security and employment opportunities, National agroforestry policy.		
Unit:4	**Contemporary Issues**	**2-hours**
Expert lectures, case studies, online seminars -webinars, Recent development and advances		
	Total Lecture hours	**26-hours**

Text Book(s)	
1	Agroforestry: Principles and Practices. Dwivedi, A.P. (1992). Oxford & IBH, New Delhi.
2	Promising Agroforestry Tree Specie in India, Chaturvedi, O.P, Handa, A.K, Uthappa, A.R, Sridhar, K.B, Kumar, N, Chavan, S.B. and Rizvi, J. (2017). CAFRI, Jhansi and ICRAF, New Delhi.
3	A Practical Manual on Agroforestry, Meena, R.N. and Singh, R. (2014). Srijan Samiti Publishers,Varanasi.
4	An Introduction to Agroforestry, Nair, P. K. R. (1993). Kluwer Academic Publishers, The Netherlands.
5	Agroforestry Systems in India: Livelihood Security & Ecosystem Services, Dagar, J. C., Singh, A. K., Arunachalam, A. (2013), Springer,UK
Reference Books	
1	New Vistas in Agroforestry, Nair, P.K.R, Rai, M.R, and Buck, L.E. (2004)., Kluwer Academic Publishers, The Netherlands
2	Trees and Tree Farming, Thampan, P. K. (1993). Peekay Tree Crops Development Foundation, Cochin, India.
3	Agroforestry for Soil Management,Young,A. (1997). CAB International, UK.
4	Agroforestry Opportunities for Enhancing Resilience to Climate Change in Rainfed Areas, Rao, G.R, Prabhakar, M, Venkatesh, G, Srinivas, I. and Reddy, K.S. (2018). ICAR–CRIDA, Hyderabad, India.
5	Tree Crop Interactions–A Physiological Approach, Ong, C. K. and Huxley, P. K. (1996). ICRAF, Nairobi, Kenya.
6	Agroforestry in Sustainable Agricultural Systems, Buck, L.E, Lassoie, P.L, Fernandes, E.C. M. (1998).CRC Publications, Florida, USA.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	WorldAgroforestryCenter(ICRAF): www.worldagroforestrycentre.org
2	AgroforestryatFAO:www.fao.org/forestry/9469.

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	M	M	M	M	M	M	M	S	M
CO2	M	M	M	L	M	S	S	S	S	M
CO3	L	M	S	M	S	M	S	M	S	M
CO4	M	M	M	S	M	S	M	M	S	S
CO5	M	S	M	M	M	S	M	M	S	M

*S-Strong; M-Medium; L-Low

Course code	25ENVAVA02	BIOFERTILIZERS AND BIOPESTICIDES	L	T	P	C
Core/Elective/Supportive		Value Added Course-2	2	0	0	2
Pre-requisite		Basic knowledge in biological sciences and microbiology	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are:

1. To impart knowledge about beneficial microbes used as biofertilizers and biopesticides and their production and application technology
2. To impart knowledge about their production and marketing
3. To provide a platform, where actual job skills could be developed among the students aiding them inself-employment

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Know about the diversity of microorganisms and their ecological services to man kind	K2
2	Distinguish the types of biofertilizers and biopesticides	K2
3	Understand importance and role of different microbes in soil fertility and crop productivity and exploit their potential for sustainable agriculture	K5
4	Synthesize biofertilizers and pesticides on a large Scale	K3
5	Design and apply for integrated nutrient management (INM) and integrated pest management (IPM) plan	K4

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Biofertilizers	8-hours

Status and scope- General account of the microbes used as biofertilizers Bacteria and Fungi- advantages over chemical fertilizers. Composted Municipal Solid Waste, Types of Biofertilizers – Nitrogen fixers – Symbiotic nitrogen fixation (Rhizobium, Frankia), free living nitrogen fixation (Anabaena, Nostoc) Associative nitrogen fixation (Azospirillum, Azotobacter) - Phosphate solubilizers – Phosphate mobilizers –Biofertilizer for micro nutrients (Potash, iron, zinc and sulphur)–Plant Growth Promoting Rhizobacteria (PGPRs)- Mycorrhizal fungi –Nanofertilizers (urea), Liquid biofertilizers –Factors influencing the efficacy of biofertilizers.

Unit:2	Biopesticides	8-hours

Importance, scope and potential of biopesticide- Types of biopesticides–Microbial pesticides (Bacterial, fungal and viral) – Plant Incorporated Protectants – Biochemical Pesticides-Insect pest control through biomolecules and traps–Botanical Pesticides–Biotic Agents (parasitoids and predators)- PGPRs for control of soil borne diseases - Biorationals - Promising plant species for pest control- Genetically Modified Micro-Organisms for Sustainable Soil Health Management.

