

SYLLABUS BASED ON CHOICE BASED CREDIT SYSTEM

M.Sc. Environmental Science
SEMESTER SYSTEM
(Effective from the session 2020-2021 *Revised*)



UTKAL UNIVERSITY

Preamble

This M. Sc. Environmental Science course will be effective from the academic year 2020–2021. It has been prepared keeping in view the unique requirements of M. Sc. Environmental Science students and ICAR/UGC-NET syllabus. The emphasis is to provide students the latest information along with due weightage to the concepts of Environmental Science so that they are able to understand and appreciate the current interdisciplinary approaches particularly in the field of research and innovation in the plant sciences and its role in societal development. Keeping the scope of various environmental issues in Odisha as well as scope of further research opportunity and consultancy, the syllabus is also customized. The scope and advancement in alternating energy will be focused with special emphasis on bio-energy, bio-fuel, solar energy solar thermal, solar photovoltaic technology, wind energy and other new technologies, coal bed methane and coal gasification etc. at Odisha State level as well as national level. This is one of the fastest growing sectors in renewable energy sector. Keeping the scope of climate studies in mind, the syllabus will allow student to explore more on the fundamental of earth, oceanic and atmospheric sciences. The effects of a variety of toxic elements on humans and on plant and animal species of direct importance to human existence will be covered. The associated disaster risk, health and its management studies will also be included in the syllabus. Some of major chapters deal with various country specific emerging environmental issues. Municipal solid waste management (MSWM) is an emerging environment issue especially in an urban region due to changing lifestyle and lack of awareness. The ongoing environmental study cum research program will help to prepare a state level MSWM action plan and will also carry out the assessment of impacts of existing landfill sites. Advancement in further studies in these directions will propose new sanitary landfill sites based on adopting site selection criteria, conducting preliminary and detailed Hydro-geological Investigations, Rapid Environmental Impact Assessment (REIA)/Environmental Health Impact Assessment. This research area has ample scope to carry out feasibility studies for municipalities, Municipal Administration, Urban Development department and Odisha State Pollution Control Board. The prime objective of the current program is to mobilize people in management of local environment and to empower them to take decisions on their own.

The proposed M. Sc. syllabus is a balanced, carefully-crafted course structure includes fundamental of environmental science, engineering and green technology. This will not only help

students and researcher to formulate various project and to make extensive studies in the areas like water conservation, development of air pollution control devices, sewage treatment plants, thermal power projects, irrigation projects etc. There is a wide scope for the application of advance sciences like remote sensing (RS) and geographical information system (GIS) in environmental science/issues through user communities, i.e. Urban Development, Logistics, Utilities, Earth Processes, Atmospheric circulation, Law Enforcement, Disaster Risk Assessment and Mitigation, Forestry, Agriculture, Environment, Defense, Health, Banking, Insurance, Education, Retailing, Marketing, etc., as a Decision Support System. Present syllabus envisage achieving above goals through regular and part time training programs and consulting services to anyone who wishes to apply GIS & RS in their domain of activity. Apart from research and teaching, the revised syllabus will provide environmental education and development program to enhance the prospects of environments and ecosystems by working with civil societies, including local communities, and policy makers. This will not only integrate its activities into a coherent program that generates and disseminates new knowledge and fosters innovative change in the ways we resolve environmental problems but also provide a spectrum of services like Clean Development Mechanism (CDM), Environmental Impact Assessment (EIA), Corporate Social Responsibility (CSR), Corporate Environmental Management, Environmental Training and Awareness, Natural Resource Management, Management System Audits, Greenhouse Gases (GHGs) Accounting and Carbon Foot Printing, Eco-tourism Services etc.

All these aspects have been given due weightage over the four semesters having special emphasis on some aspects in the last semester. Students should be encouraged to opt for one allied elective paper from other allied courses to increase interdisciplinary approaches of understanding and application. The course will also inspire students to pursue higher studies in Environmental Science, for becoming an entrepreneur and enable students to get employed in plant based industries. This new syllabus will cater the fundamental requirements for the students being employed in different sectors to serve the world as a whole.

M.Sc. Environmental Science

Department of Botany, Utkal University, Bhubaneswar

SEMESTER SYSTEM (CBCS pattern)

To be effective from the session 2020-2021 (*Revised syllabus*)

Eligibility

Any Graduate from Science & Engineering Streams or any other allied subjects such as Physics, Chemistry, Mathematics, Computer Science, Zoology, Life Science, Environmental Science, Microbiology, Earth and Atmospheric Science, Marine Sciences, B.Sc. (Agriculture/Fishery/Forestry/Biotechnology), B.V.Sc., B.Pharm./M.B.B.S., B.Sc. (Engg.) and Geology with Environmental Science as a subject can take this course.

Admission

The candidates are to take admission after qualifying in an entrance test conducted by the department. The merit list will be prepared by taking 70% of marks in career plus 30% of marks secured by a candidate in the entrance test. The admission will be strictly as per the merit list in each category as per university norms.

Course and Regulation

1. The course is of two years duration with four semesters for theory, laboratory practical work.
2. First and second semesters have four (4) theory papers each and one (1) practical paper. Third semester has two (2) core papers, one (1) allied elective paper to be opted from other department, one (1) free elective paper to be opted from this syllabus or from other department and one (1) practical paper pertaining to core papers. Fourth semester has one special paper having two (2) core elective papers, one (1) dissertation-cum-presentation and one (1) seminar presentation. The candidate shall have to appear examination (theory and practical / dissertation/seminar) at the end of each semester.
3. Each theory paper carries 100 marks.
4. Each practical paper carries 100 marks. In 4th semester the dissertation paper carries 200 marks (Dissertation-100 marks + Presentation-100 marks).
5. The semester system of examination will have internal system of evaluation as suggested by the Board of Studies approved by Teacher's council. For practical examination evaluation will be made by one external and one internal examiner together.
6. In order to pass a semester examination a candidate must have to secure a minimum of 40% marks in practical and 33% marks in aggregate of the theory papers in each

semester. If the marks secured in a theory paper are less than 25% then the said mark will not be included in the aggregate.

7. If a candidate passes all the four semester examination he / she will be declared to have passed the M.Sc. examination in Environmental science.
 - (i) In first class securing 60% or more
 - (ii) In second class securing 48% or more but less than 60%
 - (iii) In third class securing 33% marks or more but less than 48% marks in aggregate of all the semester examinations taken together.
8. Attendance in each semester shall be strictly adhered to University Rules.
9. A candidate may repeat only once in one or more papers of any semester examination within a period of one year of the said semester examination. However, if the candidate does not clear the 1st & 2nd semesters, his/her result will not be published even after successfully completing the 3rd and 4th semester. In case a candidate is unsuccessful in 3rd and 4th semester, he shall appear in the immediate next examination of the next batch for the same semester. A candidate failing on any semester examination will be allowed to appear once only in the examination for that semester conducted for the next batch of students and also be allowed to continue to the next semester. A candidate not appearing the 1st and 2nd semester examinations will be considered to have discontinued his/her study and will not be allowed to appear the remaining semesters.
10. Merit list will be prepared as per University Rules, from among the students those who have cleared all semester examinations in 1st chance in one time without repeat of any paper.
11. The candidates who have failed in one semester may be allowed to appear the same in the immediate next chance, following the due provision. However, he/she will be not given another chance to appear.
12. Each unit in the papers comprises of 06 classes where each class is equal to 01 hr and 30 min.

A. Core Papers:

1. Environmental Science and Chemistry
2. Environmental Toxicology, Statistics and Geo-informatics
3. Environmental Pollution Control and Meteorology
4. Environmental Geology
5. Ecology and Biodiversity

6. Geo-science and Natural Resources Management
7. Environmental Hazards and Disaster Management
8. Public Health and Sanitation
9. Environmental Laws and Awareness
10. Environmental Management System

SWAYAM Courses

1. Water Resources and Watershed Management
2. Solid and Hazardous Waste Management
3. Environmental Law
4. Biomass Characterization

Practical pertaining to above theory papers

B. Core Elective papers (optional- any one):

1. Elective A: Environmental Pollution and Management
2. Elective B: Environmental Biology
3. Elective C: Geo-informatics and Climate Change

Practical pertaining to each theory core elective papers

C. Allied Elective Courses

Environmental Studies and Awareness

D. Free Elective Courses

1. Environmental Microbiology & Ecology

OR

2. SWAYAM Course on Biomass Characterization

Outlines of M.Sc. Environmental Science Syllabus (CBCS system)

