**M. Sc. Environmental Sciences**

Syllabus

UNIVERSITYDEPARTMENT

**Program Code: ENVA**

**2022-2023 onwards**



**BHARATHIAR UNIVERSITY**

**(A State University, Accredited with “A” Grade by NAAC, Ranked 13th among Indian Universities by MHRD-NIRF,**

**World Ranking : Times - 801-1000, Shanghai - 901-1000, URAP - 982)**

**Coimbatore - 641 046, Tamil Nadu, India**



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| **Program Educational Objectives (PEOs)** |
| The **M. Sc. Environmental Sciences** program describe accomplishments that graduates are expectedto attain within five to seven years after graduation |
| PEO1 | The students could get employment opportunities in Central Pollution ControlBoard(CPCB) and State Pollution Control Board (SPCB), Research Institutions, Colleges, Universities and Non-governmental organizations. |
| PEO2 | After successful completion of the course, the students could get job opportunities in urban and rural environmental mitigation and awareness including social forestryprograms, 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 andhospitals. |
| 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 also having the immense opportunities to pursue higher studies in various research fields such as environmental pollution, environmental chemistry, waste management and bioremediation, environmental microbiology, waste water treatment, recycle, reuse and management, sustainable environmental food security, bioresource utilization and biodiversity conservation, functional and ecosystem ecology, environmental toxicology, xero 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 andgreen energy and environmental law, policies and auditing. |



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| **Program Specific Outcomes (PSOs)** |
| After the successful completion of M.Sc. Environmental Sciences program, the students areexpected to |
| PSO1 | Get practical knowledge about various physico-chemical parameters, mechanisms ofchemical reactions and removal/reduction of air, soil and water pollutants from the environment through different analytical techniques. |
| PSO2 | Understand the importance and conservation perspectives of natural resources, impact of climate changes in environment, biological diversity and sustainable environmentalmanagement 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 andimportance and role of environmental impact assessment. |
| PSO4 | Understand the basic and application of remote sensing and geographical informationsystem 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, xero waste discharge, xerowaste agroecosystem and environment through production of biocomposts and regenerating of useful byproducts from the waste and waste minimizationaspects |
| PSO6 | Understand the importance and role of microbial consortium along with biotechnological tools as nature based solution for effective implementation ofbioremediation, waste management, green energy and sustainable environment. |



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| **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 andbiological 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 usingartificial intelligence, big data, data analysis and internet things. |
| PO3 | Students will get skill 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 andmanagement 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 environmentalimpactassessment 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 assessvariousenvironmentalcomponentssuchasdistributionofforestareaincludingvegetation 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 greenauditing tools andtechniques, conducting of onsite assessment and preparation of audit reports before 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, toxicologicaltest 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 ofmachinesinthedegradationofvariouspollutants.Studentswouldhavegainedknowledgeabout |



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|  | 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 obtainingtheenvironmentalawarenessknowledge,studentswillbeabletounderstandnature 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 nutrientmanagement 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 andguidelines for air quality assessment and maintaining the clean air environment. |



**BHARATHIAR UNIVERSITY: COIMBATORE 641 046**

**M. Sc. Environmental Sciences Curriculum (University Department)**

*(For the students admitted during the academic year 2022 – 23 onwards)*

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| **Course Code** | **Title of the Course** | **Credits** | **Hours** | **Maximum Marks** |
| **Theory** | **Practical** | **CIA** | **ESE** | **Total** |
| **FIRST SEMESTER** |
| 22ENVA13A | EnvironmentalChemistry | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA13B | Environmental Microbiology and Biotechnology | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA13C | Environmental Health, Industrial Safety and Sustainability  | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA13D | Instrumental Methods, Data Analytics and Research Methodology | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA1EA-1 (or) 22ENVA1EA-2 | Fundamentals of Ecology(or)Natural Resources and Management | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVGS18 | Ecotourism | 2 | 2 |  | 25 | 25 | 50 |
| 22ENVA13P1 | Practical -I | 4 |  | 6 | 50 | 50 | 100 |
|  | **LIBRARY** |  | **1** |  |  |  |  |
|  | **SEMINAR** |  | **1** |  |  |  |  |
| **Total** | **26** | **24** | **6** | **325** | **325** | **650** |
| **SECOND SEMESTER** |
| 22ENVA23A | Environmental Pollution | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA23B | EnvironmentalToxicology | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA23C | Environmental Impact Assessment and Green Auditing | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA23D | Biodiversity and Conservation | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA2EB-1(or)22ENVA2EB-2 | Climate Change and Disaster Management (or) EnvironmentalGeosciences | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVGS53 | Natural DisasterManagement | 2 | 2 |  | 25 | 25 | 50 |
| 22ENVA23P1 | Practical - II | 4 |  | 6 | 50 | 50 | 100 |
|  | **LIBRARY** |  | **1** |  |  |  |  |
|  | **SEMINAR** |  | **1** |  |  |  |  |
| **Total** | **26** | **24** | **6** | **325** | **325** | **650** |
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| **THIRD SEMESTER** |
| 22ENVA33A | Waste Management and Bioremediation  | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA33B | Environmental Law,Policy and Auditing | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA33C | Remote sensing and Geographic Information System  | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA33D | Environmental Engineering  | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVA3EC-1(or)22ENVA3EC-2 |  Introduction to Industry 4.0 (or) Industrial Ecology  | 4 | 4 |  | 50 | 50 | 100 |
| 22ENVGS03 | Environmental Education andAwareness | 2 | 2 |  | 25 | 25 | 50 |
| 22ENVA33P1 | Practical -III | 4 |  | 6 | 50 | 50 | 100 |
|  | LIBRARY |  |  1 |  |  |  |  |
|  | SEMINAR |  |  1 |  |  |  |  |
| **Total** | **26** | **24** | **6** | **325** | **325** | **650** |
| **FOURTH SEMESTER** |
|  | Project Work andviva-voce Examination | 8 |  |  |  |  | 200 |
|  | Industrial Visit andSummer Project | 4 |  |  |  |  | 100 |
| **Total** | **12** |  |  |  |  | **300** |
| **Grand Total** | **90** | **72** | **18** | **975** | **975** | **2250** |

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| **CO-SCHOLASTIC COURSES** |
| **ONLINE COURSES** |
|  | Swayam, MOOC Course | 2 | - | - | - | - | - |
| **VALUE ADDED COURSES** |
| **Semester-1** |
| 22ENVAA01 |  Agroforestry | 2 | - | - | 50 | - | 50 |
| **Semester-III** |
| 22ENVAA02 | Bio-fertilizers and Bio-pesticides | 2 | - | - | 50 | - | 50 |
| **JOB ORIENTED COURSES** |
| **Semester -I** |
| 22ENVJO01 | Ornamental Fish Farming | 2 | - | - | 50 | - | 50 |
| **Semester-III** |
| 22ENVJO02 | Air Quality Monitoring | 2 | - | - | 50 | - | 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



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| **Course code** | **22ENVA13A** | **ENVIRONMENTAL CHEMISTRY** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **Core** | **4** | **0** | **0** | **4** |
| **Pre-requisite** | **Basic knowledge on various chemical process** | **Syllabus Version** | **2022-2023** |
| **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
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| **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 andtheir impact on environment | K2 |
| 3 | Have detailed knowledge on various physico-chemical parameters, chemicalreactions 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 forsustainable maintenance of the functional ecosystem | K3 |
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| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create |
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| **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. |
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| **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. |
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| **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.  |



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| **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. |
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| **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, Acid Rain; Brown Haze, nuclear winter; CFC and Ozone layer depletion. Chemistry of cleaning agents, Soap, Detergents and bleaching agents, Chemistry of colloids, Gasoline and additives antiknock compounds, Lubricants and greases, Biogases. |
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| **Unit:6** | **Contemporary Issues** | **2 – hours** |
| Expert lectures, online seminars – webinars |
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|  | **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, (5th Ed.), De, A. K. (2002), New Age International (P) Ltd. |
| 3 | Fundamentals of Environmental Chemistry, 3rd Edition, Manahan, E. S. (2011). CRC Press. |
|  | Photochemistry &Spectroscopy, Simons, J. P. (1971), Wiley Interscience. |
| 4 | Fundamentals of Photochemistry, Rohatgi-Mukherjee, K. K. (2006), New Age International |
| 5 | (P) Ltd. |
|  | Elements of Environmental Chemistry, Jadhav, H. V. (1992), Himalya Publication House. |
| 6 | Environmental Chemistry, Sharma, B. K. and H. Kaur, H. (1994), Goel Publishing House |
| 7 | Environmental Chemistry, Moore, J. W. and Moore, E. A. (1976), Academic Press |
| 8 | Inc. |
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| **Reference Books** |
| 1 | Environmental Chemistry A global perspective, (4th Ed.), 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 edition), Connell, D.W. (2005), CRC |
|  | Press. |
| 4 | Textbook of Environmental Chemistry, Pani, B. (2007), IK International Publishing House. |
| 5 | Elements of Environmental Chemistry (2nd edition), Hites, R.A. (2012), Wiley & Sons. |

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| 678 | Standard Methods for the Examination of Water and Waste Water, (23rdEd.), APHA, (2005), Washington, D.C.Fundamentals of Soil Science, (8th Ed.), Futh, H. D. (2016), Wiley India.Lehninger Principles of Biochemistry, (7th Ed.), Nelson, D. L. and Cox, M.M. (2017).W.H. Freeman & Co. |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ce57/ |
| 2 | htt[ps://www.openlearnin](http://www.openlearning.com/courses/introduction-to-environmental-chemistry/)g[.com/courses/introduction-to-environmental-chemistry/](http://www.openlearning.com/courses/introduction-to-environmental-chemistry/) |
| 3 | [https://freevideolectures.com/course/2908/green-chemistry-an-interdisciplinary-approach-](https://freevideolectures.com/course/2908/green-chemistry-an-interdisciplinary-approach-to-sustainability)[to-sustainability](https://freevideolectures.com/course/2908/green-chemistry-an-interdisciplinary-approach-to-sustainability) |
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| Course Designed By: Dr. R. Rajkumar |



