NEP 2020 & CHOICE BASEED CREDIT SYSTEM (CBCS)

SYLLABUS FOR THE
MASTER OF SCIENCE

IN

ENVIRONMENTAL SCIENCE

DEPARTMENT OF ZOOLOGY

FACULTY OF SCIENCE
DEEN DAYAL UPADHYAYA, GORAKHPUR UNIVERSITY,
GORAKHPUR-273009
2024

Semester Courses of M.Sc. Environmental Science Based on CBCS

Programme Specific Outcomes of Environmental Science

1. To develop environmental scientists and engineers and sensitize them towards environmental issues.
2. To acquire analytical skills in assessing environmental impacts through a multidisciplinary approach.
3. To identify environmental problems and solutions through organized research.
4. To improve the communication and writing skill so as to face the competitive world.
5. To impart students with strong knowledge base through theory courses and sessional that makes them suitable for industries, academics, research and consultancies.
6. To develop students analytical, computational and research skills through assignments, weekly presentations and modeling software.
7. To train the students on developing practical, efficient and cost effective solutions on problems and challenges on environmental sciences.
8. To inculcate among students sensitivity towards social and corporate responsibilities.

DEPARTMENT OF ZOOLOGY
DDU GORAKHPUR UNIVERSITY
GORAKHPUR

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PROGRAME: M.SC ENVIRONMENTAL SCIENCES

YEAR	SEMESTER	COURSE CODE	COURSE TITLE	C/O	CREDIT	SEMESTER CREDIT
1.	I	EVS -501 N	Fundamentals of Ecology	C	4+0	20
		EVS -502 N	Wild Life Biology	C	4+0	
		EVS -503 N	Environmental Chemistry	C	4+0	
		EVS -504 N	Tool and Techniques in Environmental Science	C	4+0	
		EVS -505 N	Practical based on EVS501, EVS502, EVS503 & EVS504	C	0+4	
	II	EVS-506 N	Environmental Pollution & Monitoring	C	4+0	24
		EVS-507 N	Environmental Impact Assessment	C	4+0	
		EVS-508 N	Current Socio-Environmental Aspects	C	4+0	
		EVS-509 N	Environmental Microbiology	C	4+0	
		EVS-510 N	Practical based on EVS507, EVS508, EVS509 & EVS510	C	0+4	
		EVS-511 N	Open elective interdisciplinary* Waste Management and Environmental Protection	E	4+0	
2.	III	EVS-512 N	Eco-Biotechnology and Remote Sensing	C	4+0	24
		EVS-513 N	Computational Biology and Biostatistics	C	4+0	
		Discipline Specific Elective I (Any One)				
		EVS -514 N	Natural Resource, Conservation and Management	E	4+0	
		EVS-515N	Technology, Environment and Society	E	4+0	
		EVS-516N	Atmosphere and Global Climate Change	E	4+0	
		Discipline Specific Elective II (Any One)			E	
		EVS-517N	Environmental Communication and Education	E	4+0	
		EVS-518N	Culture and Environment	E	4+0	
		EVS-519N	Biodiversity and Conservation Biology	E	4+0	
		EVS-520N	Practical based on EVS513, EVS514, DSEI & DSEII	C	0+4	
		EVS-521N	Industrial Training/Survey/research Project	C	0+4	
	IV	EVS-522N	Environmental Ethics and Philosophy	C	4+0	24
		EVS-523N	Disaster Management	C	4+0	

		EVS-524N	Environmental Economics, Policies and Law	C	4+0	
		EVS-525N	Environmental Monitoring and Toxicology	C	4+0	
		EVS-526N	Practical based on EVS523, EVS524, EVS525 & EVS526	C	0+4	
		EVS-527N	Industrial Training/Survey/research Project	C	0+4	

Open MINOR ELECTIVE to be studied in either in Semester I or in Semester II C denotes for compulsory, E -elective

Open Minor Elective Courses

YEAR	SEMESTER	COURSE CODE	COURSE TITLE	CREDIT	SEMESTER CREDIT
1	II	EVS-511N	Waste Management and Environmental Protection	4+0	4

EVS-501N: Fundamentals of Ecology **Credit:4+0**

Unit-1 Environment: meaning definition and environmental perception in Vedic literature (Air, Fire, Earth, Water, Sun in Vedas); environmental ethics and global imperatives; environmental factors: abiotic, medium, substratum, soil, water and humidity, light, temperature, current and pressure, atmospheric gases (O_2,CO_2,N_2), pH, nutrients and their importance and their role.

Unit-2 Climate of India and Indian monsoons; structure and composition of atmosphere, hydrosphere, lithosphere and biosphere; terrestrial and aquatic (freshwater and marine) habitat and atmospheric biotic factors; population and community ecology; parasitism and prey-predator relationship.