Unit:3	Production and Application	8-hours

Biofertilizers- Mass Production technology: Inoculum production- Strain selection, sterilization, growth and fermentation, mass production- field application, benefits and advantages. Biofertilizer development from households waste. Biopesticides - Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes-Application technology Biofertilizers and Biopesticides - for seeds, soil and foliage - Storage, shelf life, quality control and marketing.-Safety testing and Registration– Global Market.

Unit:4	**Contemporary Issues**	**2-hours**
Expert lectures, online seminars - webinars, Recent development and advances		
	Total Lecture hours	**26-hours**

Text Books	
1	Botanicals and Biopesticides -B.S. Parmar and C. Devakumar (Eds.), 1993. Westvill Publishing House, New Delhi.
2	Krishnendu Acharya, Surjit Sen, Manjula Rai, 2019. Biofertilizers and Biopesticides. Technoworld, Kolkatta
3	Somani, L.L., S.C. Bhandari, K.K. Vyas and S.N.Saxena. 1990. Biofertilizers, Scientific Publishers -Jodhpur.
Reference Books	
1	Biofertilizers and Biopesticides in Sustainable Agriculture.2019. B.D. Kaushik, Deepak Kumar, Md. Shamim (Eds.), Apple Academic Press.
2	Subba Rao, N.S., G.S. Venkataraman and S.Kannaiyan, 1993. Biological nitrogen fixation, ICAR Pub., New Delhi.
3	Green Trends in Insect Control, Oscar Lopez & Jose G. Fernandez-Bolanos, (Eds.), 2011. Royal Soc. of Chemistry, UK.
4	Handbook of Microbial Biofertilizers. M.K. Rai. (Ed.), 2006. Food Products Press. New York.
5	Subba Rao, N. S. 1988. Biological nitrogen fixation: recent developments, Mohan Primlani for Oxfordand IBH Pub.Co. (P) Ltd., India
Related Online Contents[MOOC, SWAYAM, NPTEL,Websites etc.]	
1	http://www.amm-mcrc.org/publications/biofertilizers.pdf
2	https://www.fnca.mext.go.jp/english/bf/bfm/pdf/Biofertilizer_Manual.pdf
3	https://www.bio-fit.eu/q8/lo1-why-biofertilizers?start=4

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	L	S	S	L	S	S	S	S	S
CO2	S	M	S	S	L	M	S	S	S	S
CO3	S	L	S	S	L	S	S	S	S	S
CO4	S	L	S	S	L	S	M	S	S	S
CO5	S	M	S	S	L	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Job Oriented Courses

Course code	25ENVAJO01	ORNAMENTAL FISH FARMING	L	T	P	C
Core/Elective/Supportive		Job Oriented Course-2	2	0	0	2
Pre-requisite	Basic knowledge on aquaculture	Syllabus Version	2025-2026			

Course Objectives:

The main objectives of this course are:

1. To provide hands on training on setting up of aquaria and maintenance
2. To impart hands on training on culture, breeding of commercially important ornamental fishes
3. To equip students for self-employment in the field of ornamental fish farming

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Set aquarium and enables to manage the home as well as commercial aquariums	K1
2	Learn to handle different aquarium equipment	K2
3	Learn Decorations of aquarium and Breeding of Aquarium Fishes.	K2
4	Understand various techniques of ornamental fish breeding, rearing and its marketing to make them self- sustainable to become an entrepreneur.	K3

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**-Create

Unit:1	Introduction to Aquaculture and Ornamental fishes trading	8-hours

Introduction to aquarium, ornamental fishes and aquarium accessories- Aerators, filters and lighting.; World aquarium trade and present status, Design and construction of public fresh water and marine aquaria and oceanarium; Water quality management in aquarium fishes, Biofilters in aquarium.; World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Ornamental Fisheries –a new dimension in aquaculture entrepreneurship.

Unit:2	Fish Breeding and rearing of Ornamental fishes	8-hours

Breeding of ornamental fish with reference to live bearer species- Breeding of Guppies, Mollies, Swordtail fish and Platy fish ; Introduction hatchery management system for live bearers, Nursery management of live bearers, Rearing of live bearers; Breeding of ornamental fish with reference to selected egg layer species., Introduction to Breeding of Angel fish, Zebra fish and Neon tetra; Introduction hatchery management system for egg layers, • Nursery management of egg layers •Special emphasis on Breeding of Gold fish

Unit:3	Construction of aquarium and farming-Management Aspects	8-hours

Setting up of aquarium – under gravel filter, pebbles, plants, drift wood, ornamental objects and selection of fishes, Quarantine measures; Aquarium maintenance and water quality. Control of snail and algal growth.; Handling, care and transportation of fish, Temperature acclimation, oxygen packing.