Semester-I	Core Papers Name	Mark	Credit
Core Papers:			
Paper-ES-101	Environmental Science and Chemistry	100	06
Paper-ES-102	Toxicology, Statistics and Geo-informatics	100	06
Paper-ES-103	Environmental Pollution and Meteorology (A) /Or SWAYAM Course on Water Resources and Watershed Management (B)	100	06
Paper-ES-104	Environmental Geology	100	06
Paper-ES-105	Practical pertaining to Theory Papers- ES-101, ES-102, ES-103, ES-104	100	06
Total		500	30
Semester-II			
Paper- ES-201	Ecology and Biodiversity	100	06
Paper- ES-202	Geo-science and Natural Resources Management	100	06
Paper- ES-203	Environmental Hazards and Disaster Management (A)/ Or SWAYAM Course on Solid and Hazardous Waste Management (B)	100	06
Paper- ES-204	Environment and Public Health	100	06
Paper- ES-205	Practical pertaining to Theory Papers ES-201, ES-202, ES-203, ES-204	100	06
Total		500	30
Semester-III			
Core Papers:			
Paper -ES-301	Environmental Management System & EIA	100	06
Paper-ES-302	Environmental Laws and Awareness (A)/ Or SWAYAM Course on Environmental Law (B)	100	06
Allied Elective Paper			
Paper-ES-303	Environmental Studies and Awareness	100	06
Free Elective Paper			
Paper-ES-304	Environmental Microbiology & Ecology (A) / Or SWAYAM Course on Biomass Characterization (B)	100	06
Paper-ES-305	Practical pertaining to Theory Papers ES-301 and ES-302	100	06
Total		500	30
Semester-IV			
Core elective papers (Any one): Only One Special paper + Dissertation + Seminar presentation			
Paper-ES-401 (A)	Environmental Pollution Monitoring	100	06
Paper- ES-402 (A)	Industrial Pollution Control and Management	100	06
Paper-ES-401 (B)	Forest Ecology and Modeling	100	06
Paper- ES-402 (B)	Stress Biology and Toxicology	100	06
Paper-ES-401 (C)	Remote Sensing and GIS	100	06
Paper- ES-402 (C)	Meteorology and Climate Change	100	06
Paper-ES-403	Dissertation-cum-presentation	200	12
Paper-ES-404	Seminar presentation	100	06
Total		500	30
Grand Total		2000	120

FIRST SEMESTER

Theory

Paper-ES-101: Environmental Science and Chemistry

100 Marks/ 6 Credits

Objectives:

The course introduces the students the basic chemistry relevant to the course and to the general chemistry of the lithosphere, hydrosphere and atmosphere. Emphasis is also placed on understanding the chemistry of various anthropogenic pollutants and basic analytical techniques.

Unit-I

Definition, Concept and Scope of ecology and environmental science. Interactions between Earth, man and environment. Bio-geographic provinces of the world and agro-climatic zones of India. Concept of sustainable development. Anthropogenic activities and ecosystem degradation.

Unit -II

Structure and composition of the Atmosphere, Hydrosphere, Lithosphere and Biosphere. Mass and energy transfer across the various interfaces, Material Balance, laws of thermodynamics, heat transfer process. Meteorological parameters: humidity, mixing ratio, saturation mixing ratio, radiation and wind velocity, adiabatic lapse rate, environmental lapse rate, wind roses.

Unit -III

Fundamentals of Environmental Chemistry: Stoichiometry, Gibb's energy, Chemical potential, chemical equilibria, chemical kinetics, Acid base reaction, Solubility product, Solubility of gases in water. The Carbonate system, Unsaturated and saturated hydrocarbons, Radioisotopes.

Unit-IV

Atmospheric chemistry: Composition of air. 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.

Unit-V

Water and Soil chemistry: Chemistry of water. Water as a universal solvent. Concept of DO, BOD and COD. Sedimentation, coagulation, flocculation, filtration, pH and Redox potential (Eh). Hydrological cycle. Inorganic and organic components of soil. Biogeochemical cycles: nitrogen, potassium, phosphorus and sulphur.

Outcomes:

This paper develops the concept of basic environmental chemistry to better understand the practical analysis of air, water and soil samples as well as understanding Environmental science.

Reference Books:

- Anjaneyulu, Y. (2004). Introduction to Environmental Science. B. S. Publications.
- Botkin, D.B. and Keller, E.A. (1995). Environmental Science Earth as a Living Planet, (9th Ed). Wileyplus.
- Chiras, D.D. (2001). Environmental Science, 6th ed., Jones and Bartlett Publishers.
- Cunningham, W. and Cunningham, M.A. (2010). Principles of Environmental Science. McGraw-Hill Higher Education.
- Cunningham, W.P., Saigo, B.W. and Cunningham, M.A. (2001). Environmental Science: A Global Concern (Vol. 412). McGraw-Hill.
- Masters, G.M. and Ela, W.P. (1991). Introduction to Environmental Engineering and Science (Vol. 3). Englewood Cliffs, NJ: Prentice Hall.
- Manahan, S. E. (2000). Environmental Chemistry 7th Edn. Lewis Publishers.
- Stumm, W. and Morgan, J.J. (2012). Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters, John Wiley & Sons.

Paper-ES-102: Toxicology, Statistics and Geo-informatics

100 Marks/ 6 Credits

Objectives:

The course focuses on biochemical mechanism of environmental toxicants, statistical methods and its application in environmental modelling. Emphasis is also placed on understanding the GIS and computer applications along with basic analytical techniques.

Unit-I

Toxic chemicals: Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). Toxicity of CO, O₃, PAN, POP. Non-target pesticide toxicity, toxic effect and environmental fate of DDT, Malathion, Carbaryl, Atrazine, Methyl Isocyanate. Antidotes and neutralization of toxicity.

Unit-II

Principles of analytical methods: Titrimetry, Gravimetry, Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flamephotometry, Spectrophotometry (UV-VIS, AAS, ICP-OES), Electrophoresis, XRF, XRD, GC-MS, SEM.

Unit-III

Statistical methods: types of variables, measurement of Central tendency and Dispersion, Standard error, Moments, Skewness and Kurtosis, concept of probability, Normal, log-normal, Binomial, Poisson distribution. Correlation, Regression, tests of hypothesis (t-test, Chi-square-test, ANOVA: one-way and two-way); significance and confidence limits. *Developmental models:* Lotka-Volterra model, air pollution dispersion: line source model, Box model, Gaussian plume model.

Unit-IV

Geo-informatics: Principles of remote sensing, EMR, Basic features of different types of sensors- Active & Passive sensors. Satellite types, platform, Signature, Geographical Information System (GIS) digitizing map, analysis and interpretation of GIS map, concept of GIS Services, Application of remote sensing and GIS Environmental management. Satellite navigation system.:

Unit-V

Computer Applications: What are Computers? Input and output devices, Central Processing Unit, Software and hardware. Printer types and principles, IP address, Programming languages for scientific/environmental application, type of operating systems, basic tools for analyzing environmental data. Scope of Computer in Environmental Sciences.

Outcomes:

This paper develops the concept of Toxicology, Statistics and Geo-informatics in the application of air, water and soil pollution prediction and modelling.

Reference Books:

- Burrough, P.A., McDonnell, R.A. and Lloyd, C.D. (2015). Principles of Geographical Information Systems. Oxford University Press.
- Freund, R.J., Wilson, W.J. (2003). Statistical Methods. Academic Press. Lillesand, T.M. and Kiefer. R.W. (1999). Remote sensing and image interpretation (4thed). Wiley.
- Colin, W. (2014). Ecotoxicology: Effects of Pollutants on the Natural Environment, 1st (ed), CRC Press
- Newman, M.C. (2015). Fundamentals of Ecotoxicology: The Science of Pollution, 4thedn. CRC Press.
- Burrough, P.A., McDonnell, R.A. and Lloyd, C.D. (2015). Principles of Geographical Information Systems. Oxford University Press.

Paper-ES-103(A): Environmental Pollution and Meteorology

100 Marks/ 6 Credits

Objectives:

The paper will deal with the monitoring of environmental pollution and includes the guidelines for pollution control. It also emphasizes on meteorological parameters and phenomena influencing environmental pollution. Furthermore, biomagnification and statistical concept of toxicology discussed for understanding the fate of toxicant in the environment.

Unit-I

Concept of Environmental Pollution and Monitoring, Meteorology: Meteorological parameters. Monitoring of parameters: Wind rose. Inversion zone. Precipitation. Evaporation, pressure

systems, temperature. Humidity. Solar intensity. Atmospheric stability, Scale of Meteorology, ITCZ, Wind circulation, Indian Monsoon, *El Nino & La Nina*, cyclones genesis.

Unit-II

Air pollution: Sources and types of Pollutants - Natural and anthropogenic sources, primary and secondary pollutants. Criteria air pollutants. Measurements of ambient air quality, Greenhouse Gases Emission Inventory and its application. National Ambient Air Quality Standards. Impact of air pollutants on human health, plants and materials. Acid rain. *Noise pollution*: Sources, weighting networks, measurement of noise indices. Noise dose and Noise Pollution standards. Noise control and abatement measures.

Unit-III

Water pollution: Types and sources of water pollution. Impact on humans, plants and animals. Sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants in water. Microbiological analysis: MPN. Indian drinking water standards. *Marine pollution*: Sources of marine pollution and its prevention and control, Radioactive and thermal pollution.