Unit-3 Ecosystem definition: types, structural components of ecosystem (Pond ecosystem) viz. autotrophs and heterotrophs i.e., producers and consumers, decomposers and transformers; ecological pyramids on number, biome and energy; concept of productivity and standing crops ecotone, ecotype: ecological indicators, edge effect.

Unit-4 Ecological succession: Zoo-geographical classification of earth, mass and energy transfer, access to various interfaces; material balance; first and second law of thermodynamics: heat transfer process

Suggested literature:

1. Field sampling: principles and practices in environmental analysis, Conklin; A.R.jr., (2004), CRC press.
2. Principles and standards for measuring primary production, Fahey, T.J. and Knapp, A.K., (2007), Oxford University Press, U.K
3. Ecological modelling, grant, W.E. and swan neck, T.M., (2008) Blackwell.
4. Fundament process in ecology: An Earth system approach Wilkinson, D.M., (2007),), Oxford University Press, U.K
5. Fundamentals of Ecology, E.P. Odum.

Course Outcomes:

- Demonstrate structures, features, and processes related to Ecosystem.
- Identify items and their related functions on diagrams, State hypotheses and theories related to Ecology.
- By the end of the course the students will be able to explain aspects, theories, and processes relevant to ecology, compare different structures and features related to ecosystems and interpret experimental data and apply in relevant situations

EVS-502 N: Wildlife Biology **Credit: 4+0**

Unit-1 Value of Wildlife, field observation, study of sin and symptoms, footprints; locomotory patterns in tetrapod; types of movement; tiger pug marks, footprints of other animals, feeding sign, animal dropping, wildlife photography.

Unit-2 Wildlife Census Method (water hole survey point count and line transect methods, pug mark count methods, kings census method); major wildlife habitat biomes, tropical and temperate habitat; components of wildlife habitat (cover, food, water, space) common flora and fauna of India.

Unit-3 Socio biology of wild animals, terrestrial behaviour, migratory behaviour, breeding behaviour, visual, acoustic and olfactory communication and their socio biological importance; India wildlife (introduction, distribution of wildlife in ecological sub division of India); IUCN categories, cinctures, biosphere, reserves, national parks, sanctuaries and zoos in India; gene -pool, habit, habitat and breeding biology of a representative wildlife and weaverbird.

Unit-4 Reasons for wildlife depletion (habitat, distribution, commercial wildlife exploitation, overgrazing etc); wildlife ecotourism management, measures for wildlife conservation (policies and programme); special projects for endangered species (project Tiger, Gir Lion Sanctuary, project, crocodile breeding project, project Hangul).

Suggested literature

1. Wildlife ecology, A.N. Mohen.
2. Wildlife ecology and management, E.G. Balen
3. Indian wildlife, Ramesh Bedi
4. Wildlife management, Rajesh Gopal.

Course Outcomes: Student will be able

- To understand quantitative approaches and technologies involved in research.
- To identify diversity of fauna on earth and implement conservation measures to save diversity.
- To understand importance of wildlife and conservation measures, National parks and Sanctuaries.
- Analyse biological data mathematically and statistically.

EVS-503N: Environmental Chemistry **Credit:4+0**

Unit-1 Fundamentals of environmental chemistry: stereochemistry, Gibbs energy, chemical potential, chemical equilibrium, acid base reaction, solubility product, solubility of gases in water, carbonate system, unsaturated and saturated hydrocarbon, radio-nuclides.

Unit-2 Chemical components of air: Classification of elements, chemical speciation of particles ions and radicals in the atmosphere, chemical processes for information of inorganic and organic particulate matter, thermo chemical and photo chemical reaction in the atmosphere, oxygen and ozone chemistry of air pollutants, photochemical smog.

Unit-3 Water chemistry: Chemistry of water concepts of D.O., BOD and COD. Sedimentation, coagulation, filtration in water purification, Redox potential, Soil chemistry, Inorganic and organic components of nitrogen pathways, NPK in soils.

Unit-4 Toxicology: Introduction, Basic concept of toxicology, Toxicants of health hazards (Lead, Mercury, Cadmium, Arsenic, Vanadium, Cyanide, Cobalt, Iron), Xenobiotics, (absorption, transport and execution of chemicals), Biological magnification, Biomonitoring of toxic chemicals, Bioindicators.

Suggested literature

1. Environmental chemistry, Ian Williams
2. Environmental chemistry, Colin Baird. M. Cann
3. Environmental chemistry, F. Helmet
4. An introduction to environmental chemistry, J.E. Andrews
5. An introduction to environmental chemistry, Andrews et al.
6. Chemistry of the environment, T.G. Spiro, W.M. Stigliani

Course Outcomes: Student will be able to:

- Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
- Recognize different types of toxic substances & responses and analyze toxicological information.
- Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil).
- Describe water purification and waste treatment processes and the practical chemistry involved.
- Describe causes and effects of environmental pollution by energy industry and discuss some mitigation strategies.