Unit:4	Contemporary Issues	2-hours

Expert lectures, case studies, online seminars- webinars, Recent development and advances

	Total Lecture hours	**26-hours**
Text Book(s)		
1	Dick Mills, 1987. Illustrated Guide to Aquarium Fishes. Published by Galley and Price, an Imprint of W.H. Smithand Sons Limited, England.	
2	Carcacson, R.H. 1977 A field guide to the Coral Reef Fishes of the Indian and West Pacific Oceans, HarperCollins Distribution Services, UK.	
3	Maurice Melzak.1984. Marine Aquarium Manual, Chrysalis Books, India.	
4	Tekrival, K., Rao, A. A. and Dawes, J. 1999. Ornamental aquarium fishes of India, Kingdom Books, Havant Publishers, UK.	
Reference Books		
1	Hawlins, A.D.1981. Aquarium Systems. Academic Press Inc., USA.	
2	Hunnam, P. 1981. Living Aquarium, Grange Books, UK.	
3	Rataj, K., Zukal, R and Coxon, D.1971. Aquarium Fishes and Plants, Littlehampton Book Services Ltd, UK.	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	Applied and economic zoology https://mooc.es/course/applied-and-economic-zoology/	

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	S
CO2	M	M	L	M	S	M	M	M	L	S
CO3	M	M	M	L	M	L	L	M	M	M
CO4	M	M	M	M	M	M	M	M	L	L

Course code	25ENVAJO02	AIR QUALITY MONITORING	L	T	P	C
Core/Elective/Supportive		Job Oriented Course-2	2	0	0	2
Pre-requisite		Basic knowledge on Air pollutants	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. Impart knowledge on the fundamentals of Air pollution
2. Understand on the urban and industry related air quality management
3. Study about the air quality monitoring system in terms of methodologies, standards and policies

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Learn about the assessment of air quality in urban and industrial environment	K1
2	Have knowledge on strategies for minimize the emission level and mitigation measures in industry	K2
3	Understand the current national standards and guidelines for air quality assessment	K2
4	Have the skill to interpret the Air Pollution Assessment	K3

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5** -Evaluate; **K6** -Create

Unit:1	Ambient Air Monitoring	8-hours

Long- term assessment of pollutant levels- Air Quality Index- Air Quality Monitoring System (AQMS)- wind speed, direction, temperature, other meteorological parameters, concentration of air pollutants-SO_2, NOx, CO, O_3 and Particulate (PM10, PM2.5 and PM1) level. WHO and national ambient air quality standards –Indian standard, National Clean Air Programme (NCAP), Continuous Ambient Air Quality Monitoring (CAAQM).

Unit:2	Urban Air Pollution	8-hours

Assess the extent of pollution- real time monitoring- providing air pollution data to the general public- implementation of air quality goals or standards-effectiveness of urban emissions control strategies- evaluation of air quality models- air pollution health risk assessment (AP-HRA)-socioeconomic, environmental, and policy circumstances. Case study– traffic emissions.

Unit:3	Industrial Air Pollution	8-hours

Planning for Air Quality, Risk Assessment and Pollution Control- Air Quality Standards and Emission Regulation - Statistical Tools for Air Pollution Assessment. Air pollution from small scale industry – case study of textile and food processing industry. Assessment in large scale industry –case study of fertilizer, petroleum and thermal power station.

Unit:4	Contemporary Issues	2-hours

Expert lectures, case studies, online seminars -webinars, Recent development and advances

	Total Lecture hours	**26-hours**
Text Books		
1	Vallero, D. Fundamentals of Air Pollution, 5th Edition. 2014. Academic Press.	
2	Sharma, N., Agarwal, A.K., Eastwood, P., Gupta, T., Singh, A. P. Air Pollution and Control, Iṣt Edition. 2018. Springer	
3	Sportisse, B. Fundamentals in Air Pollution: From Processes to Modeling.1st Edition. 2010. Springer	
4	Charlesworth, S.M. and Booth, C.A.Urban Pollution: Science and Management. 2018. John Wiley & Sons Ltd.	
Reference Books		
1	Venkatram, A.and Schulte, N. Urban Transportation and Air Pollution, 1st Edition. 2018. Elsevier	
2	Lazaridis, M. First Principles of Meteorology and Air Pollution, 1st Edition. 2011. Springer	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	WHO air pollution guidelines-https://www.who.int/health-topics/air-pollution	