Unit-IV

Soil pollution: Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Soil Pollution control. Industrial effluents and their interactions with soil components. *Bio-monitoring*: Concept and Bio-monitoring of environmental pollutants, Biological diversity indices.

Unit-V

Toxicity testing by bio-assay. Bio-magnification and bio-accumulation of pollutants. Movement of toxicants in bio-systems, factors affecting Toxicity. Dose effect and response, Response curves, Statistical concept of toxicity. LC₅₀ & LD₅₀ concepts; Toxic chemicals and hazard, concept of toxicity, toxicity test, Pathogens and mutagens.

Outcomes:

This paper helps the students to better understand the practical components of analysis of air, water, soil and solid waste samples as well as this paper explains major meteorological phenomena inducing climate change.

Reference Books:

- Botkin, D.B. and Keller, E.A. (1995). Environmental Science Earth as a Living Planet, (9th Ed). Wileyplus.
- Boston, MA. Glasson, J. and Therivel, R. (2013). Introduction to Environmental Impact Assessment. Routledge.
- Masters, G.M. and Ela, W.P. (1991). Introduction to Environmental Engineering and Science (Vol. 3). Englewood Cliffs, NJ: Prentice Hall.

- Freund, R.J., Wilson, W.J. (2003). Statistical Methods. Academic Press. Lillesand, T.M. and Kiefer. R.W. (1999). Remote sensing and image interpretation (4thed). Wiley.

Paper-ES-103 (B): SWAYAM Course on Water Resources and Watershed Management (B)

100 Marks/ 6 Credits

Paper ES-104 Environmental Geology

100 Marks/ 6 Credits

Objectives:

All human activities take place on earth using a large variety of its resources. How do we live here and use these resources, so that not only sustainable society but also life itself is sustained, need the knowledge of the science of the earth (= Geology) for all its citizens? The subject Environmental Geology is an applied one, wherein basic geologic knowledge is used to maximize the utilization of all natural resources, minimize their degradation as well as minimize the destructive potential of natural processes and to sustain a healthy biosphere on earth.

Unit-I

Land resources: Land as resource, Land use patterns, Impact assessment of land use, measure to combat Desertification. soil formation and development, classification of soil, soil conservation practices, soil pollution and its impact on man, animals & vegetation with reference to agro-chemicals and solid waste, prevention & control of soil pollution.

Unit-II

Water Resources: Surface & subsurface water resources, favorable geological condition for underground water, water holding capacity of soil & rocks, porosity, permeability & water flow characteristics types of aquifers, yield of water, water pollution & its impact on ground water quality & soil control & measurement of water pollution.

Unit-III

Energy Resources: Heat budget of the earth, thermonuclear fusion in the sun, conventional & alternative sources of energy: principle and application of fossil fuel based energy, hydropower, geothermal energy, wind energy, solar energy, biomass etc.

Unit-IV

Hazards & disaster: Earthquake: causes& effect, measurement of Intensity & location of epicenter, stability of structure & risk evaluation, seismic zone mapping. *Floods:* Causes and effect, management of flood, cyclones& their genesis, cyclone mitigation measures. *Landslides:* causes mass movement, landslide prone areas in India and control of landslides.

Unit- V

Disaster Management: Concept, type of disaster, Phases of Disaster Management, Tsunami: a cash study, 2003, Cyclonic storms of coastal India: A Case Study, Disaster Risk Reduction

Strategies, The National Policy on Disaster Management, 2009, 2016, Risk Reduction Preparedness Plans, Early Warning Systems.

Outcomes:

This paper enlightens and trained students about different aspects of natural resources and disaster management.

Reference Books:

- Dillon, J. and Wals, A. E. (2016). On the dangers of blurring methods, methodologies and ideologies in environmental education research. In Towards a Convergence Between
- Colin, W. (2014). Ecotoxicology: Effects of Pollutants on the Natural Environment, 1st (ed), CRC Press
- Sparling, D. W. (2017). Basics of Ecotoxicology, 1stEdn CRC Press.
- Stumm, W. and Morgan, J.J. (2012). Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters, John Wiley & Sons.
- Keller, E.A. (1996). Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey
- Owen, O.S., Chiras, D.D., Reganold. John P. (2002). Natural Resource Conservation. 7th Ed., Prentice Hall, Upper Saddle River, New Jersey
- Strauhler and Strahler. (1995). Physical Geography. 3rd Edition, CRC press.

Practical

Paper-ES-105: Practical based on Papers ES-101, ES-102, ES-103 and ES-104

100 Marks/6 Credits

SECOND SEMESTER

Theory

Paper ES-201: Ecology and Biodiversity

100 Marks/6 Credits

Objective:

This course entails the study of ecology and diversity existing at different levels of Biological organization and understanding the essential ecological and biological processes which ensures long terms stability of ecosystems. The course highlights different types and levels of ecosystem and the values of biodiversity and scientific approaches towards its conservation which only can lead to safeguard the interests of future generations.

Unit I

Fundamentals of ecology: Ecology as an inter-disciplinary science. Origin of life and speciation. Human Ecology and Settlement. Ecosystem Structure and functions, Biogeochemical cycles, Ecological succession. Species diversity, Concept of ecotone, edge effects, ecological habitats and niche. Ecosystem stability.

Unit II

Ecosystem: Basis of Ecosystem classification. Types of Ecosystem: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic Biomes: Concept, classification and distribution. Characteristics of different biomes across the World.

Unit III

Ecological succession: concept, type, and mechanism of ecological succession. *Community ecology*: Definition, community concept, types and interaction- predation, herbivory, parasitism and allelopathy. *Population ecology*: Characteristics of population, concept of carrying capacity, population growth and regulations. Population dispersion and metapopulation. Concept of 'r' and 'k' species. Keystone species.

Unit IV

Biodiversity: Definition, types, importance of biodiversity and threats to biodiversity. Common flora and fauna of India: phytoplankton. Zooplankton and macrophytes. Endangered and threatened species, Red List. *Forest ecology*: biogeographically zones and forest types in India, Structure and functions of forest ecosystem, Forest degradation and management.

Unit V

Biodiversity and its conservation: Concept and basis of identification of 'Hotspots'; hotspots in India. Measures of biodiversity. Strategies for biodiversity conservation: *in situ* and *ex situ* conservation. National parks, Sanctuaries, Protected areas and Sacred groves in India. Concept of restoration ecology. Endangered and Threatened flora and fauna of India.

Outcomes:

This paper has provided the students with an ample amount of knowledge on fundamentals of Ecology, basic types and levels of Ecosystems and the values of biodiversity and scientific approaches towards its conservation.

Reference Books:

- Dobson, A.P. (1996). Conservation and Biodiversity. Scientific American Library, New York, NY.
- Groombridge, B., and M. Jenkins. (2000). Global Biodiversity: Earth's Living Resources in the 21 st Century. World Conservation Press, Cambridge, UK.

- IUCN. (2004). Red list of threatened species. A global species assessment. IUCN, Gland, Switzerland
- Loreau, M., and Inchausti, P. (2002). Biodiversity and Ecosystem functioning: Synthesis

Paper ES-202: Geosciences and Natural Resources Management 100 Marks/ 6 Credits

Objective:

This paper takes an objective view of the nature of Earth's resources, particularly the non renewable resources, how and where they are generated, how they are extracted and used, and how these activities impact Earth's environment. It also addresses different ways of conservation of the natural resources and their management. Furthermore it focuses on various essential components of Geo-science that affects Earth's environment and seasons, specifically elements of Indian climate.

Unit I

Geosciences: Origin of earth. Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere, formation of igneous and metamorphic rocks. Controls on formation of landforms including plate tectonic and climatic. Energy budget of the earth. Earth's thermal environment and seasons. Coriolis force, pressure gradient force, Climates of India, Indian monsoon, droughts, *El Nino*, *La Nina*.

Unit II

Soil formation and properties: weathering reactions, erosion, transportation and deposition of sediments. Soil forming minerals and process of soil formation, Identification and characterization of clay minerals, Soil physical and chemical properties, soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls.

Unit III

Land Resources: land, soil, water, forest and their conservation and management including wildlife; CRZ, EEZ regulation, land use policy in India. Desertification and biological invasion; *Water Resources*: groundwater provinces of India, Rain water harvesting. *Mineral resources*: environmental effects of extracting and using mineral resources.

Unit IV

Natural resources: Natural resource exploration and exploitation and related environmental concerns. Historical perspective and conservation of non-renewable resources. Geochemical classification of elements, abundance of elements in bulk earth crust. Geochemical recycling of elements.

Unit V

Energy resources: Solar energy: solar collector, photovoltaic, solar ponds. Fossil fuels. Hydroelectricity, Magneto-Hydro Dynamics (MHD), tidal, wind, geothermal and ocean thermal energy conversion (OTEC). Nuclear energy: fission and fusion reactions, nuclear reactors and electric power generation. *Bio-energy resources:* energy from biomass and biogas, energy plantation, bio-ethanol and bio hydrogen generation.