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| **Mapping with Programme Outcomes** |
| **COs/POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **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



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| **Course code** | **22ENVA13B** | **ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **Core** | **4** | **0** | **0** | **4** |
| **Pre-requisite** | **Knowledge in basic microbiology** | **Syllabus Version** | **2022-2023** |
| **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.
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| **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 therole 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 typeof 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 ofecofriendly products. | K6 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **Unit:1** | **Distribution / Diversity of Microorganisms** | **14 - hours** |
| Microflora in different aquatic and terrestrial 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. |
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| **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- Standard criteria of indication; Bio-indication of water quality. |
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| **Unit:3** | **Microbes-Molecular Approaches and Applications** | **14 - hours** |
| Understanding microbial diversity in the environment by culture-dependent approaches and theirLimitations and culture-independent molecular approaches. BIOLOG, microtitre plates, analysis of  |
| FAME profiles, quantitative PCR (qPCR), fluorescent in situ hybridization and pyro sequencing.  |
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| **Unit:4** | **Role of Biotechnology in Environmental Protection** | **14 - hours** |
| Role of microbes in production of Biofuel, 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, Bio nanotechnology. |
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| **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- Plant variety protection (PVP) - Plant breeders rights (PBRs)-Genetic use restriction technology (GURT). |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **Total Lecture hours** | **72 - hours** |
| **Text Book(s)** |
| 1 | Textbook 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), 3rdedition, Academia Press, Elsevier |
| 3 | Basic Biotechnology, Ratledge, C. and Kristiansen, B. (2003), 2nd edition, CambridgeUniversity Press |
| 4 | Bioethics and Biosafety in Biotechnology, SreeKrishna.V. (2007), New Age InternationalPublishers. |
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| **Reference Books** |
| 1 | Topics in Ecological and Environmental Microbiology, Schmidt, T. M. and Schaechter,M.(2012), 3rdedition, 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 |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | [https://www.researchgate.net/publication/51905295\_Culture-independent\_methods\_for\_studying\_environmental\_microorganisms\_Methods\_application](https://www.researchgate.net/publication/51905295_Culture-independent_methods_for_studying_environmental_microorganisms_Methods_application_and_perspective)[\_and\_perspective](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/](http://www.hindawi.com/journals/ijps/2015/326745/) |
| 3 | https://pubmed.ncbi.nlm.nih.gov/23190337/ |
| 4 | https:/[/www.scienc](http://www.sciencedirect.com/science/article/pii/S0960852418304310?via%3Dihub)e[direct.com/science/article/pii/S0960852418304310?via%3Dihub](http://www.sciencedirect.com/science/article/pii/S0960852418304310?via%3Dihub) |
| 5 | https:/[/www.scienc](http://www.sciencedirect.com/science/article/pii/S0734975010000728)e[direct.com/science/article/pii/S0734975010000728](http://www.sciencedirect.com/science/article/pii/S0734975010000728) |
| 6 | https:/[/www.scienc](http://www.sciencedirect.com/science/article/pii/S0167779917301051)e[direct.com/science/article/pii/S0167779917301051](http://www.sciencedirect.com/science/article/pii/S0167779917301051) |
| 7 | https:/[/www.ncbi.nlm.nih.gov/pm](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC6100491/)c[/articles/PMC6100491/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC6100491/) |
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| Course Designed By: Dr. M. Rajkumar & Dr.B. Sathya Priya |

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| **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 |

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| **Course code** | **22ENVA13C** | **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** | **2022-****2023** |
| **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
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| **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 canpollute 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 communityabout environmental health issues | K3 & K4 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **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 and Occupationally induced illness - Prevention and Control. Health problems in different types of industries – construction, textile, steel and food processing, pharmaceutical, Occupational Health and Safety considerations in Wastewater Treatment Plants. Measures for Workers. Health Education Medical First-Aid and Management of Medical Emergencies. Epidemiological approaches. Ergonomics – Need, Task Analysis, Preventing Ergonomic Hazards, Ergonomics Programme.  |
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| **Unit:2** | **Industrial Safety Management and Occupational Safety Laws** | **14 - hours** |
| Industrial Safety Standards. Industrial Accidents and Disasters - Frequency Rate, Prevention and Control. Dispersion of Radioactive material and release of Toxic and inflammable materials. Work Study - Method of Study and Measurement. Measurement of Skills. Safety - Cost of Expenses. Principles and Functions in Safety Management. Case Study - Preparation of report on safety and remedial measures followed in Industry. Occupational Safety and Health Act and Health Administration, Right to know Laws- Indian Acts – Labour Act, Factories Act, OSHA. Parameters of safety – Factors affecting the conditions of occupational and Industrial safety – Concept of safety organization and Management - Safety Regulations - Supervisors and safety department in motivation. ISO systems for EHS – ISO 14001, 18001.  |



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| **Unit:3** |  **Hazards Exposure Evaluation Control Measure** | **14 - hours** |
| Sampling techniques, Personal monitoring, Biological monitoring; Threshold Limit Values (TLV), STEL; List of Industries involving Hazardous process Occupational Hazards under the First Schedule of the Factories Act,1948; Permissible Limits of certain Chemical substances in work environment under the 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. |
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| **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. |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **Total Lecture hours** | **72 - hours** |
| **Text Book(s)** |
| 1 | A B C of Industrial Safety, Walsh, W. and Russell, L. (1984), Pitman Publishing Ltd., UnitedKingdom. |
| 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 RiskAssessment 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, Londonand New York. |
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| **Reference Books** |
| 1 | Environmental Strategies–Hand Book, Kolluru, R. V. (1994), McGraw Hill Inc., NewYork. |
| 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 NostrandReinhold International Thomson Publishing Inc. New York. |
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| **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 | htt[ps://www.ncbi.nlm.nih.gov/books/NBK55873/](http://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 | htt[ps://www.eschooltoda](http://www.eschooltoday.com/waste-recycling/what-is-recycling.html)y[.com/waste-recycling/what-is-recycling.html](http://www.eschooltoday.com/waste-recycling/what-is-recycling.html) |
| Course Designed By: Dr. D. Prabha and Dr. J. Manivannan |

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| **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 |
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| **Course code** | **22ENVA13D** | **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** | **2022-2023** |
| **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
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| **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 varioussophisticated equipment | K2 |
| 2 | Execute quantitative and qualitative analyses of various environmental samplesthrough 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 |
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| **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 - 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. |
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| **Unit:2** | **Environmental Monitoring Techniques** | **14 - hours** |
| Principle, interferences, instrumentation and applications of Turbidimetry, Nephelometry, Kjeldahl N analyzer, Elemental Analyzer, TOC Analyzer; Portable Gas Analysis, Particulate matter analyzer, O3 analyzer, Beta-attenuation, Stack Monitoring, Meteorological Equipment. Portable water analyzer. Radiation detectors – Geiger Muller Counter, Scintillation Counters; Application of isotopes inbiological and environmental studies. PCR techniques.  |
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| **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). |
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| **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. |
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| **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. |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, case studies, online seminars - webinars |
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|  | **Total Lecture hours** | **72 - hours** |
| **Text Book(s)** |
| 1 | Vogel’s Text 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). Thakurpublications (pvt.) Ltd, Lucknow, India |
| 4 | Instrumental Methods of Analysis, Chatwal, G. R. and Anand, S. K. (2018). HimalayaPublishing 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, 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 |
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| **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 SocietyofAmerica, Washington D.C. |
| 3 | Environmental Sampling Analysis: A Practical Guide, Keith, L.H. (1991), 3rd Edition, LewisPublication, Boca Raton, Florida. |
| 4 | Handbook of Analytical Instruments, Khandpur, R. S. (2015), 3rd Edition, McGraw HillEducation (India) Private Limited, New Delhi. |
| 5 | Fundamentals of Analytical Chemistry, Skoog, D. A. and West, D.M. (2004), Thomson AsiaPvt 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. |
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| **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/ |
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| Course Designed By: Dr. A .Manimekalan, Dr. J. Manivannan, Dr. M. Muniasamy |

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| **Mapping with Programme Outcomes** |
| **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 |
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| **Course code** | **22ENVA1EA-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** | **2022-2023** |
| **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
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| **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 includinglandscape ecology. | K2 |
| 4 | Have the skill to interpret the limiting and regulatory factors that influencefunctioning of the Ecosystem. | K3 |
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| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
|  |
| **Unit:1** | **Introduction to Ecology** | **14 - hours** |
| Ecology: History and Relevance to Humankind, Levels-of-Organization Hierarchy, The Emergent Property Principle, Transcending Functions and Control Processes, Ecological Interfacing. Conceptof the Ecosystem and Ecosystem Management, Tropic Structure of the Ecosystem, Gradients and Ecotones, Techno ecosystems, Concept of the Ecological Footprint. |
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| **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 ofIndividuals, Net Energy Concept, Energy**-**Based Classification of Ecosystems, Energy Futures, Energy and Money. |
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| **Unit:3** | **Limiting and Regulatory Factors** | **14 - hours** |
| Concept of Limiting Factors, Factor Compensation and Ecotypes, Conditions of Existence asRegulatory Factors, Fire Ecology, Other Physical Limiting Factors, Biological Magnification of Toxic Substances, Anthropogenic Stress as a Limiting Factor for Industrial Societies. |
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| **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 andTerritoriality, Metapopulation Dynamics, *r-* and *K-*Selection. |