EVS-504N: Tools and Techniques in Environmental Science **Credit:4+0**

Unit-1 Principles of analytical methods: Titrimetry, Gravimetry, Colorimetry, Spectrophotometry, Spectrophotoflurometry

Unit-2 Microbial technique: Media preparation and Sterilization, Inoculation and Growth Monitoring, Use of microbes in Fermentation, Microbial Assays.
Basic principle and uses of fluorescence, basic principles of light and electron microscope, x-ray diffraction, lyophilization.

Unit-3 Separation and Identification of Bio-molecules by Chromatography: Paper and thin layer Chromatography, Gel exclusion Chromatography, High performance Liquid Chromatography (HPLC), Affinity Chromatography.

Unit-4 Electrophoresis techniques: General principles, Support media; Electrophoresis of proteins and nucleic acid; Capillary Electrophoresis, Principles of Differential and Density centrifugation Differential centrifugation.

Suggested literature

1. Essential laboratory techniques, S.R Gallagher. E.A Wiley
2. An introduction to practical biochemistry, D.T Plummer
3. Techniques in life sciences, D.B. Tembhare
4. Modern experimental biochemistry, R.F. Boyer.
5. Principles and techniques of biochemistry and molecular biology, K. Wilson, Walker

Course Outcomes: Student will learn to:

- Explain Microscopy, Colorimetry, Chromatography principle, process, applications and working of related instruments.
- Demonstrate Microbiological, Cytological, Histological, Molecular biological techniques. Apply and demonstrate Surgical Immuno-detection and Cell culture techniques.
- Understand Radioisotope and Isotope techniques and applications of all the techniques in biology.

EVS-505N: Practical based on EVS501, EVS502, EVS503 & EVS504 Credit:0+4

Time: 8 hours

Exercise on environmental chemistry
Techniques and instrumentation
Wildlife exercise
Ecological exercise
Spotting (10 spots) on ecological specimens and instruments
Viva- voice
Total marks

1. Study of different structural adaptations to ecological conditions
2. Measurements of physico-chemical Eco factors: temperature, pH, turbidity and light intensity in freshwater samples.
3. Study of seasonal variation in plankton population.
4. Demonstration of Parallaxvision and height perception.
5. Analysis of plant community and biodiversity and biomass.
6. Study of different structure adaptation to ecological conditions.
7. Study of seasonal variation in plankton population both qualitative and quantitative.
8. Study of wildlife of local and suburban areas and submission of the report.
9. Study on wild life in adjoining area with biodiversity of wild flora & fauna.
10. Study on wild animals and their behaviour
11. Comparison of dissolve oxygen (D.O) in water samples from different sources.
12. Determination of the chloride demand and chloride residue.
13. Estimation of chemical oxygen demand.
14. Estimation of biological oxygen demand.
15. Estimation of free carbon dioxide demand.
16. Estimation of chloride concentration.
17. Determination of turbidity.
18. Estimation of pH
19. Determination of temperature, colour, odour.
20. Determination of conductivity.
21. Determination of total solids in water samples.
22. Determination of alkalinity
23. Determination of total kjedol nitrogen and sulphate.
24. Demonstration of basic principle of paper/thin layer, column chromatography, principle of microtomy, spectrophotometry,Atomic absorption, flame photometry, gas chromatography (GLC), high liquid performance chromatography (HPLC) and centrifugation.

EVS-506N: Environmental pollution and monitoring **Credit: 4+0**

Unit-1 Air pollution: sources of air pollutants (natural sources and man-made sources), types of air pollutants: primary pollutants- aerosols, gaseous particulate, metallic, pesticides, biological contamination, carcinogens and radio-active pollutants, secondary pollutants-photochemical smog, effect of air pollutants (biological, physical and economical) and their control. Factors affecting air pollution: wind, temperature, height, precipitation, topography, turbulent diffusion, separated flows and plume behavior. Global warming, Greenhouse effect, ozone depletion, acid rains, El-Nino and La-Nino Effect, and Bhopal gas tragedy.

Unit-2 Water pollution: types: ground water, surface water, lake water, river water and marine water. Sources of water pollution: sewage, domestic wastes, agriculture waste, chemical fertilizers, industrial effluents, detergents, toxic metals, siltation, thermal pollutants and radio- active materials. Eutrophication, effects of water pollutants and their control.

Unit-3 Terrestrial pollution: sources of industrial waste, municipality and urban waste, radio- active substances, biomedical waste. Agricultural practices, chemical and metallic pollutants, sedimentation, biological agents, effect of terrestrial pollutants on soil, bio-indicators of terrestrial pollution.

Unit-4 Radio-active pollution: introduction, types of radiation (ionizing and non-ionizing), sources of radiation (natural sources and anthropogenic sources), biological effects of radiation. Noise pollution: sources of noise (industrial, transport, neighborhood). Noise exposure levels (standards), effects of noise pollution and its control.