Outcome:

This paper helps students in understanding aspects of Geo-science and its impacts on climate systems throughout the globe especially India. At the same time this paper also supplies students with knowledge of natural resources and their management.

Reference Books:

- Keller, E.A. (1996). Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey.
- Kesler, S. F. (1994). Mineral resources, economics and the environment. Upper Saddle River, NJ: Prentice Hall.
- Owen, O.S., Chiras, D.D., Reganold. John P. (2002). Natural Resource Conservation. 7th Ed., Prentice Hall, Upper Saddle River, New Jersey
- Skinner, Brian J., Porter, Stephen C. (1995). The Dynamic Earth: An Introduction to Physical Geology. Casebook, 3rd Edition (Paperback), John Wiley, New York
- Skinner, B. J., and Porter, S. C. (1995). The Blue Planet, An Introduction to Earth System Science. John Wiley & Sons, Inc.
- Slaymake, Olav, (Ed). (2000). Geomorphology, Human Activity and Global Environmental Change. John Wiley, New York.

Paper ES-203 (A): Environment Hazards and Disaster Management 100 Marks/ 6 Credits

Objective:

This paper introduces the students to various environmental hazards, their causes, nature, preparedness and assessment of loss. It teaches them about different types of disasters and familiarizes them with methods of disaster assistance and management. Additionally this paper supplies students with knowledge on Solid and Hazardous Waste Management techniques.

Unit I

Concepts of Hazard and Disaster: Definition of Hazard and Disaster, Hazardous waste – Types, characteristics and health impacts. Hazardous waste management: Treatment Methods: neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal. Hazardous waste management and Handling rule, 1989.

Unit II

Solid waste management: Solid waste collection and transportation: container systems - hauled and stationary, layout of collection routes, transfer stations and transportation. Solid waste processing and recovery, Electrical energy generation from solid waste: Fuel pellets, Refuse derived fuels, incineration of solid waste.

Unit III

Risk Assessment: Hazard identification, Hazard accounting, Scenarios of exposure, vulnerability analysis, Risk assessment methodologies, Risk characterization and Risk management.

Unit IV

Disaster Management: Concept of disaster management plan, guidelines, methodologies, forecasting and warning systems of disasters, emergency preparedness, case studies. Pre-disaster phase, Actual disaster phase, post-disaster phase, case studies. Different types of disasters: Earthquake, flood, Landslide, cyclone, avalanche etc. and their causes, effect and management.

Unit V

Disaster assistance: Technological assistance, Rescue and emergency relief camps, role of paramilitary forces, home department, NDRF, NGOs in disaster response. NDMA and Calamity Relief Fund. Role of UN in Disaster management, information administration, firefighting and tent pitching, camping, Rope knots and their use, case studies.

Outcome:

This paper enlightens and trained students about different aspects and types of Hazard and familiarizes students with disaster management. This paper also introduces students to techniques of Hazardous and Solid Waste Management.

Reference Books:

- Bell, F.G. (2003). Geological Hazards: Their Assessment, Avoidance and Mitigation. CRC Press.
- Bilham, R. (2004). Earthquakes in India and the Himalaya: tectonics, geodesy and history. Annals of Geophysics, 47: 2-3.
- Blaikie, P., Cannon, T., Davis, I. and Wisner, B. (2014). At Risk: Natural Hazards, People's Vulnerability and Disasters. Routledge.
- Burton, I. (1993). The Environment as Hazard. Guilford Press.
- Margottini, C. and Casale, R. (2004). Natural disasters and sustainable development. Environmental Science Series, Springer.
- Hewitt. K. (1997). Regions of Risk. Longman Press.
- Henry J.G. and Heinke, G.W. (2004). Environmental Science and engineering. Pearson education, Delhi, India.

- Shroder, J. & Wyss, M. (eds). (2014). Earthquake Hazard, Risk and Disasters (1st Edition). Elsevier.
- Smith, K. (2003). Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge.
- Watts, M. (2017). On the poverty of theory: natural hazards research in context. In Environment (pp. 57-88), Routledge.

Paper ES-203 (B): SWAYAM Course on Solid and Hazardous Waste Management

100 Marks/ 6 Credits

Paper ES-204: Environment and Public health

100 Marks/ 6 Credits

Objective:

The paper will deal with the impact of population, waste management, epidemiological issues, food safety issues and environmental disasters on public health. It will also focus on the current Environmental Issues on a global platform.

Unit-I

Environment and Population: biotic, abiotic and social components; Weather and climate; History and evolution of human settlement; Effect of various developmental activities on environment. Human population and environment: population growth, Family welfare programme; World food resources; World food problems; Environment and human health.

Unit-II

Waste management: qualitative and quantitative characteristics of garbage. Disposal method: sanitary landfill, incineration, composting etc. Recycle and refuse of solid waste. Swachha Bharat Abhiyan Vector borne diseases, control methods, rodents and public health, control measures.

Unit-III

Current Environmental Issues: Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision. Carbon sequestration and carbon credits.. Sustainable Habitat: Green Building, GRIHA Rating Norms. Vehicular emission norms in India.

Unit-IV

Epidemiological Issues & Food safety: Fluorosis, Arsenocosis, Goitre, Dengue. Public health consideration of food poisoning, food storage and preservation, methods and types of food preservation. Food Safety and Standards Act 2006, role of FCI, FSSAI.

Unit-V

Environmental Disasters: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011. Water sanitation- biological contamination, water pollution and health, drinking water.

Outcome:

The paper introduces students to various factors that influence public health directly. It also focuses on current environmental issues on a global scale. At the same time it provides an historical but up-close study of various environmental disasters.

Reference Books:

- Holgate, S.T., Koren, H.S., Samet, J.M. and Maynard, R.L. eds. (1999). Air pollution and health. Elsevier.
- Kampa, M. and Castanas, E. (2008). Human health effects of air pollution. Environmental Pollution, 151: 362-367.
- McGranahan, G. and Murray, F. (2012). Air pollution and health in rapidly developing countries. Earthscan.
- Murray J.F. and Nadel. J.A. (2000). Text book of respiratory medicine, 3 rd ed., W.B. Saunders & Co.
- Partdos, C.D., Ignatius, R. and Schneider, T. (2005). Topley and Wilson's microbiology and microbial infections. Oxford University Press.
- Park. J.E. and Park. K. (1994). Text book of preventive and social medicine, Banarsi Das & Bhanot, Jabalpur.
- Smith, K.R. (2013). Biofuels, air pollution, and health: a global review. Springer Science & Business Media

Practical

Paper- ES-205: Practical based on Papers ES-201, ES-202, ES-203 and ES-204

100 Marks/ 6 Credits

THIRD SEMESTER

PAPER- ES-301: Environmental Management System & EIA

100 Marks/ 6 Credits

Objective:

This paper is an introduction to EIA, a systematic process that examines the environmental consequences of development actions, in advance. This process is firmly on the agenda of all environmental agencies as a result of introduction of legislations in various countries.

Additionally it presents comprehension on International Conferences, Agreements and Organizations pertaining to Environmental issues.

Unit I

International conference and agreements: Concept of Environmental Management System (EMS), dimensions of environmental degradation and concern of UNO on this Matter. World Conference on Human Environment of Stockholm 1972, UNEP, Rio Conference 1992 and subsequent climate agreements. International Chamber of Commerce, Business Charter for Sustainable Development. World Organizations: Green Peace International, IUCN, WWF.

Unit II

Environmental Management System and EIA: Environmental Impact Analysis (EIA) concept, Environmental Impact Statements and Environmental Management Plan, Impact assessment methodologies. EIA Notification, 2006 and its amendments from time to time. Social Impact Assessment (SIA). Principles and elements, Continuous performance elevation of EMS.

Unit III

Environmental planning: Concept and principles. General aspects, identification of Environmental aspects and evaluation of associated environmental impacts. Environmental labelling and life cycle assessment standards. Environmental Legislation & legal requirements. Environmental performance criteria, Environmental objectives and targets. Environmental management plans and programmes. Urban and Rural Planning in India.

Unit IV

Implementation of EMS: resource-human, physical and Financial, environmental values and modification, knowledge, skills and training, EMS Report writing and documentation, EMS records, information management records and Operational control, emergency preparation and regulations.

Unit V

Measurement and evaluation of EMS: benefit-Cost analysis, ISO and Indian standards, Development of ISO 14000 series. Guidelines for environmental audit, Audit of EMS, Principles, British, Audit practices for ISO 14011 and 14012, code of practice and registration for Environmental Auditors, EMS Audit preparation and execution, Corrective and preventive action.

Outcome:

The paper helps students to understand the basic concept and principles of Environmental Management System and Environmental Impact Assessment. It also enhances the student's knowledge on International Conferences, Agreements and Organizations pertaining to Environmental Issues.