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| **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. |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **Total Lecture hours** | **72 - hours** |
| **Text Book(s)** |
| 1 | Fundamentals of Ecology, Fifth Edition, Odum, E. P. and Barrett, G.W. (2004), BrooksCole, Belmont, CA. |
| 2 | Ecology, Russell, P.J., Wolfe, S.L., Hertz, P.E., Starr, C. And McMillan, B. (2008), BrooksCole, Course Technology, Cengage Learning India Private Limited, New Delhi. |
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| **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 | htt[ps://www.nature.com/scit](http://www.nature.com/scitable/knowledge/library/energy-economics-in-ecosystems-)a[ble/knowledge/library/energy-economics-in-ecosystems-](http://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/ |
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| Course Designed By: Dr. L. Arul Pragasan |

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| **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

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| **Course code** | **22ENVA1EA-2** | **NATURAL RESOURCES****MANAGEMENT** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **Elective** | **4** | **0** | **0** | **4** |
| **Pre-requisite** | **Basic knowledge on the environmental****issues and its related information** | **Syllabus****Version** | **2022-2023** |
| **Course Objectives:** |
| The main objectives of this course are to:1. To enrich the knowledge on natural resources and their significance and to know the strategies for sustainable management
2. To discuss the process of recognizing and defining NRM issues within an ecosystem management Framework
3. To explains with an analysis of the role of ethics, social justice, and communication in the

sustainable management of natural resources. |
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| **Expected Course Outcomes:** |
| On the successful completion of the course, student will be able to: |
| 1 | Gain a thorough knowledge of natural resources, their distribution and factorsaffecting their availability. | K2 |
| 2 | Understand how developmental activities will affect the natural resources of anation. | K3 |
| 3 | Understand the importance of natural resources, the need to conserve them and canattempt for alternative energy sources. | K4 |
| 4 | Create awareness to incorporate best management plans in planning activities fornature conservation and sustainable environmental protection. | K6 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create |
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| **Unit:1** | **Natural Resources** | **14 - hours** |
| Concept and types of natural resources, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Concern on Productivity issues- ecological, social and economic dimension and sustainable management of natural resources. |
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| **Unit:2** | **Soil and Water Resource** | **14 - hours** |
| Soil types and formation, soil profiles, types of erosion, estimation of soil loss, land use and land use planning, earth resource mapping soil erosion and desertification. Landscape impact analysis. Major water resources- surface and ground water - distribution and supply- hydrological cycle, Causes of water resource depletion - Use and over use of water resources, water resource management - Ground water recharging, rain water harvesting; Watershed management Concept, and objectives, flood control-Dams; Wetlands: definition, importance and classification. |
|  |
| **Unit:3** | **Land and Mineral Resources** | **14 - hours** |
| Land as a resource. Dry land, land use classification, land degradation, man induced landslides, Landscape impact analysis; Types, distribution and reserves of mineral resources, - use and exploitation - environmental effects of extracting and using mineral resources. igneous, sedimentary and metamorphic rocks, mineral resources of India, erosion and weathering, Deep Ocean mineral resources, Types of mining; Resource extraction, access and control system – Ecological, economic, and ethnological approach and their implications; integrated resource management strategies. |
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| **Unit:4** | **Forest and Energy Resource** | **14 - hours** |
| Types and extent of forests in India - deforestation and conservation strategies; Importance of natural areas - carbon sequestration; forest fragmentation, national forest policy; Developing and developed world strategies for forestry. World energy demand – renewable, non-conventional, nuclearenergy,tidalenergy-alternateenergysources-solarandwindenergy-Oilandnaturalgas,coal, biomass energy, geothermal energy, hydropower; Environmental implication of energy use. |
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| **Unit:5** | **Management of Common International Resources** | **14 - hours** |
| Ocean, Antarctica: the evolution of an international resource management regime; Living Resources of the sea; International and Regional Fisheries Management Organizations. |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars – webinars |
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|  | **Total Lecture hours** | **72 - hours** |
| **Text Book(s)** |
| 1 | Global Biodiversity: Status of the Earth’s Living Resources, World conservation MonitoringCentre, Groom bridge, B. (2010), UNEP, Cambridge. |
| 2 | The Environment, Raven, P.H. and Berg, L. R. (2011), 8th Edition, Wiley, UK. |
| 3 | Resource Ecology, Agarwal, S. K. (1993), Himanshu Publications. Delhi. |
| 4 | Ecology of Natural Resources, Ramade, F. (1984), John Wiley& Sons Ltd. |
| 5 | Fundamentals of Ecology, Odum, E. P. (1971),W.B. Saunders Co. USA. |
| 6 | Monitoring Sustainability: Indices and Techniques of Analysis, Ramachandran, N. ( 2000).Concept Publishing Company, New Delhi. |
| 7 | Coastal Ecology & Management, Ecology of Coastal Waters with implications for Management (2nd Edition).Chap. 2-5, pp.18-78 & Chap. 16, pp.280-303,Mann, K.H. (2000),Wiley-Blackwell |
|  |
| **Reference Books** |
| 1 | Global Change and Natural Resource Management, Vitousek, P.M. (1994), Beyond globalwarming: 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), CambridgeUniversity Press. |
| 5 | Introduction to Environmental Science, Anjaneyulu, Y. (2004), B S. Publications,Hyderabad |
| 6 | Environmental Science, Miller T.G. Jr. (1989), Wadsworth Publishing Co. (TB) |
| 7 | Essentials of Ecology, Townsend, C.R., Begon, M. and Harper, J. L. (2008), 3rd edition,Blackwell Science. |



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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | https://onlinecourses.swayam2.ac.in/cec20\_hs10/preview |
| 2 | https://[www.mooc-list.com/tags/natural-resource-management.](http://www.mooc-list.com/tags/natural-resource-management) |
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| Course Designed By: Dr. M. Muniasamy |

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| **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 |
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Second Semester



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| **Course code** | **22ENVA23A** | **ENVIRONMENTAL POLLUTION** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **Core** | **4** | **0** | **0** | **4** |
| **Pre-requisite** | **Knowledge in basic chemistry and biology** | **Syllabus Version** | **2022-2023** |
| **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.
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| **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 onenvironment | 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 sorptionsoil pollutants | K2 |
| 4 | Gain detailed knowledge about physico-chemical and biological control methodsof various air/soil/water pollutants. | K3 |
| 5 | Gain more information about the causes, consequences and control measures ofindustrial disasters | K5 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **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 O2, N2, CO2 and 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 – PM 10 and PM 2.5, Black carbon, clean energy and clean development mechanisms – online monitoring of pollution. |
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| **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. Purification of water by adsorption, flocculation, ion exchange and reverse osmosis methods. Alternatives of end of pipe treatments, online monitoring of industrial effluents – Sediment Pollution - Marine pollution (oil pollution) - sources & control, Emerging Contaminants |
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| **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 andplants, persistent organic pollutants and recalcitrant pollutants, Soil pollution control measures – In situ and Ex situ Physico-chemical and Biological methods. |

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| **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, Radioactive Wastes - Sources, Transport, Disposal.  |
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| **Unit:5** | **Industrial Disasters and Pollution** | **14 - hours** |
| Chemical and Pesticide Industries; Bhopal Disaster, Mayapuri Radiological Disaster, Chernobyl accident, Love canal Disaster, Oil Disasters –Exxon, British Petroleum- Gulf of Mexico; e-wastes, Impact and Remedial Measures. |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **Total Lecture hours** | **72 - hours** |
| **Text Book(s)** |
| 1 | Chemistry for Environmental Engineering and Science, Sawyer, C.N., Mc Carty P.L., andParkin, 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 PublishingCompany 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. |
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| **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. andShiekluna, J. C. (1987), Prentice Hall of India. |
|  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | htt[ps://www.who.int/](http://www.who.int/ceh/capacity/Outdoor_air_pollution.pdf)c[eh/capacity/Outdoor\_air\_pollution.pdf](http://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 | htt[ps://www.unenvironment.org/b](http://www.unenvironment.org/beatpollution/forms-pollution)e[atpollution/forms-pollution](http://www.unenvironment.org/beatpollution/forms-pollution) |
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| **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 |



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| **Course code** | **22ENVA23B** | **ENVIRONMENTAL TOXICOLOGY** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **Core** | **4** | **0** | **0** | **4** |
| **Pre-requisite** | **Basic knowledge on pollutants and its****effects** | **Syllabus****Version** | **2022-****2023** |
| **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
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| **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 inorganictoxicants 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 toexplain the potential fate and effects of a contaminant in the environment | K3 |
| 5 | Understood the importance of animal ethics to be followed in toxicological testingmethods and option for alternative test methods | K4 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **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 tochemicals; basis of selective toxicity; laboratory determination of toxicity of chemicals. |
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| **Unit:2** | **Chemical and Metal Toxicants** | **14 - hours** |
| Classification of pesticides – Pest surveillance, resistance, residual effects, toxic effects of insecticides on man and mammals. 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. Emergingpollutants in environment- Endocrine disruptors-Pharmaceuticals and personal care products. |
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| **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- |



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| Biomonitoring - Bioindicators- Environmental specimen banking. |
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| **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 |
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| **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. |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **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), BlackwellScience, London |
|  |
| **Reference Books** |
| 1 | Introduction to Environmental Toxicology- Landis, W. G. and Yu, M. H. (2003),3rdedition, LewisPublishers, 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),CRC Press. |
| 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. andTsunoda, 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/ |
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| Course Designed By: Dr. J. Manivannan |