Suggested literature

1. Toxicology, Earnest Hodgson.
2. Environmental pollution and management, G.R. Pathade, P.K. Goel.
3. Pollution, A.D. Stern
4. Pollutants and their determination, Gryson
5. Assessment and Management of Carbon, Nitrogen and Sulphur, P.A. Debarry.

Course Outcomes: The course will:

- Inculcate knowledge on the types, sources, effects and control of environmental pollution on human health.
- Enhance analytical ability to link cause and effect of pollution Critical issues of handling pollution vis a vis human beings.
- Develop ability to come up with mitigation/abetment strategies against pollution.

EVS-507N: Environmental Impact Assessment **Credit:4+0**

Unit-1 Environmental impact assessment: introduction, aims, objectives, constraints in EIA, environmental assessment process (impact prediction, evaluation, mitigation and monitoring).

Unit-2 Environmental impact statement (EIS): methods of impact analysis (checklist, overlays, matrix, models, comparative studies), environmental items in Leopold's identification matrix, question for impact identification, impact, interpretation, impact communication, impact statement**.**

Unit-3 Prediction, evaluation, assessment and monitoring of impact of different developmental activities on the air, water, cultural and socio-economic environment.

Unit-4 Effects of urbanization, socio-economic and environmental impacts of tourism, impact of coal mining, impacts of hydro-electric development, impact of fly-ash, impact of sewage and other effluents, impact of leather tanning, impact of green revolution.

Suggested literature

1. Environmental Impact Assessment and management, H Osetti
2. Environmental Impact Assessment, L.W. Canter
3. Environmental Impact Assessment for wetland protection, K. Kaul
4. Environmental Impact Assessment, Lawrence.

Course Outcomes: Student will be able to:

- Explain the environment and its natural, and socio-economic and cultural components, and its temporal and spatial dimensions.
- Comprehensively understand of the origin and development of EIA and the developments in India.
- Appreciate the EIA process.
- Define impact and identify, and predict impacts.
- Understand the Indian EIA process and clearance regime and functional knowledge of environmental management plan (EMP), and environmental audit.

EVS-508N: Current Socio Environmental Aspects **Credits: 4+0**

Unit-1 Evolution, origin of life and speciation, Human ecology, its components, values, rising needs for fuel, food and energy, Effects of developmental activities on society, culture, human health and economy. Eco marks for labeling of eco-friendly products.

Unit-2 Environmental education and awareness, concept of sustainable development and its implementation, Human settlement schemes, Urban and Rural Planning in India, and land use pattern.

Unit-3 Current environmental issues in India: Effects of Narmada dam, Tehri dam, Almatti Dam construction on local people, rehabilitation of people and restoration of local ecology. Soil erosion, alkaline and saline soils, Waste lands and reclamation of Usar land

Unit-4 Desertification, causes and its control; waste: types, disposal and recycling of waste and power generation, and fly-ash utilization. Wet lands and its conservation, water crisis and conservation of water rain water harvesting, coastal management.

Suggested literature

1. Environment and society, Fransic Moori
2. Environmental sociology, I. Sundar, P.K. Muthu Kumar
3. Socio-economic aspects, A. Kumar

Course Outcomes: The course will make student:

- Understand core concepts and methods from ecological and physical sciences and their application in environmental problem-solving.
- Appreciate key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
- Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.

EVS-509N: Environmental Microbiology **Credit: 4+0**

Unit-1 Soil microbiology: introduction, microorganisms in soil, role of microbes in biogeochemical cycles, Oxygen, Nitrogen, Carbon, Nitrogen, Sulphur and Phosphorus.

Unit-2 Air microbiology: introduction, microorganism in air, aquatic microbiology; introduction, microorganisms in water, role of microbe in natural water, water quality: water purification (assessment by microbes).

Unit-3 Microorganisms and diseases: epidemiology, (introduction, factors affecting epidemiology, modes of transmission, control of communicable diseases); air borne diseases (tuberculosis, meningitis, chicken pox).

Unit-4 Soil borne diseases (tetanus and gas-gangrene); water and food borne disease (Cholera, Typhoid, Amoebiasis, Giardiasis and Hepatitis), epidemiology issues: role of microbes in oil-pollution control and chemical pollution control.

Suggested literature

1. Microbiology, Abraham I. Braude
2. Principles of microbiology, R.M. Atlas
3. Soil microbiology, Tate
4. Diagnostic of microbiology, A.S. Weissfield
5. Environmental microbiology, Raina M. *Maier*, Ian L. *Pepper* and Charles P. *Gerba*
6. Microbiology of water borne diseases, Steven L. Percival, Rachel M. Chalmers, Martha *Embrey*, Paul R. *Hunter*, Jane *Sellwood*, Peter *Wyn-Jones*

Course Outcomes: This course will help student to:

- Apply knowledge of the biology and distribution of certain species of microorganisms, principally bacteria, in order to use them as bio-indicators of contamination and other environmental impacts.
- Apply the metabolic processes of microorganisms, principally bacteria, to industrial processes related to the environment. Develop analysis and synthesis skills.
- Obtain information, design experiments and interpret results.
- Recognise and use the properties of microorganisms, principally bacteria, to remedy problems of contamination and other environmental impacts.