Reference Books:

- Blaikie, P., Cannon, T., Davis, I. and Wisner, B. (2003). *At Risk: Natural Hazards, People's Vulnerability and Disasters* (2nd ed.). Abington. Routledge.
- Glasson, J. and Therivel, R. (2013). *Introduction to Environmental Impact Assessment*. Routledge.
- Morris. P. and Therivel. R. (2001). *Methods of environmental impact assessment*, 2 nd Ed. Spon Press, New York, With a chapter on GIS and EIA by A.R. Bachiller and G. Wood, p. 381-401.
- Grumbine, R. E. and Pandit, M.K. (2013). *Threats from India's Himalaya dams*. Science. 339:36-37. Petts, J. (1999). *Handbook of Environmental Impact Assessment*. Vol. 1, Blackwell Science.
- Craig, J.R., Vaughan, D.J. Skinner, B.J. (1996). *Resources of the Earth: Origin, Use, and Environmental Impact* (2nd ed). Prentice Hall, New Jersey.
- Nieuwenhuijsen, M. J. (ed.) (2015). *Exposure Assessment in Environmental Epidemiology*. Oxford University Press, USA.

PAPER - ES-302: Environmental Law and Awareness

100 Marks/ 6 Credits

Objective:

This paper introduces the students to some of the important elements of Constitution of India for the protection of Environment. It familiarizes student to the politics of environmental issues at the national and international levels.

Unit I

Protection of Environment under Constitution of India: 42nd Amendment 1976 of the Constitution, Article 48 'A'- Directive Principle of State Policy, Article 51(A)g-Fundamental Duties. Fundamental Rights and Environment Art-14, Art-19, Art-21, Art-25, Art-253. Right to Life and Environment Pollution. Role of United Nations and Environment Protection, Stockholm Declaration-1972, Rio Declaration-1992 and Johannesburg Declaration-2002.

Unit II

Pollution Control Laws: The Water (Prevention and Control of Pollution) Act, 1974- Composition, Constitution, Power and Function of Different boards and Restrictions. Water Cess Act, 1977. The Air (Prevention and Control of Pollution) Act, 1981-Composition, Power and Function of Different boards and Restrictions. The Environment (Protection) Act, 1986- Power of the Central Govt, majors related to hazardous substances. Noise Control Rule-2000 and control of Noise under other Laws.

Unit III

Waste management Rules: Manufacture, storage and impart of Hazardous Chemical Rules-1989, Biomedical waste (management and Handling)Rules- 1989, Municipal Solid waste(management

and Handling)Rules-2000, E-Waste Management Rule, 2011 and Recent developments. Scheme of Environmental Labeling (ECOMARK) notification.

Unit IV

Laws Relating to Forest and Wildlife: Biodiversity Conservation Act, 2006, The Forest Act, 1927- Declaration of Reserve Forest, Restrictions and Classification of Forest, Indian Forest Act (revised), 1982, The Wild life (Protection) Act, 1972 – National Park, Sanctuaries, Restriction and Protected areas, Forest (Conservation) Act, 1980, Forest Rights Act, 2006.

Unit V

Legal Remedies to Environmental victims: The Public Liability Insurance Act, 1991, National Green Tribunal Act, 2010, Constitutional Remedies under Act-32 and Act-226, Environmental Litigations and Role of Supreme Court of India.

Outcomes:

The paper helps students to understand various Laws, Rules and Acts related to Environment. It also provides a platform to perceive and learn some of the vital elements of Indian Constitution.

Reference Books:

- Bodansky, D., Brunnée, J. and Rajamani, L. (2017). International Climate Change Law, Oxford University Press: New Delhi.
- Bell, S. and McGillvray, D. (2001). Environmental Law, Universal Law Publishing Co.
- Divan, S. and Rosencrantz, A. (eds). (2001). Environmental Law and Policy in India: Cases, Materials and Statutes. New Delhi: Oxford University Press.
- Jariwala C.M. (2004). Environmental Justice, APH Publishing Corporation, N. Delhi
- Mcinerney-Lankford S., Darrow, M. and Rajamani, L. (2011). Human Rights and Climate Change: A Review of the International Legal Dimensions. The World Bank.
- Mohanty. S. K. (2004). Environment and Pollution Law, Universal Law Publishing Co. Pvt. Ltd.
- Plater, Z.J., Abrams, R.H., Graham, R.L., Heinzerling, L., Wirth, D.A., Hall, N.D., Abrams, R.H. and Graham, R.L. (2016). Environmental Law and Policy: Nature, Law, and Society. Wolters Kluwer Law & Business.
- Percival, R.V., Schroeder, C.H., Miller, A.S. and Leape, J.P. (2017). Environmental Regulation: Law, Science, and Policy. Wolters Kluwer Law & Business.
- Rajamani, L. (2006). Differential Treatment in International Environmental Law. Oxford University Press: New Delhi.
- Rengarajan, S., Palaniyappan, D., Ramachandran, P. and Ramachandran, R. (2018). National Green Tribunal of India—an observation from environmental judgements. Environmental Science and Pollution Research, pp.1-6.
- Singh, G. (2004). Environmental Law in India, Mcmillan& Co.
- Shastri, S. C. (2005). Environmental Law, Eastern Book Company.

- White, R. ed., (2017). Transnational Environmental Crime. Routledge

Paper ES-301 (B): SWAYAM Course on Environmental Law

100 Marks/ 6 Credits

Allied Elective Paper:

PAPER ES-303: Environmental Studies and Awareness

100 Marks/ 6 Credits

Objective:

This paper familiarizes students with current environmental issues and includes techniques and methods of environmental awareness. It also includes detailed curriculum on some important meteorological parameters and Bio-geographic Provinces of the world along with Agro-Climatic Zones of India.

Unit I:

Water conservation: Development of watersheds, Rain water harvesting and ground water recharge. Conservation of wetlands, Ramsar sites in India. Soil erosion, reclamation of degraded land, desertification and its control. Forest Conservation – Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement.

Unit II

Meteorological parameters - pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, radiation and wind velocity, adiabatic lapse rate, environmental lapse rate. Wind roses. Natural resources and their assessment.

Unit III

Biogeographic provinces of the world and agro-climatic zones of India. Remote Sensing and GIS: Principles of remote sensing and GIS. Application of remote sensing and GIS in land cover/land use planning and management, waste management and climate change.

Unit IV

Environmental Issues – Biodiversity loss, Climate change, Ozone layer depletion. Sea level rise. International efforts for environmental protection. National Action Plan on Climate Change. National river conservation plan – Namami Gange and Yamuna Action Plan. Eutrophication and restoration of lakes.

Unit V

Environmental Awareness: Environmental education and awareness. Environmental ethics. Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam,

Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States. Climate change - adaptability, energy security, food security and sustainability.

Outcome:

This paper helps students to get in details with the current environmental issues and most importantly it provides them an ample amount of knowledge on Environmental Awareness and detailed analysis on various Case studies.

Reference Books:

- Anjaneyulu, Y. (2004). Introduction to Environmental Science. B. S. Publications.
- Barrett, E.C. (2013). Introduction to Environmental Remote Sensing. Routledge.
- Botkin, D.B. and Keller, E.A. (1995). Environmental Science Earth as a Living Planet, (9th Ed). Wileyplus.
- Chiras, D.D. (2001). Environmental Science, 6ed., Jones and Bartlett Publishers.
- Cunningham, W. and Cunningham, M.A. (2010). Principles of Environmental Science. McGraw-Hill Higher Education.
- Cunningham, W.P., Saigo, B.W. and Cunningham, M.A. (2001). Environmental Science: A Global Concern (Vol. 412). McGraw-Hill. Boston, MA
- Masters, G.M. and Ela, W.P. (1991). Introduction to Environmental Engineering and Science (Vol. 3). Englewood Cliffs, NJ: Prentice Hall.
- Wright. R.T, and Nebel. B. J. (2004). Environmental Science, 8thed. Prentice Hall India Ltd.

Free Elective Paper:

Paper ES-304(A): Environmental Microbiology and Climate Change 100 Marks/ 6 Credits

Objective:

The aim is to familiarize students to the various techniques and aspects of microbiology used in environmental science. It also focuses on Global Climate Change which is the most pressing concern of mankind at this point of time.

Unit I

Microbial nutrition and growth: nutritional requirements and classification, culture media, Isolation of microbes, purification & preservation, staining techniques for bacteria and fungi. Growth and measurement of microorganisms, generation time, factor affecting growth. Microbes in ecosystem and their importance, soil microflora and organic matter decomposition (composting, vermicomposting).

Unit II

Microbial toxins and bio-energy: Survey and classification of microbial toxins, Absorption, distribution and excretion of toxic agents, Major water borne diseases and air borne microbes,

faecal contamination of water, Microbiological and public health aspects of waste disposal. Biogas, bio-fuel and biosensors.