Mapping with Programme Outcomes										
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	M	S	S	S	S	S
CO2	M	M	L	M	S	M	M	M	L	S
CO3	M	M	M	L	M	L	L	M	M	M
CO4	M	M	M	M	M	M	M	M	L	L

*S-Strong; M-Medium; L-Low

Annexure

PRACTICAL-I: 25ENVA13P1

ENVIRONMENTAL CHEMISTRY, INSTRUMENTAL METHODS OF ANALYSIS, DATA ANALYTICS AND RESEARCH METHODS, ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

A. ENVIRONMENTAL CHEMISTRY AND INSTRUMENTAL METHODS OFANALYSIS

1. Physiochemical properties of water
2. Determination of pH and conductivity
3. Determination of Dissolved Oxygen content
4. Determination of chlorides
5. Estimation of Total Hardness
6. Estimation Acidity and Alkalinity
7. Physical and Chemical properties of soil: Collection, particle size analysis (silt and clay), Soil profile, water holding capacity, density, porosity, NPK, TOC.
8. Spectrophotometric Methods of Estimation: Nitrate, Phosphate.
9. Flame photometric analysis of Na, K, and Ca.
10. Determinations of TKN.
11. Estimation of sulphate by turbidimetry
12. HPLC determination of pharmaceuticals-Demo
13. Heavy metal analysis by ICP-MS-Demo

B. DATA ANALYTICS AND RESEARCH METHODS

1. Collection of Data: Primary data – Secondary data – Classification and Tabulation– Diagrammatic Representation
2. Data Analysis using software: SPSS and Excel stat: Editing, DataTabulation,
3. Analysis: Descriptive statistics – Correlation – Regression – Factor analysis – Cluster analysis–Principal Component Analysis (PCA),Graph Plotting- One way ANOVA- Two way ANOVA
4. Environmental chemicals related databases and uses.
5. Data analytics using R – Installing R and R Studio- Understanding R Features –Importing and Exporting Files–Plots and Visualization –Case Study using R

C. ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

1. Different types of media preparation- liquid /solid media.
2. Enumeration of microbes from air /water /soil sample.
3. Pure culture–Different streaking techniques.
4. Staining Techniques- Simple/Gram staining for bacteria.
5. Membrane filter technique.
6. Bacteriological analysis of wastewater –Most Probable Number (MPN) method.
7. Screening and isolation of biosurfactant producing bacteria from soil/water sample.
8. Screening and isolation of lipase producing bacteria from soil/ water sample.
9. Isolation of genomic DNA from plant/bacteria sample
10. Isolation of Plasmid DNA from bacteria.

PRACTICAL-II: 25ENVA23P1

ENVIRONMENTAL POLLUTION, ENVIRONMENTAL TOXICOLOGY AND BIODIVERSITY AND CONSERVATION

A. ENVIRONMENTAL POLLUTION

1. Determination of Chemical oxygen demand
2. Determination of Biological oxygen demand
3. Sampling and analysis of SO_2, NOX, PM
4. Analysis of TS,TDS, TSS
5. Measurement of noise level
6. Analysis of heavy metals in soil

B. ENVIRONMENTALTOXICOLOGY

1. Dose- Response relationship
2. LC 50 and LD 50
3. Mutagenic assay
4. Air borne pollutants collection and Airborne pollutants collection and Cytotoxicity assays
5. Genotoxicity assays
6. UV radiation exposure DNA damage assay
7. Embryonic toxicity assessment
8. Tissue function markers
9. Computational toxicity prediction

C. BIODIVERSITY AND CONSERVATION

1. Water analysis for DO, BOD and CO_2
2. Identification and inventory of important crop plants and economic plants.
3. The field trip focused on observing wildlife products used by local communities and the sustainable use of minor forest products.
4. Plankton community study: Phytoplankton and Zooplankton: Species identification -Diversity– density – abundance– distribution– Primary productivity
5. Bird watching: Species identification
6. Vegetation studies: Line, quadrates and belt transect methods– Species identification-Diversity– density –abundance–distribution
7. Taxonomic identification of plants and animals using morphological characters