EVS-510N: Practical based on EVS-506N, EVS-507N, EVS-509N & EVS-509N **Credit: 0+4**

Exercise on environmental pollution
Microbiology exercise
Environmental impact assessment exercise
Exercise on current socio-economic aspects
Viva- voice
Total marks

1. Determination of gas pollution in different localities of the city.
2. Measurement of noise pollution in different areas of city
3. Demonstration of vectors of different diseases.
4. Measurement of humidity by hair hygrometer.
5. Measurement of temperature by Max. Min thermometer
6. Study on environmental awareness in different group of society.
7. Effect of certain common toxicant on the acetylcholinesterase activity in the nervous tissues of fish.
8. Epidemiology study of certain common microbial diseases in local area.
9. Isolation and enumeration of microorganisms from soil/water.
10. Demonstration of bacterial microflora present in soil/water/food smear by gram stain reaction.
11. Isolation of genomic DNA from bacterial culture.
12. Quantification and purity checking of DNA isolated from samples by UV Spectrophotometer.
13. Study of selected pollutants such as Ammonia, Mercuric Chloride and Malathion on the behaviour of animals.
14. Study the physical characteristics of soil (temperature, texture, colour) and moisture content
15. Measure the common pollutants as oil/ gas and fluoride in water samples.

Open Minor Elective Courses

EVS-511: Waste Management and Environmental Protection Credit:4+0

Unit I- Solid Waste: Types and sources, municipal (e.g., residential, institutional, and commercial), agricultural and special (e.g., construction and demolition, household hazardous, sewage sludge, and non-hazardous industrial) wastes. Solid waste characterization, components minimization, collection, separation, transportation (container systems -hauled and stationary), treatment**,** and disposal. Generation rates, proximate and ultimate analyses of solid wastes.

Unit II- Solid waste processing and recovery: Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermin-composting, bio-methanation of solid waste.

Unit III- Disposal of solid wastes: Sanitary land filling and its management, incineration of solid waste. Hazardous waste: Types, characteristics and health impacts. Hazardous waste management methods: neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal

Unit IV- E-waste: classification, methods of handling and disposal, Fly ash: sources, composition and utilization. Plastic waste: sources, consequences and management.

Suggested Readings:

1. Solid *Wastes Management* by Stephen Burnley.
2. Sustainable Solid *Waste Management* by Ni-Bin Chang
3. Food and Agricultural Wastewater Utilization and *Treatment* by Sean X. Liu.

Course Outcomes:

This course will help students to come up with ability to classify waste and plan its management in eco-friendly way. This will also help them to spread awareness and come up with new research proposals.

EVS-512N:Ecobiotechnology and Remote Sensing **Credit: 4+0**
Theory

Unit-1 Vermiculture Biotechnology waste management: introduction ecology and distribution of earthworm and species of earthworms for vermicomposting, vermiculture and vermicomposting methods, Chemical composition of waste based vermicompost. Economies of vermiculture and vermicomposting, , *in situ* application of vermiculture and crop productivity, use of earthworm in land improvement and reclamation

Unit-2 Biological waste and aquaculture: Generation of wastes, Recycling and conservation measures, Bio-fertilizers from waste products, use of micro algae, Intensive aquaculture (Integrated fish farming system and sewage fed fish cultures), Use of sludge, Biogas slurry and livestock waste in vermicomposting, application in aquaculture: bio-fertilizer technology: introduction, Rhizobium culture, green algae culture, Azolla culture, and mycorrhiza culture. Use of bio-fertilizers in agriculture, fermentation technology.

Unit-3 Principles of remote sensing, energy sources and radiation principles, introduction of EMR with atmosphere, energy interaction with earth surface spectral reflectance of vegetation, soil and water components. Characteristics of real remote sensing system, Arial photography, characteristics of Arial photography.

Unit-4 Interpretation and application of Arial photographs in forestry: mapping of forest types, species analysis, characteristics of remote sensing for landscape analysis and environmental monitoring, environmental impact analysis, habitat management, geographical information system (GIS), application of GIS in environmental management

Suggested literature:

1. Environmental biotechnology, Banerjee
2. Remote sensing principles and interpretation, F.F Sabins
3. Remote sensing and image interpretation, T.N Lillesand. R, W Kiefer
4. Environmental remote sensing- and introduction to animal, Mukherjee
5. Introduction to remote sensing, J.B. Campbell
6. Environmental biology and biotechnology, H Kreuzer, A. Massey
7. Biofertilizers by A.K. Sharma

Course Outcomes: This course will introduce student to:

- Vermiculture biotechnology waste management and ecology and distribution of earthworm.
- Biology of waste and aquaculture, generation of wastes, recycling and conservation measures.
- Energy interaction with earth's surface, spectral reflectance of vegetation, remote sensing for landscape analysis and environmental monitoring and environmental impact analysis.