Unit III

Environmental biotechnology: Bioremediation – definition, types and role of plants and microbes for *in situ* and *ex situ* remediation. Bio-indicators and Bio-fertilizers. Air pollution and its biotechnological monitoring. Agro-biological effects of CO₂ fertilization on crops; Carbon sequestration. Aerobic and anaerobic treatment of waste water.

Unit IV

Microbial Degradation: Heavy metal contamination of environments, source and sinks of heavy metals. Soil micro-organisms and their functions: degradation of pesticides and synthetic fertilizers. Sanitary land filling and its management.

Unit V

Climate change: Global warming, greenhouse effect and Global Warming Potential (GWP), Emission of greenhouse gases (GHGs) and climate modeling; Global climate change - its history and future predictions. Impact of climate change on ecosystem and environment; Climate change and food security; Stratospheric ozone layer depletion and its health effect; mitigation strategies of climate change, global dimming, agrobiological effects of CO₂ fertilization on crops; Carbon sequestration and clean development mechanism.

Outcome:

This paper enlightened and trained students in the field of Environmental Microbiology and its usage in Practical. It also developed valuable knowledge on Global Climate Change.

Reference Books:

- Brown, K. (2015). Resilience, Development and Global Change. Routledge, London.
- Agarwal, B. (2010). Gender and Green Governance. Oxford and Delhi: Oxford University Press.
- Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2006). Principles of Genetics. John Wiley, 8th Edition.
- Mohapatra, P. K. (2006). Text Book of Environmental Biotechnology. I K International.
- Olguin, E., Sanchez, G. and Hernandez, E. (1999). Environmental Biotechnology and Cleaner Bioprocesses. Taylor & Francis, London.

Paper ES-304 (B): SWAYAM Course (any related to Environmental Science)

100 Marks/ 6 Credits

Practical

Paper- ES-305: Practical based on Paper-ES-301 and ES-302

100 Marks/ 6 Credits

SEMESTER- IV

CORE ELECTIVE PAPER (OPTIONAL): The student has to choose Paper ES-401 and ES-402 from any ONE of the following elective courses:

Elective A: Environmental Pollution and Management

Elective B: Environmental Biology

Elective C: Geo-informatics and Climate Change

ENVIRONMENTAL POLLUTION MONITORING-I

Paper ES-401 (A):

100 Marks/ 6 Credits

Objective:

The paper will deal with the monitoring devices and methods of environmental pollutants analysis and includes the guidelines for pollution control. It emphasises specifically on physico-chemical and ecological parameter analysis in Air, Water and Soil. It also points a special view over Marine and Thermal Pollution with a brief comprehension about Biodiversity and its Conservation.

Unit I

Water: Water chemistry and ecological aspects of Water Pollution. Physico-chemical and bacteriological sampling and analysis, water quality criteria and standards; health effects of Water Pollution; instrumental methods of analysis, for example, Titrimetry, Gravimetric, AAS, ICP-OES, HPLC, GC-MS etc., Water Pollution control and case study.

Unit II

Air: Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Dispersion of air pollutants. Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model. Measurement of noise indices and impact of noise and vibrations on human health.

Unit III

Soil: Physico-chemical, mineralogical and biological properties of soil. Soil organic matter. Micro-organisms of soil. Decomposition of organic matter in soil. Pollution and residual toxicity from the application of insecticides, fungicides, weedicides and synthetic fertilizers.

Unit IV

Thermal, Marine Pollution and Radioactive: Sources of Thermal Pollution, Heat Islands, causes and consequences. Sources and impact of Marine Pollution. Methods of Abatement of Marine Pollution. Coastal management. Radioactive pollution – sources, biological effects of ionizing radiations, radiation exposure and radiation standards, radiation protection.

Unit V

Biodiversity and its conservation: Definition, types, importance of biodiversity and threats to biodiversity. Concept and basis of identification of 'Hotspots'; hotspots in India. Measures of biodiversity. *in situ*, *ex situ* and *in vitro* conservation. National parks, Sanctuaries, Protected areas and Sacred groves in India. Concepts of gene pool, bio-piracy and bio-prospecting.

Outcome:

The paper provided an up-close and practical approach towards learning different methods of physicochemical and ecological parameters analysis of air, water and soil. It also helps students in understanding marine and thermal pollution in details. Furthermore it describes aspects of biodiversity conservation.

Reference Books:

- Holgate, S.T., Koren, H.S., Samet, J.M. and Maynard, R.L. eds. (1999). Air pollution and health. Elsevier.
- Kampa, M. and Castanas, E. (2008). Human health effects of air pollution. *Environmental Pollution*, 151: 362-367.
- McGranahan, G. and Murray, F. (2012). Air pollution and health in rapidly developing countries. Earthscan.
- Murray J.F. and Nadel. J.A. (2000). Text book of respiratory medicine, 3 rd ed., W.B. Saunders & Co.

INDUSTRIAL POLLUTION AND MANAGEMENT-II

Paper ES-402 (A):

100 Marks/ 6 Credits

Objective:

This paper introduces students to different treatment methods for air, water and soil pollutants. It focuses specifically on treatment methods for different types of industrial and mining pollutants.

Unit I

Waste water treatment: Preliminary; Primary (Sedimentation, Neutralisation, Coagulation/Flocculation etc.), Secondary treatment (Aerated lagoons, trickling filtration, activated sludge process, Oxidation pond, anaerobic digestion etc.) and Tertiary treatment (evaporation, reverse osmosis, dialysis, ion exchange, chemical precipitation, activated carbon treatment etc.). Water quality standards for drinking water and industrial effluents.

Unit II

Origin characteristics effects and treatment of the liquid effluents generated from the following industries, Sugar, Paper, textile, iron and steel tannery industries. Design and function of effluent treatment plant.

Unit III

Ambient air quality and permissible limit. Methods for control of air particulates: Settling chamber, Inertial separators, cyclones, bag-houses and electrostatic precipitators; gaseous pollutants: scrubbers, absorbers, combustion and thermal decomposition.

Unit IV

Origin, characteristics, effects and control of gaseous effluents generated from the following industries coal based thermal power plant, iron and steel, aluminium, paper, chemical manufactures, cement factories, fertilizer industries.

Unit V

Water, Air and Soil pollution due to mining activities. Reclamation of distributed land due to mining pollution control methods in mining areas. Management of over burdens. Characterisation of solid waste generated from industries, fly-ash, food processing waste, sugar industries waste (bagasse) and management.

Outcomes:

This paper develops the knowledge of industry specific treatment methods to maintain the environmental management system of the organization as a part of Environmental Impact Assessment.

Reference Books:

- Partdos, C.D., Ignatius, R. and Schneider, T. (2005). Topley and Wilson's microbiology and microbial infections. Oxford University Press.
- Park. J.E. and Park. K. (1994). Text book of preventive and social medicine, Banarsi Das & Bhanot, Jabalpur.
- Smith, K.R. (2013). Biofuels, air pollution, and health: a global review. Springer Science & Business Media.
- Bhatia S. C. (2008), Industrial Pollution Control and Management, CRC Press New Delhi.

FOREST ECOLOGY AND MODELING-I

Paper ES-401 (B):

100 Marks/ 6 Credits

Objective:

This paper deals with the understanding of the structure and functions of plant communities in natural and managed ecosystems. The course highlights the values of biodiversity and scientific approaches to conservation which only can lead to sustainable development and safeguard the interests of future generations.

Unit – I

Forest types and composition, primary production of forest ecosystem, Composition and structure of forest and their ecosystem, major biomes in World, major forest types in India: studies of forest diversity – methods of measurement of forest diversity, Forest depletion and its impact, Forest floor management, weed control.

Unit – II

Aforestation programs, Social forestry, Agro-forestry, Plantation Programs, silviculture principles, Forest management, Concept of Endangered species, Conservation of Forest biodiversity, Forest regeneration, Concept of overgrazing, forest litter degradation.

Unit – III

Forest policy in India, Forest policy on 1994 and 1952, National commission and agriculture, report in forestry, Indian Forest act 1927, Wildlife Protection Act 1972, Biological Diversity Act 2002, Wasteland Development Award.

Unit – IV

System concept in ecology, state variables and forcing functions. Modeling components, Mathematical tools for model building. Nature and types of models. Modeling of energy flow processes and matter transfer, modeling of nutrient flow in forest ecosystem (N and P model compartmental model for ecosystem analysis).

Unit – V

Approaches for ecological model building. Modeling procedure, data collection, conceptual models, model formulation, and analysis of model sensitivity, simulation and calibration. Model testing and validation, Model stability test, Determination of model complexity, Modeling constraints, Application of models as experimental tools.

Outcome:

This paper assists students in understanding structure, composition and function of different forest types and different forest policies in India. It also introduces students to basic aspects of Ecological Modeling.

Reference Books:

- Biju, S.D. and Bossuyt, F. (2003). New frog family from India reveals an ancient biogeographical link with the Seychelles. *Nature*, 425: 711-714.
- Daily, G.C., ed. (1997). *Nature's Services: Societal Dependence on Natural Ecosystems*. Island Press, Washington, D.C.
- Dobson, A.P. (1996). *Conservation and Biodiversity*. Scientific American Library, New York, NY.