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| **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  |



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| **Course code** | **22ENVA23C** | **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** | **2022-2023** |
| **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
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| **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 inidentifying and solving problems | K2 |
| 2 | Locate, analyse and evaluate informations from various environmental matricessystematically | K4 |
| 3 | Access and analyse different case studies/examples of EIA in practicefor evaluation/assessment | K4 |
| 4 | Explain the importance of environmental audits and other management tools inbusiness for social benefit by improving environmental performance | K3 |
| 5 | Calculate the carbon footprint of any organization and identify suitable mitigationstrategies for carbon reduction solutions. | K5 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **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** |
| Adhoc Method – Checklist Methods – Matrix Methods – Network Methods. Prediction and Assessment of Impacts on Natural Resources–Biota, Surface Waters, Ground Water, Air, Noise, Hazards, Historic and Cultural Resources, Transportation, Socio-economic relationships.  |
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| **Unit:3** |  **Project based EIA**  | **14 - hours** |
| Land Clearing Projects – Dam sites –Aquaculture– Mines–Steel–Hydel–Thermal–Nuclear–Oil and Gas based Power Plants – Highways projects – Industrial Projects. Inter linking of Rivers and RiverBasin Management. |

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| **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. Greenbelt Designing and development.  |
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| **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.  |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **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 StrategicPlanning, 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 TelfordPublishing, 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 | htt[ps://www.iisd.org/l](http://www.iisd.org/learning/eia/eia-essentials/timeline/)e[arning/eia/eia-essentials/timeline/](http://www.iisd.org/learning/eia/eia-essentials/timeline/) |
| 3 | htt[ps://www.open.edu/openle](http://www.open.edu/openlearn/nature-environment/organisations-environmental-)a[rn/nature-environment/organisations-environmental-](http://www.open.edu/openlearn/nature-environment/organisations-environmental-)management-and-innovation/content-section-2.8 |
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| Course Designed By: Dr. L. Arul Pragasan |





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

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| **Course code** | **22ENVA23D** | **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** | **2022-2023** |
| **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. |
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| **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 species and environment and the impact of social development on biodiversity.Will gain knowledge in distribution of species in different ecosystemWill gain knowledge in threats to species, extinction and indicator species | K3 |
| 3 | The importance of conservation of biodiversity which serving to the mankind and the ecosystem, and the major threats to biodiversity due to human developmental activities. The loss of biodiversity and the impact to the humankind. | 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 |
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| **Unit:1** | **Scope and Constraints of Biodiversity Science** | **14 hours** |
| Scope and Constraints of Biodiversity Science, 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 freshwater –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 Caused Extinctions; Man and animal conflicts. Biodiversity hotspot-Western Ghats- Eastern Ghats– Himalayas. |
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| **Unit:3** | **Habitats and Ecosystem** | **14 hours** |
| History of ecosystem ecology, Human induced Ecosystem change, Urban Ecosystem Classification– Ecosystem mapping; Habitat lass: Habitat destruction–Fragmentation and degradation–desertification; Invasive Species: biological impacts on terrestrial and aquatic systems; Overexploitation: Impacts of Exploitation on Target and Non-target Terrestrial and Aquatic species and Ecosystems; Wildlife monitoring techniques: Pug mark identification - Camera trap - Radio collaring; Case Studies–Deciduous Forests- Desert Lizard communities– Marine and Coral Reef-Fish Communities- Island species. |
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| **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. |
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| **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 – Patent Act – Agenda 21 – Forest protection Act-Forest conservation Act 1980-Multilateral Treaties – Biodiversity Conventions. Environmental ethics – Biodiversity – a Socio – Political Perspective; Community conserved Areas (CCAs) - Range sand significance of CCAs. |
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| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars – webinars |
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|  | **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 hot spots, 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 Textbook on Biodiversity – Principles and Practice, Krishnamurthy, K.V.(2003), Oxford and IBH Publishing, New Delhi. |
|  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 grims son, 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), Volume 1, Academic Press. |
| 19 | Manual of patent Practice and procedure Patent office, India, 2005.  |
| 20 | Evolution Understanding Evolution http:// evolution. berkeley.edu /evolibrary/ article/ evo\_01 accessed 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 encyclopedia en.wikipedia.org/wiki/Center of origin accessed on 28.12.2014  |
| 3 | Biodiversity Hotspots - http://en.wikipedia.org/wiki/Biodiversity\_hotspot accessed on 28.12.2014.  |
| 4 | Plant Genetic Resources: Otto, H., Anthony, H.D., Brown and Burdon J.J. (1995).  |
| 5 | The Conservation of Plant Biodiversity, 1st edition, Cambridge University Press  |
| 6 | Megadiverse Countries; http:// geography. about.com/od/ physicalgeography /a/Megadiverse - Countries. htm accessed on 28.12.2014. |
| 7 | Geo data base Standards: www.data. gov.bc.ca/local/dbc /docs/geo/services/ standards procedures/ file\_geobase\_standards.pdf accessed on 31.12.2014. |
| 8 | Barcode Standards: barcoding.si.edu/pdf/dwg\_data\_standards-final.pdf accessed on 31.12.2014 |
| 9 | UNESCO http://en.wikipedia.org/wiki/Biosphere\_reserves\_of\_India accessed on 31.12.2014 |
| 10 | Biodiversity Databases Techniques, Politics, and Applications, Curry, G.B. and Humphries, C. J. (2007), CRC Press, Taylor & Francis Group. Frankel,  |
| 11 | UNIT V: 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/ accessed on 31.12.2014  |
| 15 | Patent office of India http://www.ipindia.nic.in/ accessed on 31.12.2014 |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | Wildlife Conservation- https://onlinecourses.nptel.ac.in/noc19\_bt32/preview |
| 2 | Ecology and Wildlife 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 |
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| Course Designed By: Dr. A. MANIMEKALAN |

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| **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



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| **Course code** | **22ENVA2EB-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** | **2022-2023** |
| **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.
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| **Expected Course Outcomes:** |
| On the successful completion of the course, student will be able to: |
| 1 | Will be able to 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 | Will be able to create awareness among the vulnerable population as a measure ofdisaster mitigation | K6 |
| 3 | Educate people about the importance of preparedness in vulnerable areas. | K3 |
| 4 | will be able to know about the various national and international agencies thatplay a major role in disaster management | K2 |
| 5 | The knowledge gained will enable the students to volunteer themselves in disastermanagement programs thus helping affected community. | K4&K5 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **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.  |
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| **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 |
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| **Unit:3** | **Introduction to Disasters** | **14 - hours** |
| Types of Disasters : Nature and characteristics : Cyclone – Tornadoes – Avalanches – Flood –Drought – Volcanic eruptions – Earthquakes – 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 and Assessment. 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.

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| **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. |

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| **Unit:5** | **Mitigation and Adaptation 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. |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars, case studies - webinars |
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|  | **Total Lecture hours** | **72 - hours** |
| **Text Book(s)** |
| 1 | Natural Disaster, Sharma, R. K. & Sharma, G. (2005), APH Publishing Corporation, NewDelhi. |
| 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. |
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| **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), AsianDevelopment Bank, Manila. |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | [www.iirs.nrsa.org](http://www.iirs.nrsa.org/) |
| 2 | www.GIS. Development.net |
| 3 | [http://quake.usgs.gov](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 | NIDM http://nidm.gov.in/default.asp |
| 10 | NDMA http://www.ndma.gov.in/en/ |
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| Course Designed By: Dr. D. Prabha, Dr. P. Siddhuraju |
| **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 |

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| **Course code** | **22ENVA2EB-2** | **ENVIRONMENTAL GEOSCIENCES** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **Elective** | **4** | **0** | **0** | **4** |
| **Pre-requisite** | **Basic knowledge on Earth Resources** | **Syllabus Version** | **2022-2023** |
| **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
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| **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 theenvironment | K2 |
| 3 | Understanding the Earth system of interacting rock, water, air and life and howthese elements have shaped Earth’s surface | K2 |
| 4 | Have the skill to identify the geologic features of the earth and use them tounderstand the geologic history of a region. | K2 |
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| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **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. |
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| **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. |
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| **Unit:4** | **Water Resources and Environment** | **14 - hours** |
| Global Water Balance. Ice sheets and fluctuations of sea levels. Origin and composition of seawater. 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. |

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| Land use Planning: The land use plan. Soil surveys in relation to land use planning. Methods of siteselection and evaluation. |
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| **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.  |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **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 | Groundwater 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. |
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| **Reference Books** |
| 1 | Natural Hazard, Bryant, E. A. (1991), Cambridge University Press. |
| 2 | Geology and Society, Coates, D.R. (1985), Chapman & Hall, New York. |
| 3 | Environmental Geology, Keller, E.A. (1999), 8thediton, 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 | htt[ps://www.edx.org/l](http://www.edx.org/learn/geosciences)e[arn/geosciences](http://www.edx.org/learn/geosciences) |
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| Course Designed By: Dr. R. Rajkumar |

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| **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