EVS-513N: Biostatistics and Computational Biology **Credit: 4+0**

Unit-1 Basic Components of Computer- Hardware (CPU, input, output, storage devices), Software (operating systems), Application software: Introduction to Microsoft EXCEL : use of worksheet to enter data, edit data, copy data, move data, use of inbuilt statistical functions for computation of mean, S.D., correlation, regression coefficients, etc, use of bar diagrams, histogram, scatter plots etc. graphical tools in excel for presentation of data, Introduction to MSWORD word processor: editing, copying, moving, formatting, table insertion, drawing flowcharts, etc ; Introduction to PowerPoint: image and data handling.

Unit-2 Sampling technique: methods of sampling, sampling and non-sampling errors, tabulation and graphic representation of data, bar diagram, histogram, pie diagram, Measures of dispersion: interquartile ranges, variance and standard variation, coefficient of variation, measures of skewness, coefficient of skewness, kurtosis, standard error of a statistic, estimation theory, Null and alternative hypothesis, confidence limit testing of hypothesis, degree of freedom, Probability: theorems on probability, application of permutation and combination, (a) binominal distribution : mean, variance, conditions for application, Pascal's triangle, characteristics of binominal distribution; (b) Poisson distribution: (c) normal distribution : properties and applications

Unit-3 Probit analysis, correlation covariance, correlation analysis, correlation of coefficient, spearman's rank, correlation coefficient, regression; regression analysis, regression coefficient and its properties, coefficient of determination; test of significance of mean (large sample), two means (large sample); students' t-test: assumption, properties and application of t-test, Chi-square test: Properties and uses of chi-square, analysis of variance – one way and two of classification, f-test; types of non-parametric tests, its advantage/disadvantage and use, sign-test for paired data, Mann-Whitney U-tests, Spearman's rank correlation test; experimental design: basic concepts and principles

Unit-4 Introduction to Bioinformatics, Sources: WWW, HTML, URLs, Google Scholar, PUBMED, GenBank, Databases: nucleic acids, genomes, protein sequences, and structures, Sequence analysis (homology): pair wise and multiple, sequence alignments, BLAST, CLUSTALW, Phylogenetic analysis and detection of open reading frames

Suggested literature:

1.Biostatics by P N Arora and P.K Malhan, Himalaya publishing house
2. Principles of Biostatistics by Pagano M. Gauvreau, K (2000), Duxbury press, USA
3. Fundamental of Biostatics by I A Khan and A Khanam, Ukaaz publication, Hyderabad

Course Outcomes: Students will be:

- Introduced to basic components of computers, Software (operating systems) and application software used in biological and statistical studies.
- An overview of databank search data mining, data management and interpretation.
- Learning of Probit Log analysis for interpretation of toxicity data.

EVS-514N: Natural Resources, Conservation and Management **Credit: 4+0**
Theory

Unit-1 Sun as a source of energy. Solar radiation and its spectral characteristics, fossil-classification, composition, Physico-chemical characteristics of coal, Petroleum and natural gas. Hydroelectric power, Tidal wind and Geothermal energy.

Unit-2 Principles forest types in India. Causes of forest degradation (forest fires, forest land degradation illicit felling. Grazing, shifting cultivation, etc). forest conservation measures- social forestry (farm forestry, Agro- forestry, extension forestry), role of forestry in eco-development of rural areas, ethno-botanical studies in India.

Unit-3 Fundamentals of biodiversity. Global biodiversity conservation/strategies, biodiversity conservation plans in India. Hotspots of biodiversity, significance of biodiversity to human society, reason for its depletion, scope of biodiversity.

Unit-4 Land use and planning, soil characteristics (mineral matter, soil water, organic matter, soil air and soil organisms). Causes of soil degradation, soil conservation methods, mineral resources and reserves; global water balance, ice-sheets and fluctuations in sea levels, origin and composition of sea-water, hydrological cycle, factors influencing the surface water. Run off process and water resources of India.

Suggested literature:

1. Assessment and Management of Carbon, Nitrogen, and Sulphur, By P.A. Debarry
2. Elements of Nature and Properties of Soil byBrady And Weil.
3. Environment Management by B. Narayan
4. Integrated Environmental Management by O'Callaghan

Course Outcomes:

- Solar radiation and its spectral characteristics, fossil classification, composition, physic-chemical characteristic of coal, petroleum and natural gas.
- Forest conservation measures social forestry, role of forestry in eco-development of rural areas.
- Land use and planning, soil characteristic, cause of soil degradation.
- To assess the fundamentals of biodiversity, hot spots of biodiversity and significance of biodiversity.