- Groombridge, B., and M. Jenkins. (2000). *Global Biodiversity: Earth's Living Resources in the 21 st Century*. World Conservation Press, Cambridge, UK.
- IUCN. (2004). *Red list of threatened species. A global species assessment*. IUCN, Gland, Switzerland
- Loreau, M., and Inchausti, P. (2002). *Biodiversity and Ecosystem functioning: Synthesis and Perspectives*. Oxford University Press, Oxford, UK.
- Pandit, M.K. (2017). *Life in the Himalaya: An Ecosystem at Risk*. Harvard University Press.
- Primack, R.B. (2002). *Essentials of Conservation Biology*, 3 rd edn., Sinauer Associates, Sunderland, Ma. USA.
- Sodhi, N. S., Gibson, L., and Raven, P. H. (2013). *Conservation Biology: Voices from the Tropics*. John Wiley and Sons Ltd.: UK.
- Wilson, E. O. (1993). *Diversity of Life*. Harvard University Press, Cambridge, MA.
- Recknagal, F., (Ed.), (2003). *Ecological Informatics*. chapters I, II, III and IV. Springer, Germany.
- Refsgaard, J.C., van der Sluijs, J.P., Højberg, A.L. and Vanrolleghem, P.A. (2007). Uncertainty in the environmental modelling process—a framework and guidance. *Environmental Modelling & Software*, 22:1543-1556.

STRESS BIOLOGY AND TOXICOLOGY-II

Paper ES-402 (B):

100 Marks/ 6 Credits

Objective:

The course is aimed at providing comprehensive training in investigating the natural environment and to develop potential solutions to remedy its damage using chemical, biochemical and molecular technologies.

Unit – I

Environmental stresses and organismal responses to stress, Biological stress and strain. Concepts of Homeostasis. Stress injury and resistance. Classifications of injuries and resistance in general. General aspects of Toxicology. Properties of toxicants and fate of toxicants in the environment.

Unit – II

Temperature and Oxidative stress – Low and high temperature stresses. Light stress. Organismal response to chilling, freezing and high temperature stresses and molecular mechanisms of resistance. Heat shock proteins and their expressions. Oxidative stress.

Unit – III

Water, Salinity and Heavy metal stress – Drought and flooding stresses - nature of stress injuries and resistance. Osmotic stress. Osmoregulation. Salt stress – injury and resistance. Ion and heavy metal stress.

Unit – IV

Uptake and accumulation of toxic substances: patterns of uptake toxicities, analysis of dose effect relationship, acute, sub-acute and chronic toxicity tests. Statistical concept of toxicity. Experimental design for response analysis. Toxicity test systems (bacterial, algal, daphnia and fish test systems). Bioaccumulation and biomagnifications.

Unit – V

Toxic action of metals and Pesticides. Ecosystem response to toxicants. OSAR, chemical and biological degradation of pesticides. Sources of metal pollution, metal uptake, biological transformation of toxic metals, metal and pesticide tolerance. Phytoremediation of metal and pesticide pollution. Genetic aspects of toxin resistance.

Outcome:

This paper helps students to understand stress biology and toxic effects of metals and pesticides on plants in details.

Reference Books:

- Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2006). Principles of Genetics. John Wiley, 8th Edition.
- Mohapatra, P. K. (2006). Text Book of Environmental Biotechnology. I K International.
- Olguin, E., Sanchez, G. and Hernandez, E. (1999). Environmental Biotechnology and Cleaner Bioprocesses. Taylor & Francis, London.
- Rittman, B. E., and McCarty, P. L. (2001). Environmental Biotechnology. Principles and applications. McGraw-Hill, New York.
- Scragg, A. H. (2005). Environmental Biotechnology. Oxford University of Press.
- Wainwright, M. (1999). An introduction to environmental biotechnology. Springer Verlag, New York.

REMOTE SENSING AND GIS-I

Paper ES-401 (C):

100 Marks/ 6 Credits

Objective:

Remote sensing is a powerful tool to study landscapes. It involves extracting information from spectral images and then analyzes them to understand various earth surface features and processes. Geographic Information Systems (GIS) are spatial analysis software that forms an integral part of remote sensing application. Integrating remote sensing and GIS, the course aims to offer knowledge base for geo-spatial analysis of various elements.

Unit-I

Remote Sensing over Traditional methods of resource survey, components of remote sensing, System-Electromagnetic radiation (EMR) and their interaction with vegetation, soil, water,

minerals and rocks. Fundamental properties of sensors and their functions. climate dynamics: *El Nino, La Nina*, ENSO, Indian Monsoon, IOD etc.

Unit-II

Basic features of different types of sensors- Active (LASER, LIDAR, RADAR & Scatterometer) & Passive sensors (Radiometer, Sounder, Spectrometer). Principles of satellite Remote sensing, data acquisition, Remote Sensing Data Products, Monochromatic and FCC images, interpretation of Satellite images, influence of atmosphere on remote sensing.

Unit-III

Geographical Information System (GIS), Concept, definition & components. Spatial data and its analysis, Map type, Map Scale, Map Projection, Geo-referencing, Digitization, Ground Control Point (GCP), vector and raster data, Basic analysis using GIS tools, Spatial and 3D analysis, Digital Terrain Modeling, application of GIS in environmental analysis and management.

Unit-IV

Satellite navigation system concept, principle, Trilateration, Data acquisition and processing, Indian navigation satellite system, GPS satellites, Image rectification and classification.

Unit-V

Application and benefits of remote sensing in different fields, biodiversity, coastal zones, flood management, forest/natural resource management, ground water prevention, disaster. Current role of geo-informatics on environment and climate change science.

Outcome:

This paper provides students a practical approach to not only understands but also to use Remote Sensing and GIS technology for various types of monitoring.

Reference Books:

- Introduction to Environmental remote sensing - Curtis
- Principles of Remote sensing - Lily and kliffer.
- Remote sensing of the Environment – Jenson
- Remote Sensing and Image Interpretation by T.M. Lillesand and R.W. Kiefer John Wiley & Sons, Inc., New York
- Introduction to Remote Sensing by James B. Cambell Taylor & Francis
- Principles of Geographical Information System for Land Resource Assessment by P.A. Burrough Oxford University Press

METEOROLOGY AND CLIMATE CHANGE-II

Paper ES-401 (B):

100 Marks/ 6 Credits

Objective:

This paper introduces the student to the development of the Earth's atmosphere, its dynamic nature and variability in terms of the global energy balance. It also deals with elements of the climate, climate change and human impacts on climate initiative policies.

Unit-I

Atmosphere and its structure, Weather and Climate, Weather parameters, temperature and radiation, Seasonal and Daily temperature, Heat Transfer in the Atmosphere, Atmospheric Stability, Radiation and Temperature, and its interaction with earth and atmosphere, Earth-Atmosphere Energy Balance.

Unit-II

General Circulation of the atmosphere: Single/three cell model, Global precipitation/pressure/temperature pattern, Global Wind Patterns and Surface Ocean Currents.

Unit-III

Local Wind Systems, Thermal Circulations, Sea and Land Breezes, El Niño, La Nina, El Niño and the Southern Oscillation (ENSO), IOD, Cyclone and its genesis, Thunderstorms, Hurricanes, tornado, typhoon, Indian Monsoon and modulating factors,

Unit-IV

Emission of greenhouse gases (GHGs) and its role in climate change, anthropogenic and natural sources of emission in India, National GHGs Emission Inventory, Urban Air quality and Climate modeling

Unit-V

Climate Change: Causes of climate change, Climate change signal, Global warming, Introduction to climate modeling; climatology of global weather data. Impact of climate change on ecosystem, environment, health and food security; global dimming, carbon footprint and carbon trading, National Action Plan on Climate Change.

Outcome:

This paper helps students to understand meteorology and its impact on Global Climate Change in details. It also provides opportunity to study about various emerging threats in the field of Climate Change.

Reference Books:

- Environmental geology- Edward A. Keller
- Physical geology - C.W. Montgomery.
- Geology of India - National book trust series.
- Barry, R. G. (2003). Atmosphere, weather and climate. Routledge Press, UK
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DISSERTATION-CUM-SEMINAR

Paper ES-403

200 Marks/ 12 Credits

Semester IV (Elective A: Environmental Pollution and Management, Elective B: Environmental Biology, Elective C: Geo-informatics and Climate Change). This paper comprises of dissertation submission and presentation carrying 100 marks/6 credits each. *The detailed guidelines for dissertation preparation is given in Annex-I.*

SEMINAR PRESENTATION

Paper ES-404

100 Marks/ 6 Credits

Semester IV (The presentation is based on the selected elective paper (one) i.e. Elective A: Environmental Pollution and Management, Elective B: Environmental Biology, Elective C: Geoinformatics and Climate Change).