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| **Course code** | **22ENVA33A** | **WASTE MANAGEMENT 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** | **2022-2023** |
| **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 andindustrial sources. | K2 |
| 2 | Apply the principles of remedial measures of recycling, reuse and recovery fromthe wastes. | K3 |
| 3 | Understand and describe the principle and mechanistic role of microbes in thedegradation of various pollutants. | K2 |
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| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **Unit:1** | **Waste Management** | **14 - hours** |
| Different Types of waste and sources – Solid 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, pyrolysis |
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| **Unit:2** | **Recycling of Wastes** | **14 -hours** |
| 3R 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 paper, pulp and beverages industries, Strategies for conversion of biodegradable waste into organic fertilizers and fuels. Composting, Vermicomposting and biomethanization. |
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| **Unit:3** | **Microbial Activity and Geomicrobiology** | **14 - hours** |
| Microbial Activity in Soil, Lithosphere as Microbial habitat, Nutritional diversity among prokaryotes, Geomicrobial transformations – Biodegradation of carbonates – Biomobilization of silicon, phosphate, nitrogen. Geomicrobiology of fossil fuel, methane, peat, coal and petroleum. |
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| **Unit:4** | **Principles of Bioremediation** | **14 - hours** |
| Microbial growth and Metabolism - Genetic plasticity – 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. |
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| **Unit:5** | **Bioremediation of waste pollutants, soil and water ecosystem** | **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. Bio treatments of harbor Sediments. Bioremediation of fresh water and marine ecosystems:  |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars – webinars |
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|  | **Total Lecture hours** | **72 - hours** |
| **Text Book(s)** |
| 1 | Hazardous Wastes and Solid Wastes, Liu, D.H.F and 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), McGraw–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), McGrawHill Publishing Co. |
|  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | <http://cbs.teriin.org/pdf/Waste_Management_Handbook.pdf> |
| 2 | htt[ps://www.eschooltoda](http://www.eschooltoday.com/waste-recycling/what-is-recycling.html)y[.com/waste-recycling/what-is-recycling.html](http://www.eschooltoday.com/waste-recycling/what-is-recycling.html) |
| 3 | https://[www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-](http://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-)maps/geomicrobiology |
| 4 | htt[ps://www.mdeq.ms.gov/wp](http://www.mdeq.ms.gov/wp-content/uploads/2017/06/Bioremediation)-[content/uploads/2017/06/Bioremediation](http://www.mdeq.ms.gov/wp-content/uploads/2017/06/Bioremediation) |
| 5 | https://clu-in.org/techfocus/default.focus/sec/Bioremediation/cat/Aerobic\_Bioremediation\_(Direct)/ |
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| Course Designed By: Dr. M. Rajkumar, Dr. L. Arul Pragasan and Dr. B. Sathya Priya |

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| **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 |
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| **Course code** | **22ENVA33B** | **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** | **2022-****2023** |
| **Course Objectives:** |
| The main objectives of this course are:1. To understand statutory and regulatory framework 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
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| **Expected Course Outcomes:** |
| On the successful completion of the course, student will be able to: |
| 1 | Understand Environmental issues and response of judiciary system toenvironmental issues. | K1 |
| 2 | Exercise his rights like right to information, and know about legal remedies available for environmental protection – national and international environmentallaws | 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 improvingenvironmental 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** | **History of Environmental Policy** | **14 - hours** |
| (Ancient India, Medieval India, British India, during post independent era, the seventies, eighties and nineties)- 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, disputesettlement procedures, non state actors and international environmental policy - Transnational environmental policies – the Indus river basin, the Ganga – Brahmaputra river basin system. . |
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| **Unit:2** | **International Environmental Laws** | **14 - hours** |
| Hazardous Wastes-Basal convention – Necessity for International Environmental Court - United Nations Environment Programme [UNEP] role on international environment laws. Land use policy for India – Urban planning. Constitutional and legislative provisions in India : 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 informationand the right to know, Hazardous Waste Rules, 2016. |
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| **Unit:3** | **Indian Environmental Legislation** | **14 - hours** |



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| Nodal Agencies - Ministry of Environment, Forest and Climate Change, Central Pollution Control Board, Tamilnadu Pollution Control Board- The Water (prevention and control of pollution) Act of 1974, The Water Cess act of 1977, The Wildlife Protection Act 1972, The Air (prevention and control of pollution) act of 1981, The Public Liability Insurance act of 1991, The National Environment Tribunal Act, 1995, The National Environment Appellate Authority act, 1997, The Mines and Minerals act, 1957- The Atomic Energy Act, 1962, The Factories Act, 1948. The Environmental Protection Act, 1986, The forest conservation act 1980, National Green Tribunal Act 2010, Plastics Waste management Rules 2015. |
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| **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 –ISO 14001, 19011 - EA in India – Gazette Notification, 1992- Case studies: South India Viscose rayonunit case. |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **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), OxfordUniversity Press, New Delhi. |
|  |
| **Reference Books** |
| 1 | Environmental Management in Practice, Nath B., Hens, L., Compton, P. and Devuyst, D.(1998), Vol I, Routledge, London and New York. |
| 2 | The ISO 14000 Handbook: The New International Environmental Management Standards,Cascio. J. (1996), McGraw Hill Professional. |
| 3 | ISO 14004 – Environmental management systems: General guidelines on principles, systemsAnd supporting techniques (ISO 14004: 1996 (E). |
| 4 | ISO 14001: 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, Tamilnadu Pollution Control Board,Chennai |
|  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | htt[ps://www.coursera.o](http://www.coursera.org/learn/environmental-law)r[g/learn/environmental-law](http://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 |

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| 5 | htt[ps://www.soas.a](http://www.soas.ac.uk/cedep-demos/000_P508_EAEMS_K3736-)c[.uk/cedep-demos/000\_P508\_EAEMS\_K3736-](http://www.soas.ac.uk/cedep-demos/000_P508_EAEMS_K3736-)Demo/module/pdfs/p508\_unit\_01.pdf |
| 6 | htt[ps://www.iloenc](http://www.iloencyclopaedia.org/part-vii-86401/environmental-policy/item/748-)y[clopaedia.org/part-vii-86401/environmental-policy/item/748-](http://www.iloencyclopaedia.org/part-vii-86401/environmental-policy/item/748-)environmental-auditing-definition-and-methodology |
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| Course Designed By: Dr. D. Prabha |

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| **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 |
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| **Course code** | **22ENVA33C** | **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** | **2022-****2023** |
| **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 environmentalstudies
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| **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 |
|  |
| **Unit 1** | **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. Aerial photo-classification based on attitude of camera lens, distortions caused due to flight irregularities, overlaps, scale, relief displacement and its effects. Photo recognition elements, Different types ofphotographs. |
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| **Unit 2** | **Introduction to GIS and GIS Software** | **14 -hours** |
| Fundamentals of GIS: Concepts of components Layers and features, Raster/Vector data sets - Georeferencing 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 |
|  |
| **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, 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 etc. |
|  |
| **Unit: 5** | **GIS Applications** | **14 –hours** |
| Resources mapping, Inventory and monitoring natural resources, Land cover mapping, Wetlandmapping – Applications to Agriculture – Water Management, Specific Applications – Infrastructure – Ground Water. GPS applications – Principles of Accuracy – Database Creation – Networking ofData. |
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| **Unit:6** | **Contemporary Issues** | **2 –hours** |
| Expert lectures, online seminars – webinars |
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|  | **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),Chapman and Hall. |
| 5 | Fundamentals of Remote Sensing, Joseph, G. (2003), Universities Press (India) Ltd.,Hyderguda, Hyderabad. |
| 6 | PRINCIPLES OF REMOTE SENSING  PAUL J. CURRAN, RAWAT Publishing, 2020 edition |
| 7 | Basics of Remote Sensing and GIS by Dr. S.Kumar Laxmi Publications 2005 |
|  |
| **Reference Books** |
| 1 | Remote Sensing and image interpretation, Lillesand, T., Keifer, R. W. and Chipman, J. W.(2004), 5th edition, John Wiley and sons, New York. |
| 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), JohnWiley & Sons. |
| 6 | Space Remote Sensing Systems – An Introduction, Chen, H.S. (1985), 2nd edition, AcademicPress. |
| 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](http://www.classcentral.com/course/swayam-remote-sensing-and-gis-14272) |
| 3 | https://[www.classcentral.com/report/swayam-moocs-course-list/](http://www.classcentral.com/report/swayam-moocs-course-list/) |
| 4 | https://[www.mooc-list.com/course/introduction-urban-geo-informatics-edx](http://www.mooc-list.com/course/introduction-urban-geo-informatics-edx) |
| Course Designed By: Dr. A. Manimekalan |





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| **Course code** | **22ENVA33D** | **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** | **SyllabusVersion** | **2022-****2023** |
| **CourseObjectives:** |
| 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 abatement and odour control methods
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| **ExpectedCourseOutcomes:** |
| 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 rtreatment | K2 |
| 3 | Attempt to design a water treatment method for real time effluents | K3 |
| 4 | Know the different analytical methods of wastewater treatment andDisinfection methods | K4 |
| 5 | Gain knowledge about environment protection and operation of pollutionControl devices | K5 |
| **K1**-Remember;**K2**-Understand; **K3**-Apply;**K4**-Analyze;**K5**–Evaluate;**K6-**Create |
|  |
| **Unit:1** | **Wastewater Characteristics and Primary Wastewater Treatment** | **14-hours** |
| Physico-chemical and biological characteristics of wastewater -domestic wastewater, industrial effluents, Preliminary treatment- barracks and screens, grit removal-Designing of primary treatment of wastewater—flow measurement, equalization, mixing, sedimentation, flocculation, neutralization, floatation, flash mixer, clariflocculator, sedimentation tanks. |
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| **Unit:2** | **Secondary Wastewater Treatment-Aerobic Methods** | **14-hours** |
| Designing of Secondary treatment of wastewater-Types- Aerobic wastewater treatment-Designing ofAerationTanks,Diffusers,mechanicalaerators,TricklingFilters,WasteStabilizationPonds,Rotating Biological contactor (RBC), Fluidized Bed Reactor (FBR), Activated sludge process (ASP),modifications,Advancedactivatedsludgeprocess(AASP),Advantagesofaerobicwastewatertreatment. |
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| **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 wastewatertreatment, importance of microorganisms in biological treatment. Disinfection methods- chlorination-chlorine dosage, chlorine demand and residual chlorine. |
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| **Unit:4** | **Tertiary Wastewater Treatment** | **14-hours** |