EVS-515N: Technology, Environment and Society **Credit: 4+0**

Unit-1 Understanding the relationship of technology with environment through the analysis of shifts in the perception of societies in the countries of technology advanced and developing world; study of "technological innovation as a solution/remedy for environmental problem". Technological impacts/innovation and technology adoption effects of environmental policies.

Unit-2 Environmental policy assessment for the evaluation of impact on environmental costs, assessment of effectiveness of alternate policy instruments in containing environmental damage, the encouragement to technology transitions and environmental technology innovation for the achievement of ecological and social justice.

Unit-3 Assessments of the developments within the relevant fields of science and technology for the achievement of sustainable development in the world in general and in India in particular; the management of transition to environmentally and socially just futures for energy, transportation, climate change, handling of toxics, agriculture, water, forest, etc

Unit-4 Impacts of social movements for the achievement of ecological and social justice in India; corporate responsibility movement, appropriate technology movement, environmental groups and movements, citizen group, etc.; development within the field of integrated technology assessment, innovation policy tools, pathways creation sustainable development, etc

Suggested literature:

1. Effiot David, 2003, energy, soc

Course outcomes: This course will provide factual knowledge and help student to:

- Acquire a comparative background in major social, political, ecological, and technological processes in the history of the global water-energy-food crises.
- Know how to read different kinds of historical sources and secondary writings by identifying the central arguments, evaluating evidence critically, and recognizing the writers' perspectives or biases.
- Demonstrate the ability to use primary and secondary sources to create and discuss thesis arguments that are supported by evidence, and that critically interpret the past and present.

EVS-516N: Atmosphere and Global Climate Change **Credit: 4+0**

Unit-1 Earth systems: atmosphere, hydrosphere, lithosphere, biosphere and their linkage. Earth's geological history and development and evolution of the atmosphere: Gia hypothesis, atmosphere and climate. Basic atmospheric properties, climate controls. Climate classification and variability. Movement in the in the atmosphere: global scale, regional scale, local scale. Oceans: general circular patterns air-sea interaction.

Unit-2 Global energy balance: sources, transfer, distribution. Energy balance of the atmosphere. Wind, stability and turbulence: monsoons, El-Nino southern oscillations, cyclones, natural climate\changes: records of climate change (glacial cycles, ocean sediments, coral, tree rings)

Unit-3 Human impacts on climate (i) causes and consequences of global warming. Green house effect, global and regional trends in greenhouse gas emissions; sea level rise, role of oceans and forests as carbon sinks. (ii) ozone depletion stratospheric ozone shield; ozone hole.

Unit-4 Impacts of climate change: effects on organisms including humans, effects on ecosystems and productivity; species distribution ranges, spread of disease; extinction risk for temperature sensitive species; UV effects; climate change and policy; Montreal protocol; Kyoto protocol; carbon trading; clean development mechanism.

Suggested literature:

1. Berry R G 2003, atmosphere, weather and climate. Routledge press, UK
2. Critclifield, Howard J.1998. General climatology, prentice hall India pvt. Ltd., new Delhi
3. Firor, J and J.E Jacobsen, 2002. The crowded greenhouse population, climate change and spending a sustainable world. Yale university press
4. Hantz, M.H .2000, climate and global climate change, prentice hall.
5. Hump I. R kasting, J.F., and Carne, R.G., 2004. The earth system 3_{rd} Ed. Prentice hall

Course Outcomes:

- To study the various biospheres of earth: atmosphere, lithosphere, biosphere and their linkage.
- Study of the energy balance of the atmosphere, wind, monsoon, El Nino, cyclones and natural climate change.
- Global and regional trends in green house gas emissions, sea level rise, role of ocean and forest as carbon sink.
- Effects of Climate change on organisms including humans, effect on ecosystem and productivity.

EVS-517N:Environmental Communication and Education **Credit: 4+0**

Unit-1 Environmental education and environmental literacy: need for public awareness; fundamentals of mass communication: what is communication? Defining communication; types of communication; mass communication; an introduction; role of mass media.

Unit-2 Basics of science and technology(S&T) communication: role of communication in modern science 'public' nature of science; science and public; historical overview; why communicate S&T, when public meets science; channels of S&T communication; what are channels; broadcast media and S&T; print media and S&T; telecast media and S&T science through little media; use of group media for S&T communication.

Unit-3 Pragmatic aspect and contexts of science & environmental communication; strategies for communication; use of analogies; metaphor and simile; human and with examples and illustrations; anecdotes and personalizing; context for science and environmental communication; human interest cultural needs; survival needs; source of information; ethics in reporting & fundamentals of media laws.

Unit-4 Educating consumers: consumer behavior and environment: role of information, eco-labeling environmental communication today: introduction; over view of the scenario in the country; international scenario; canonical texts (critical reading of books on environmental communication such as silent spring), case studies of media reports that had impact. Analysis of mass media coverage of complex environment issues and the media's effects on public opinion and government environment policies.