Reference Books:

- 1 Environmental Biology and Toxicology by P.D. Shrama Rastogi Publication
- 2 Essentials of Toxicology by Cassert and Doull Mc Graw Hill
- 3 Elements of Ecology by Thomas M. Smith & Robert leo Smith Pearson
- 4 Ecology- theories and application by Peter D Stilling Pearson
- 5 Environmental Chemistry by B.K. Shrama Krishan Prakashan
- 6 Physical Geography by D.S. Lal Sardar Pustak bhavan
- 7 Climatology by Sarbinder Singh Pravalika Publication
- 8 Fundamentals of Computer by V. Rajaraman & Niharika Adasala
- 9 Water Pollution by P.K.Goel U.P., India
- 10 Basic Statics by P.K. Mohanty Scientific Publisher
- 11 Environmental Law by Dr. S.C.Tripathy Central Law publication
- 12 Text book of Environmental Microbiology by P.K.Mohapatra I.K International
- 13 Environmental Impact Assesment by M.Anji.Reddy BS Publication
- 14 The complete guideon industrial pollution control H. Panda AB Publisher
- 15 Handbook of Solid waste Management by G. TCHOBANOGLOUS Mc Graw Hill
- 16 GIS tutorial for Arc GIS 10.1 Wilpen L.Gorr ,Kristen

Annexure-I

GUIDELINES FOR DISSERTATION/THESIS PREPARATION

M.Sc. Environmental Science, Utkal University

Preamble: This document, herein after referred to as the Thesis Guide, lists the general and specific requirements governing thesis preparation including guidelines for structuring the contents. For style, structure and presentation of the thesis, students may refer to additional style manuals or reference guides (some of which are listed below) and to the published literature in their respective field of study.

- I. MLA Style Manual and Guide to Scholarly Publishing. 3rd ed. New York: Modern Language Association, 2008.
- II. Booth, W.C., Colomb, G.G. and Williams, J.M. The Craft of Research. Chicago: The University of Chicago Press, 2003.
- III. Publication Manual of the American Psychological Association. 6th ed. Washington, DC: APA, 2009.

Thesis Submission: To have the thesis examined, the number of thesis copies to be submitted to the Office should correspond to (a) the number of examiners (including thesis supervisors) and (b) one seminar library copy for M.Sc. degree student.

1. Statement of Thesis Preparation

1. Thesis title:
2. Degree for which the thesis is submitted:
- 3 Thesis Guide was referred to for preparing the thesis.
4. Specifications regarding thesis format have been closely followed.
5. The contents of the thesis have been organized based on the guidelines.
6. The thesis has been prepared without resorting to plagiarism.
7. All sources used have been cited appropriately.
- 8 The thesis has not been submitted elsewhere for a degree.

(Signature of the student)

Name: Roll No.:

Department/IDP:

2. SPECIFICATIONS FOR THESIS FORMAT

2.1 Preparation of Manuscript and Copies

2.1.1 The thesis needs to be prepared using a standard text processing software and must be printed in black text (color for images, if necessary) using a laser printer or letter quality printer in standard typeface (Times New Roman or Arial). 2.1.2 All copies of thesis pages must be clear, sharp and even, with uniform size and uniformly spaced characters, lines and margins on every page of good quality white paper of 70 gsm or more. 2.1.3 Thesis should be free from typographical errors.

2.2 Size and Margins

2.2.1 A4 is the recommended thesis size. 2.2.2 The top, bottom and right side margins should be 25 mm, whereas the left side margin should be 35 mm for both textual and non-textual (e.g., figures, tables) pages. 2.2.3 Content should not extend beyond the bottom margin except for completing a footnote, last line of chapter/subdivision, or figure/table caption. 2.2.4 A sub-head at the bottom of the page should have at least two full lines of content below it. If the sub-head is too short to allow this, it should begin on the next page. 2.2.5 All tables and figures should conform to the same requirements as text. Color may be used for figures. If tables and figures are large, they may be reduced to the standard size (provided the reduced area is not less than 50% of the original) and /or folded just once to flush with the thesis margin (if the page size does not exceed 250x360 mm). 2.2.6 Students should also submit the thesis in soft form (PDF) for storage and archival.

2.3 Page Numbering

2.3.1 Beginning with the first page of the text in the thesis (chapter 1), all pages should be numbered consecutively and consistently in Arabic numerals through the appendices. 2.3.2 Page numbers prior to Chapter 1 should be in lower case Roman numerals.

2.4 Line Spacing

The general text of the manuscript should be in double spacing (3 lines per inch). Long tables, quotations, footnotes, multi-line captions and bibliographic entries (references) should be in single spacing (6 lines per inch), with text size in 11 points.

2.5 Tables, Figures and Equations

2.5.1 All tables (tabulated data) and figures (charts, graphs, maps, images, diagrams, etc.) should be prepared, wherever possible, on the same paper used to type the text and conform to the specifications outlined earlier. They should be inserted as close to the textual reference as possible. 2.5.2 Tables, figures and equations should be numbered sequentially either throughout the thesis or chapter-wise using Arabic numerals. They are referred to in the body of the text capitalizing the first letter of the word and number, as for instance, Table 17, Figure 24, Equation (33), or Table 5.3, Figure 3.11, Equation (4.16), etc. 2.5.3 Images, Photographs, etc. must be scanned in resolution exceeding 200dpi with 256 grayscales for the monochrome images and 24 bit per pixel for the color images.

2.6 Binding

The student should submit the copies of the thesis in fully bound form (soft cover, coiled wire binding, clamping, or filing) for M.Sc. dissertation. Once the thesis is accepted, it is the student's responsibility to get it properly bound before depositing the required number of copies with the Seminar Library of the Department concerned.

3. GUIDELINES FOR STRUCTURING CONTENTS

Sequence of Contents

The following sequence for the thesis organization should be followed:

- (i) Preliminaries
 - Title Page
 - Thesis Abstract/Synopsis
 - Guide Acknowledgement and/ or Dedication (where included)
 - Table of Contents List of Figures, Tables, Illustrations, Symbols, etc (wherever applicable)
- (ii) Text of Thesis
 - Introduction
 - Review of Literature
 - Materials and Methodology
 - Result
 - Discussion
 - Summary and conclusions
- (iii) Reference Material List of References, Bibliography (where included)
- (iv) Appendices where included
- (v) Index where included All the headings are centered (without punctuation) 25mm down the top edge of the page.

4. Reference Format

Journals

H.E. Exner, "Physical and Chemical Nature of Cemented Carbides," *International Metals Review*, 1979, v. 24, pp. 149-173. G.E. Spriggs, "The Importance of Atmosphere Control in Hard Metal Production," *Powder Metallurgy*, 1970, v. 13, n. 26, pp. 369-393.

Conference Proceedings

H.F. Fischmeister, "Development and Present Status of the Science and Technology of Hard Materials," *Science of Hard Materials*, R.K. Viswanadham, D.J. Rowcliffe, and J. Gurland (eds.), Plenum Press, New York, NY, USA, 1982, pp. 1-45. W.H. Baek, M.H. Hong, S. Lee, and D.T. Chung, "A Study on the Shear Localization Behavior of Tungsten Heavy Alloy," *Tungsten and Refractory Metals 2*, A. Bose and R.J. Dowding (eds.), Metal Powder Industries Federation, Princeton, NJ, USA, 1995, pp. 463-471.

Books

R.M. German, *Powder Injection Molding*, Metal Powder Industries Federation, Princeton, NJ, USA, 1990. Thesis J.L. Johnson, "Densification, Microstructural Evolution, and Thermal Properties of Liquid Phase Sintered Composites,"

Ph.D. Thesis

The Pennsylvania State University, University Park, PA, USA, 1994. Technical Reports E.G. Zukas, P.S.Z. Rogers, and R.S. Rogers, “Experimental Evidence for Spheroid Growth Mechanisms in the Liquid Phase Sintered Tungsten Based Composites,”

Informal Report

Los Alamos Scientific laboratory, USA, 1976, pp. 1-35. Patents V. Oenning and I. S. R. Clark, U. S. Patent No. 4988386, 1991.

Journals in Non-English Language

L. Weihong and T. Xiuren, “Tungsten Matrix in Cu-W Contact Materials by Impregnation Process,” Powder Metallurgy Technology, 1988, v. 6, n. 8, pp. 1-4. (in Chinese).

4. CONCLUDING REMARKS

This Thesis Guide lists only the basic requirements for preparing the thesis. Over and above the aforementioned points, a thesis should be reader-friendly in both its appearance and presentation. Several aspects of thesis preparation, particularly style of writing and presentation, have not been discussed in great detail. The student should follow appropriate ideas from standard literature of his/ her area of research, and adopt a uniform style and format throughout the thesis, such as in the structural divisions/subdivisions of the thesis, in the mode of citing references and footnotes in the text, in using dimensions, units and notations, and in preparing tables and figures, etc.