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| Designing of Tertiary wastewater treatment- Advanced oxidation processes, Reverse osmosis-Ion exchange method, Methods for removal of nitrogen and phosphorus-Multiple Evaporators, Sludge Drying Bed- Grey water management, zero liquid discharge, Eco-friendly reuse of wastewater  |
|  |
| **Unit:5** | **ETP and Air Pollution Abatement** | **14-hours** |
| Criteria for Effluent Treatment Plant (ETP), Industrial Effluent treatment plant–Paper, food, tannery, sugar and textile industries, Air Pollution control- Designing of Settling Chamber, stack height, flue gas recirculation, bio beds, Cyclones, Fabric filters, wet scrubbers and Electrostatic Precipitators |
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| **Unit:6** | **Contemporary Issues** | **2-hours** |
| Expert lectures, online seminars, case studies- webinars |
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|  | **Total Lecture hours** | **72-hours** |
| **TextBook(s)** |
| 1 | WastewaterEngineering:TreatmentandReuse,MetcalfandEddy.(2003),TataMcGrawHillPublishing Company Ltd., New Delhi. |
| 2 | HandbookofWaterandWastewaterTreatmentPlantOperations,Spellman,F.R.(2003),Lewis Publishers, London. |
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| **ReferenceBooks** |
| 1 | WaterandWastewaterTechnology,Hammer,M.J.andHammer,Jr.M.J.(2001),PrenticeHall of India Pvt. Ltd., NewDelhi. |
| 2 | EnvironmentalEngineering:ADesignApproach,Sincero,A.P.andSincero,G.A.(1999),Prentice-Hall of India Pvt. Ltd., New Delhi. |
| 3 | IntroductiontoEnvironmentalEngineeringandScience,Masters,G.M.(2004),Prentice-Hall of India Pvt. Ltd., New Delhi. |
| 4 | EnvironmentalEngineering,Peavy,H.S.(2003),TataMcGrawHillPublishingCompanyLtd., New Delhi. |
|  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | [https://sswm.info/sites/default/files/reference\_attachments/SPERLING%202007%20Waste](https://sswm.info/sites/default/files/reference_attachments/SPERLING%202007%20Wastewater%20Characteristics%2C%20Treatment%20and%20Disposal.pdf)[water%20Characteristics,%20Treatment%20and%20Disposal.pdf](https://sswm.info/sites/default/files/reference_attachments/SPERLING%202007%20Wastewater%20Characteristics%2C%20Treatment%20and%20Disposal.pdf) |
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| Course Designed By: Dr. B.Sathya Priya |
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| **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 |
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| **Course Code** | **22ENVA3EC-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** | **2022-2023** |
| **Course Objectives:** |
| The main objectives of this course are to:1. Educate the students about industry 4.0tools
2. Impart knowledge on Big data analysis
3. Impart knowledge on Artificial Intelligence and Internet of Things with Environmental Sciences perspectives
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| **Expected Course Outcomes:** |
| On the successful completion of the course, student will be able to: |
| 1 | Understand the need for adopting Industry 4.0 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** | **Industry 4.0** | **14 - hours** |
| Need – Reason for Adopting Industry 4.0 - Definition – Goals and Design Principles -Technologies of Industry4.0 – 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 -AssociatedTechnologies 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 toIoT–ArchitectureofIoT-TechnologiesforIoT-DevelopingIoTApplications-ApplicationsofIoT -Security in IoT |
|  |
| **Unit:4** | **Applications and Tools of Industry 4.0** | **14 - hours** |
| Applications of IoT – Manufacturing – Healthcare – Education – Aerospace and Defense – Agriculture–TransportationandLogistics–ImpactofIndustry4.0onSociety:ImpactonBusiness,Government, People. Tools for Artificial Intelligence, Big Data and Data Analytics, Virtual Reality, |

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| Augmented Reality, IoT, Robotics |
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| **Unit:5** | **Jobs 2030** | **14 - hours** |
| Industry 4.0 – Education 4.0 – Curriculum 4.0 – Faculty 4.0 – Skills required for Future - Tools for Education – Artificial Intelligence Jobs in 2030 – Jobs 2030 - Framework for aligning Educationwith Industry 4.0 |
|  |
| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars, case studies - webinars |
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|  | **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 |
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| Course Designed By: Dr. J. Manivannan |

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



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| **Course code** | **22ENVA3EC-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** | **2022-****2023** |
| **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 framework for consideration of environmental and sustainability-related aspects of science and technology
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| **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 lifecycle 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 EnergyEnergy considerations in (i) Material Choice (ii) Product manufacture (iii) Product use (iv) remanufacturing and recycling  |





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| **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 |
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|  | **Total Lecture hours** | **72 - hours** |
| **Text Book(s)** |
| 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. |
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| **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, 3nd 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/> |
| Course Designed By: Dr. D. Prabha |

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| **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



Supportive Course



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| **Course Code** | **22ENVGS18** | **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** | **2022-2023** |
| **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
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| **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 framework to plan andimplement 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 wellas consider the needs of local people | K6 |
|  |  |  |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
|  |
| **Unit:1** | **Concepts of Tourism** | **8- hours** |
| Classification – Religious Tourism – Cultural Tourism – Heritage Tourism – Monumental Tourism – Adventure Tourism – Mass Tourism – Sustainable Tourism – Consumptive and Non-Consumptive Tourism. Principles of Ecotourism – Types of Ecotourism – Concepts of Ecotourism – Origin ofEcotourism – 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 ecotourismservice 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-DisastersandEcotourism-Roleofethicsinecotourism-AdvantagesandDisadvantagesofEcotourism- Eco-branding and Eco-labeling of Ecotourism Products - Marketing of Ecotourism, Ecotourism and Sustainable Development - Management Issues in Ecotourism, |



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| Ecotourism‐based/related employment: Scope and areas of employment. |
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| **Unit:6** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **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), |
|  | Earthscan, 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: a guide for planners and managers, Lindberg, K. and Hawkins. D.E. (eds). |
|  | (1993), The Ecotourism Society, North Benninton. |
| 9 | Ecotourism, Page, S.J. and Dowling, R.K. (2002), Prentice Hall, New York. |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | [https://www.acseduonline.com/courses/ecotourism-14/certificate-in-ecotourism-ctecotour-](https://www.acseduonline.com/courses/ecotourism-14/certificate-in-ecotourism-ctecotour-184.aspx)[184.aspx](https://www.acseduonline.com/courses/ecotourism-14/certificate-in-ecotourism-ctecotour-184.aspx) |
| 2 | [https://www.classcentral.com/course/edx-sustainable-tourism-society-environmental-](https://www.classcentral.com/course/edx-sustainable-tourism-society-environmental-aspects-10356)[aspects-10356](https://www.classcentral.com/course/edx-sustainable-tourism-society-environmental-aspects-10356) |
| 3 | htt[ps://www.openlearnin](http://www.openlearning.com/csu/courses/introduction-to-ecotourism/)g[.com/csu/courses/introduction-to-ecotourism/](http://www.openlearning.com/csu/courses/introduction-to-ecotourism/) |
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| Course Designed By: Dr. R. Rajkumar |

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| **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



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| **Course Code** | **22ENVGS53** | **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 Ve** | **Syllabus****Version** | **2022-****2023** |
| **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 ofDisaster Management and to inform them about the prospects of a Natural Disaster Manager.
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| **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 potentialimpact on the natural and man-made environments. | K2 |
| 2 | Educate people about the importance of preparedness in vulnerable areas. | K3 |
| 3 | Will know about the various national and international agencies that play a majorrole 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 |
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| **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 onEnvironment. |
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| **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. DisasterManagementCycle–VulnerabilityAnalysis–Warningsystem–LegalAspects–casestudies for disasters and management, Safety Measures – Disaster Management plans. |
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| **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. |
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| **Unit:4** | **Contemporary Issues** | **2 - hours** |



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| Expert lectures, online seminars – webinars |
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|  | **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), AsianDevelopment 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 PublishingHouse, 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), SpringerVerlay, New York. |
| 7 | Disaster Management, Singh, S. K., Kundu, S. C. and Singh, S. (1998), Mittal Publications,New Delhi. |
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| **Reference Books** |
| 1 | www.GIS. Development.net |
| 2 | www.GIS. Development.net |
| 3 | Disaster Management, Prakash, I. (1994), Rashtra Prahari Prakasan, Gaziabad.PublishingHouse, New Delhi. |
| 4 | Natural Disaster Reduction, Misra, G. K. And Mathur, G.C. (1993), Reliance |
| 5 | [www.iirs.nrsa.org](http://www.iirs.nrsa.org/) |
| 6 | [http://quake.usgs.gov](http://quake.usgs.gov/) |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | https://onlinecourses.swayam2.ac.in/cec19\_hs20/preview |
| 2 | htt[ps://www.mooc](http://www.mooc-list.com/tags/disaster-management)-[list.com/tags/disaster-management.](http://www.mooc-list.com/tags/disaster-management) |
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| Course Designed By: Dr. M. Muniasamy |

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| **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