PRACTICAL -III: 25ENVA33P1

WASTE MANAGEMENT AND BIOREMEDIATION, REMOTE SENSING & GEOGRAPHICAL INFORMATION SYSTEM AND ENVIRONMENTAL ENGINEERING

A. WASTEMANAGEMENTANDBIOREMEDIATION

1. Studying the effect of temperature/pH/salinity on microbial growth.
2. Isolation of Metal Resistant Bacteria and effect of heavy metals on microbial growth
3. Assessment of Microbe and Heavy metal interaction (Cr reduction metal biosorption etc.)
4. Isolation and characterization of hydrocarbon tolerating/degrading microbes from polluted environment
5. Isolation and characterization of dye degrading microbes from polluted environments.
6. Assessment of P solubilisation/ ammonification potential of microbes
7. Assessment of the effects of pollutants on soil enzyme activity
8. Production of biogas from different organic waste materials
9. Exercises on estimation, composition and segregation of solid waste

B. REMOTE SENSING & GEOGRAPHICAL INFORMATION SYSTEM

1. Importing Aerial/ Satellite image in ERDAS
2. Georeferencing and Image/ Map Projection in ERDAS
3. Supervised and Unsupervised classification
4. Map reading (survey of IndiaToposheet)
5. Marginal Information and Extra Marginal Information
6. Relief and Cultural Features
7. Importing Aerial/ Satellite Imagery and Scanned Raster Image
8. Georeferencing and Co-Ordinate System
9. Map Projection (Type of Map Projection)
10. Digitization and Editing
11. Topology Creation
12. Proximity Analysis (Buffer, Distance Measures)
13. Interpolation Analysis (Kriging, IdwEtc)
14. Density Analysis (Point, LineEtc.)
15. Surface analysis: Tin Creation–Aspect– Slope- Hill Shade-View Shed- Cut and Till

C. ENVIRONMENTAL ENGINEERING

1. Jar test Experiment- Optimization of coagulant dose
2. Determination of residual chlorine
3. Determination of percentage of available chlorine in a disinfectant
4. Designing and calculation of Sedimentation tank
5. Designing and calculation of Aeration tank
6. Designing and calculation of Activated Sludge Process
7. Designing and calculation of Trickling Filter
8. Designing and calculation of Disinfection process
9. Designing and calculation of Electrostatic precipitator

M.Sc. Environmental Sciences

Syllabus
(With effect from 2025-2026)

Program Code: ENVA

DEPARTMENT OF ENVIRONMENTAL SCIENCES
Bharathiar University
(A State University, Accredited with "A++" Grade by NAAC and 26th Rank among Indian Universities by MHRD-NIRF)
Coimbatore 641046, INDIA

QUESTION PAPER PATTERN (2025-26)
CORE & ELECTIVE PAPERS

PRACTICAL COMPONENTS MAXIMUM MARKS - 100

INTERNAL MARKS: 40

Major Practical	20 Marks
Minor Practical	10 Marks
Spotters (A, B, C, D and E)	5 ×2= 10 Marks
Total	40 Marks

EXTERNAL MARKS: 60

Major/ Minor Practical	40 Marks
Spotters (A, B, C, D and E)	5 ×2=10 Marks
Record	5 Marks
Viva-Voce	5 Marks
Total	60 Marks

THEORY COMPONENTS;
CORE & ELECTIVE PAPERS –MAXIMUM MARKS-100

INTERNAL MARKS: 25

Test	15 Marks
Assignment	5 Marks
Seminar	5 Marks

EXTERNAL MARKS:75
Question paper pattern

Time: 3.00 Hrs.
Max. Marks:75

Section A (10 × 1 = 10)
Answer all the questions
Each question carries one mark
Choose the correct answer
Q.No.1- Q No.10- Objective questions with four multiple choices

Section B (5 × 5 = 25)
Answer all the questions
Each question carries *five* marks
Q.No.11- Q. No.15- Questions with internal choices (either (a) or (b) type)

Section C (5 × 8 = 40)
Answer all the questions
Each question carries *eight* marks
Q.No.15- Q. No.20- Questions with internal choices (either (a) or (b) type)

NON-MAJOR ELECTIVE (SUPPORTIVE), ADD-ON COURSE AND JOB ORIENTED COURSE PAPERS-
MAXIMUM MARKS -50

INTERNAL MARKS: 12

Test	6 Marks
Assignment	3 Marks
Seminar	3 Marks

EXTERNAL MARKS: 38

Section-A (5×1 =5) Time: 2.00 Hrs
Answer all questions Max. Marks: 38
Each question carries one mark
Q. No.1- Q. No.5- Objective questions with four multiple choices

Section B (5 × 3 = 15)
Answer all the questions
Each question carries *three* marks
Q. No.6- Q. No.10- Questions with internal choices (either (a) or (b) type)

Section-C (3 × 6 = 18)
Answer all the questions
Each question carries *six* marks
Q. No. 6-11- Q. No.13- Questions with internal choices (either (a) or (b) type)