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| **Course Code** |  **22ENVGS03** | **ENVIRONMENTAL EDUCATION ANDAWARENESS** | **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** | **2022-****2023** |
| **Course Objectives:** |
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| 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
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| **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 EnvironmentalEducation for school children. | K2 |
| 2 | Through obtained the environmental awareness knowledge, students will be able tounderstand 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 andother living beings and protection of the environment. | K4 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create |
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| **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 environmentaleducationforsecondaryschoolchildren-Programsofenvironmentaleducationforattitude changes among the children. |
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| **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 andtheir implications - Mitigation efforts. |
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| **Unit:3** | **Environmental Awareness** | **8 - hours** |
| Learning to live in harmony with nature - environmental education for development, conservation ofsoil, water, forests, wild life, energy resources, movement to save environment, eco-friendly technology - Alternate sources of energy – Waste management - Population and environment. |
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| **Unit:4** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars– webinars |
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|  | **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. MerrilPublishing Co. |
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| **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 HiranGate, Jallandhar. |
| 4 | The Handbook of Environmental Education, Palmer, J. and Philips, N. (1994), Routledge,London. |
|  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | htt[ps://www.mooc](http://www.mooc-list.com/categories/sci-environment)-[list.com/categories/sci-environment](http://www.mooc-list.com/categories/sci-environment) |
| 2 | https://swayam.gov.in/explorer?category=Environmental\_Sciences |
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| Course Designed By: Dr. M. Muniasamy |

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



Value Added Course



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| **Course code** | **22ENVAA01** | **AGROFORESTRY** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **Value Added Course-1** | **2** | **0** | **0** | **2** |
| **Pre-requisite** | **Basic Knowledge on Agroforestry** | **Syllabus Version** | **2022-****2023** |
| **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
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| **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 nutrientcycling | K2 |
| 3 | Understand the positive and negative tree-crops-soil interactions (for light, waterAnd nutrients). | K2 |
| 4 | Acquire knowledge about the familiar of environmental conservation and international conventions, in particular the Convention on Climate Change and theConvention 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 positiveimpact on economy and environment | K4 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **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 contextof climate change and hazards, carbon sequestration potential of agroforestry systems, managing component interaction in agroforestry for higher yield, enhancing adaptive capacity. |
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| **Unit:2** | **Ecosystem Services of Agroforestry** | **8 -hours** |
| Potential species for edible oil, industrial oil and biofuel sources, agroforestry for soil conservation |



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| 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 N2 fixing trees in agroforestry, management of problem soil through agroforestry, waste land developmentthrough agroforestry, reclamation of mine soils, controlling seepage-canal and water storage, agroforestry interaction, effective insect and pest control. |
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| **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, Nationalagroforestry policy. |
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| **Unit:4** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, case studies, online seminars - webinars |
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|  | **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 Speciein 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, NewDelhi. |
| 3 | A Practical Manual on Agroforestry, Meena, R.N.and Singh, R.(2014). Srijan SamitiPublishers, Varanasi. |
| 4 | An Introduction to Agroforestry, Nair, P. K. R. (1993). Kluwer Academic Publishers, TheNetherlands. |
| 5 | Agroforestry Systems in India: Livelihood Security & Ecosystem Services, [Dagar,](https://www.amazon.ca/s/ref%3Ddp_byline_sr_ebooks_1?ie=UTF8&field-author=Jagdish%2BChander%2BDagar&text=Jagdish%2BChander%2BDagar&sort=relevancerank&search-alias=digital-text) J. C.,[Singh,](https://www.amazon.ca/s/ref%3Ddp_byline_sr_ebooks_2?ie=UTF8&field-author=Anil%2BKumar%2BSingh&text=Anil%2BKumar%2BSingh&sort=relevancerank&search-alias=digital-text) A. K., [Arunachalam](https://www.amazon.ca/s/ref%3Ddp_byline_sr_ebooks_3?ie=UTF8&field-author=Ayyanadar%2BArunachalam&text=Ayyanadar%2BArunachalam&sort=relevancerank&search-alias=digital-text), A. (2013), Springer, UK |
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| **Reference Books** |
| 1 | New Vistas in Agroforestry, Nair, P. K. R, Rai, M. R, and Buck, L. E. (2004).,KluwerAcademic Publishers, The Netherlands |
| 2 | Trees and Tree Farming, Thampan, P. K. (1993). Peekay Tree Crops DevelopmentFoundation, Cochin, India. |
| 3 | Agroforestry for Soil Management, Young, A. (1997). CAB International, UK. |
| 4 | Agroforestry Opportunities for Enhancing Resilience to Climate Change in Rain fed 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,](https://www.routledge.com/search?author=Louise%20E.%20Buck) L. E, [Lassoie,](https://www.routledge.com/search?author=James%20P.%20Lassoie) P. L, [Fernandes](https://www.routledge.com/search?author=Erick%20C.M.%20Fernandes), E. C. |

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|  | M. (1998). CRC Publications, Florida, USA. |
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| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | World Agroforestry Center (ICRAF): [www.worldagroforestrycentre.org](http://www.worldagroforestrycentre.org/) |
| 2 | Agroforestry at FAO: [www.fao.org/forestry/9469.](http://www.fao.org/forestry/9469) |
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| Course Designed By: Dr. P. Siddhuraju |

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



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| **Course code** | **22ENVAA02** | **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 Ve** | **Syllabus****Version** | **2022-****2023** |
| **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
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| **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 tomankind | K2 |
| 2 | Distinguish the types of biofertilizers and biopesticides | K2 |
| 3 | Understand importance and role of different microbes in soil fertility and cropproductivity 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 pestmanagement (IPM) plan | K4 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create |
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| **Unit:1** | **Biofertilizers** | **8 - hours** |
| Status and scope - General account of the microbes used as biofertilizers Bacteria and Fungi - advantages over chemical fertilizers. 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 micronutrients (Potash, iron, zinc and sulphur) –Plant Growth Promoting Rhizobacteria (PGPRs)-Mycorrhizal fungi - Liquid biofertilizers - Factors influencing the efficacy of biofertilizers. |
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| **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 andpredators)- PGPRs for control of soil borne diseases - Biorationals - Promising plant species for pest control - Genetically Modified Micro-Organisms for Sustainable Soil Health Management. |
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| **Unit:3** | **Production and Application** | **8 - hours** |
| Biofertilizers - Mass Production technology: Inoculum production - Strain selection,sterilization,growthandfermentation,massproduction-fieldapplication,benefitsandadvantages.Biofertilizer |



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| development from households waste. Biopesticides - Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes-Applicationtechnology Biofertilizers and Biopesticides - for seeds, soil and foliage - Storage, shelf life, quality control and marketing. - Safety testing and Registration – Global Market. |
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| **Unit:4** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, online seminars - webinars |
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|  | **Total Lecture hours** | **26 - hours** |
| **Text Book(s)** |
| 1 | Botanicals and Biopesticides - B. S. Parmar and C. Devakumar (Eds.), 1993. WestvillPublishing 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, ScientificPublishers - Jodhpur. |
|  |
| **Reference Books** |
| 1 | Biofertilizers and Biopesticides in Sustainable Agriculture. 2019. B. D. Kaushik, DeepakKumar, 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. NewYork. |
| 5 | Subba Rao, N. S. 1988. Biological nitrogen fixation: recent developments, Mohan Primlanifor Oxford and IBH Pub. Co. (P) Ltd., India |
|  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| 1 | <http://www.amm-mcrc.org/publications/biofertilizers.pdf> |
| 2 | htt[ps://www.fnc](http://www.fnca.mext.go.jp/english/bf/bfm/pdf/Biofertilizer_Manual.pdf)a[.mext.go.jp/english/bf/bfm/pdf/Biofertilizer\_Manual.pdf](http://www.fnca.mext.go.jp/english/bf/bfm/pdf/Biofertilizer_Manual.pdf) |
| 3 | htt[ps://www.bio](http://www.bio-fit.eu/q8/lo1-why-biofertilizers?start=4)-[fit.eu/q8/lo1-why-biofertilizers?start=4](http://www.bio-fit.eu/q8/lo1-why-biofertilizers?start=4) |
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| Course Designed By: Dr.P.Siddhuraju, Dr. D. Prabha |

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



Job Oriented Course



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| **Coursecode** | **22ENVJO01** | **ORNAMENTAL FISH FARMING** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | **JobOrientedCourse-2** | **2** | **0** | **0** | **2** |
| **Pre-requisite** | **Basic knowledge on aquaculture** | **Syllabus Version** | **2022-2023** |
| **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** |
| Expertlectures, casestudies, online seminars-webinars |
|  |

|  |  |  |
| --- | --- | --- |
|  | **TotalLecturehours** | **26-hours** |
| **TextBook(s)** |
| 1 | Dick Mills, 1987. Illustrated Guide to Aquarium Fishes. Published by Galley and Price, an imprint of W.H. Smith and Sons Limited, England.  |
| 2 | Carcacson, R.H. A field guide to the Coral Reef Fishes of the Indian and West Pacific Oceans.  |
| 3 | Maurice Melzak. Marine Aquarium Manual. B.T. Balsford Ltd., London. |
| 4 | Ornamental aquarium fishes of India- 1999- K.L.Tekrival and A.A. Rao.- TFH United Kingdom. |
|  |
| **ReferenceBooks** |
| 123 | Hawlins, A.D. (Ed). Aquarium Systems. Academic Press. Hunnam, P. Ward Lock, Living Aquarium.  Ratjak, K. and Zukal, R., Aquarium Fishes and Plants. |
|  |
| **RelatedOnlineContents[MOOC,SWAYAM, NPTEL,Websitesetc.]** |
| 1 | Applied and economic zoology https://mooc.es/course/applied-and-economic-zoology/ |
|  |
| Course Designed By: Dr. M. Muniasamy |

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| **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** | **22ENVJO02** | **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** | **2022-2023** |
| **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 mitigationmeasures 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 airpollutants - SO2, NOx, CO, O3 and Particulate (PM10, PM 2.5 and PM1) level. WHO and national ambient air quality standards – Indian standard. |
|  |
| **Unit:2** | **Urban Air Pollution** | **8 - hours** |
| Assess the extent of pollution - real time monitoring- providing air pollution data to the general public-implementationofairqualitygoalsorstandards-effectivenessofurbanemissionscontrolstrategies - 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 scaleindustry – case study of textile and food processing industry. Assessment in large scale industry – case study of fertilizer, petroleum and thermal power station. |
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| **Unit:4** | **Contemporary Issues** | **2 - hours** |
| Expert lectures, case studies, online seminars - webinars |
|  |

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| --- | --- | --- |
|  | **Total Lecture hours** | **26 - hours** |
| **Text Book(s)** |
| 1 | Daniel Vallero. Fundamentals of Air Pollution, 5th Edition. 2014. Academic Press. Elsevier |
| 2 | Sharma, N., Agarwal, A.K., Eastwood, P., Gupta, T., Singh, A. P. Air Pollution and Control1st Edition. 2018. Springer |
| 3 | Sportisse, Bruno. Fundamentals in Air Pollution. 1st Edition. 2010. Springer |
| 4 | Susanne M. Charlesworth Colin A. Booth. Urban Pollution: Science and Management. 2018.John Wiley & Sons Ltd |
|  |
| **Reference Books** |
| 12 | AkulaVenkatram Nico Schulte. Urban Transportation and Air Pollution1st Edition. 2018. ElsevierLazaridis, Mihalis. 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> |
|  |
| Course Designed By: Dr.J.Manivannan, Dr. R. Rajkumar |

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| --- |
| **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:22ENVA13P1

##  ENVIRONMENTAL CHEMISTRY , INSTRUMENTAL METHODS

##  OF ANALYSIS , DATA ANALYTICS AND RESEARCH METHODS,

##  ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

1. **ENVIRONMENTAL CHEMISTRYAND INSTRUMENTAL**

**METHODS OF ANALYSIS**

1. Determination of pH

2. Determination of conductivity

3. Determination of Dissolved Oxygen content

4. Determination of chlorides

5. Estimation of Total Hardness

6. Estimation Acidity and Alkalinity

7. Physical, Chemical and Biological 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, andCa.

10. Determinations of TKN.

11. Estimation of sulphate byturbidimetry.

12. HPLC determination of pharmaceuticals

13.Heavy metal analysis by ICP-MS

## DATA ANALYTICS AND RESEARCH METHODS

1. Collection of Data: Primary data – Secondary data – Classification and Tabulation – DiagrammaticRepresentation
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 wayANOVA
4. Environmental chemicals related databases anduses.
5. Data analytics using R – Installing R and R Studio- Understanding R Features – Importing and Exporting Files – Plots and Visualization – Case Study usingR

## ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

1. Different types of media preparation-liquid/solid media.
2. Enumeration of microbes from 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 bio surfactant producers from soil sample.
8. Screening and isolation of industrially important enzyme producers (lipase/protease) from soil sample.
9. Industrially important enzyme (lipase/protease) production using waste substrate by bacteria.
10. Isolation of genomic DNA from plantsample
11. Isolation of genomic DNA from bacteria.
12. Isolation of Plasmid DNA frombacteria.
13. Agarose gelelectrophoresis.
14. Polymerase Chain Reaction (PCR) technique.
15. Bacterial Transformation.

## PRACTICAL - II: 22ENVA23P1

## ENVIRONMENTAL POLLUTION, ENVIRONMENTAL TOXICOLOGY AND ENVIRONMENTAL ENGINEERING

##  A. ENVIRONMENTAL POLLUTION

 1. Determination of Chemical oxygen demand

 2. Determination of Biological oxygen demand

 3. Sampling and analysis of SO2, CO2, NOX,PM

 4. Analysis of TS, TDS, TSS

 5. Measurement of noise level

 6. Analysis of heavy metals in soil and water

 7. Analysis of pesticide content in soil and water samples

 **B. ENVIRONMENTAL TOXICOLOGY**

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

## C.BIODIVERSITY AND CONSERVATION

1. Plankton community study: Phytoplankton and Zooplankton: Species identification - Diversity – density – abundance – distribution– Primary productivity
2. Aquatic insect community study: Species identification - Diversity – density – abundance – distribution
3. Fish community study: Species identification - Diversity – density – abundance – distribution
4. Amphibians community study: Species identification - Diversity – density – abundance – distribution
5. Reptiles community study: Species identification - Diversity – density – abundance – distribution
6. Bird community study: Species identification - Diversity – density – abundance – distribution
7. Mammals community study: Species identification - Diversity – density – abundance – distribution
8. Vegetationstudies: Line, quadrates and belt transect methods– Species identification - Diversity – density – abundance –distribution
9. Grassland community study: Species identification - Diversity – density – abundance – distribution
10. Taxonomic identification of plants and animals using morphological andmolecular techniques.

## PRACTICAL - III: 22ENVA33P1

## WASTE MANAGEMENT AND BIOREMEDIATION

1. Studying the effect of temperature/pH/salinity on microbialgrowth.
2. Isolation of Metal resistant Bacteria and effect of heavy metals on microbialgrowth
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 ofmicrobes
7. Assessment of the effects of pollutants on soil enzyme activity
8. Production of biogas from different organic wastematerials
9. Exercises on estimation, composition and segregation of solidwaste

**B. REMOTE SENSING & GEOGRAPHICAL INFORMATION SYSTEM**

1. Importing Aerial/ Satellite image inERDAS
2. Georeferencing and Image/Map Projection in ERDAS
3. Supervised and Unsupervisedclassification
4. Map reading (survey of India Toposheet)
5. Marginal Information and Extra MarginalInformation
6. Relief and CulturalFeatures
7. Importing Aerial/Satellite Imagery and Scanned RasterImage
8. Georeferencing and Co-OrdinateSystem
9. Map Projection (Type of MapProjection)
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 anddose
2. Determination of residualchlorine
3. Demonstration of adsorption process using activatedcarbon
4. Determination of percentage of available chlorine in a disinfectant
5. Designing and calculation of Sedimentationtank
6. Designing and calculation of Aerationtank
7. Designing and calculation of Activated SludgeProcess
8. Designing and calculation of TricklingFilter
9. Designing and calculation of Disinfectionprocess
10. Designing and calculation of Electrostaticprecipitator

# M. Sc. Environmental Sciences

**Syllabus**

**(With effect from 2022-23)**

**Program Code:ENVA**



# DEPARTMENT OF ENVIRONMENTAL SCIENCES

**Bharathiar University**

**(A State University, Accredited with “A” Grade by NAAC and 13th Rank among Indian Universities by MHRD-NIRF)**

# Coimbatore 641 046, INDIA

## QUESTION PAPER PATTERN (2022-23)

## PRACTICAL COMPONENTS

## MAXIMUM MARKS -100

**INTERNAL MARKS: 50**

Record Work15 Marks

Test 30Marks

Attendance 05Marks

**Total 50Marks**

## EXTERNAL MARKS: 50

Major Practical 20 Marks (2 x 10)

Minor Practical 10 Marks (2 x 5)

Spotters (A, B, C, D and E) 10 Marks (5 x 2)

Record 05 Marks

Viva-Voce 05 Marks

**Total 50Marks**

## QUESTION PAPER PATTERN (2022-23) CORE & ELECTIVE PAPERS

Time:3.00 Hrs. Max. Marks:50

**SECTION-A – (10 X 1 =10)**

Answer ALL the questions

Each question carries *one* mark

Q. No.1. – Q. No. 10 - Objective questions with four multiple choices

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

## SECTION-B (5 X 3 = 15)

Answer ALL the questions

Each question carries *three* marks

 Q. No. 11 – Q. No. 15 - Questions with internal choices (either (a) or (b) type)

11.

12.

13.

14.

15.

## SECTION-C (5 X 5 = 25)

Answer ALL the questions

Each question carries *five* marks

Q. No. 16 – Q. No. 20 - Questions with internal choices (either (a) or (b) type)

16.

 17.

 18.

 19.

 20.

(Unit wise distribution of questions should be followed)

## QUESTION PAPER PATTERN (2022-23) SUPPORTIVE PAPERS

 **Time: One Hour 30 Minutes Max. Marks: 25**

**Section A – (5 x 2 = 10)**

Answer all the questions

Each question carries two marks

Q. No. 1 – Q. No. 5

**Section B – (3 x 5 = 15)**

Answer all the questions

Each question carries five marks

Q. No. 6 – Q. No. 8 - Questions with internal choices (either (a) or (b) type)

## QUESTION PAPER PATTERN (2022-23)

**VALUE ADDED AND JOB ORIENTED COURSE PAPERS (DEPARTMENT SELF EVALUATION**)

Time: 1.30 Hrs. Max. Marks: 25

1.

2.

3.

4.

5.

6.

7.

8.

9.

10

 PART-A

Answer ALL Questions (5× 1 = 5) Five Multiple choice questions each carrying one mark

PART-B

Answer all the questions(5× 2 = 10)

Each question carries two marks

PART-C

Answer ALL Questions (2 × 5 = 10) TWO questions with Internal Choice

1. a orb
2. a orb