Suggested literature:

1. Greenough, Paul et al., 2003. Nature in the global south: environmental project in south, and South-east Asia, orient Longman.
2. Erarup. S. and Russell. C.S., 2005. Environment, Information and consumer behaviour (Ed.), Edward Elgar, U.K.
3. Orr.D.,1994. Earth in mind: on education, Environment and the human prospect, is land press Washington, D.C.
4. Saberwal, Vasant et al., 2001, people, parks, wildlife: Towards co-existence, Orient Longman.
5. Valdia, K., S., 2004, Geology, Environmental and Society, Universities Press

Course Outcomes:

- This learning outcomes based curriculum for this programme would have definite goals to be achieved to keep the students, teachers and the offering institutions stay focused on the primary objectives of the programme.

EVS-518N: Culture and Environment Theory **Credit: 4+0**

Unit-1 Introduction: concepts and theories concept o culture, material culture, technology; role of culture in adaptation of human population. Basic forms of human adaptation to environment: hunting and food gathering pastoralism; shifting cultivation; agriculture; transition to market economy and industrialization.

Unit-2 Social and cultural implications of various forms of adaptation: evolution of political organization, distribution and exchange of resources, political economy of the state (land and forest policies colonial).

Unit-3 Environmental culture in business organizations: development of environmentally aware corporate cultures, linkage between organizational environmental culture and environmental strategy.

Unit-4 Development and environment: current debates; how development policy defines degradation in largely physical terms, and not in terms of access inequality and exploitation. Landscapes: how landscapes are invested with cultural meaning, changes in landscape over time and their cultural and ecological implications.

Suggested literature:

1. Baruah Samib 2005 Durable Disorder: Understanding the politics of North east India. O.U.P.
2. Gadgil Madhav and Geha Ramachandra. 1992, This Fissured Land: An Ecological history of India, O.U.P.
3. Gold, Ann and Bhoju Ram Gujar, 2002, in the times of tree and Sorrows: nature, power, and Memory in Rajasthan, Durham, Duke University Press
4. Guha, Rama Chandra, Social Ecology, 1998, Oxford University Press
5. Ingold Tim.1994, Companion Encyclopaedia of Anthropology, Routledge
6. Kelley Ailey, 2002. On the banks of the Ganga: Waste water meets a Sacred River. University of Michigan press. Ann Arbel.

Course Outcomes:

- Define culture, society, cultural universals, and cultural relativism.
- Describe the basic elements of culture. Examine pop culture, subculture, and cultural change.
- Describe of the evolution of societies.
- Contrast the various theoretical perspectives on culture society.
- Explain how society shapes in reality with respect to environmental theories.

EVS-519N: Biodiversity and Conservation Biology **Credit: 4+0**

Unit-1 Ecosystems, biomes etc: levels of biodiversity; community diversity (alpha, beta and gamma biodiversity) gradients of biodiversity (latitudinal, insular), ecosystems diversity: biomes, mangroves, coral reefs, wetlands and terrestrial diversity(equilibrium mix of G and W); species diversity: richness and evenness, loss of species, magnitude of biodiversity (global and Indian data). Direct and indirect benefits, bio-prospecting (molecular technique like RAPL, RFLP, AFLP, DNA sequencing etc).

Unit-2 Genetic diversity: sub species, breeds race, varieties and forms. Variation in genes and alleles of DNA sequence levels (selected case studies). Microbial diversity and useful prokaryotic genes. Speciation (amount of genetic variation is the basis of speciation). Consequences of monotypic agricultural practice (detailed case studies); threats to biodiversity; habitat loss and fragmentation; distribution and pollution; introduction of exotic species, extinction of species; Human intervention and Biodiversity loss; Global Environmental changes, land and water use changes.

Unit-3 History of conservation movements; international and national, ecologically relevant parameters (viable population, minimum dynamic area, effective population size, meta population); reproductive parameters in conservation (breeding habits, mating systems, inbreeding depression, genetic bottlenecks, genetic constraints). IUCN categorized endangered, threaten vulnerable species. Red data book and related documentation.

Unit-4 Methods of conservation. In-situ (biosphere reserve, national parks, sanctuaries, sacred grooves, etc) and ex situ (botanical gardens, gene banks, pollen, seed and seedling banks, tissue culture and DNA banks etc) modes of conservation; benefits of conservation. Biodiversity as a source of food and improved varieties, sources of drugs and medicine, aesthetics and cultural benefits, sustainable development, ecosystem services, maintenance of gaseous composition of atmosphere, climate control by forest and oceanic systems, natural pest control, pollination of plants by insects and birds, formation and protection of soil, conservation and purification of water, nutrient cycling.

Suggested literature:

1. V.H. Heywood, and R.T. Watson, 1995. Global Biodiversity Assessment. UNEP, Cambridge University Press.
2. D. Hill, M.Fasham, and P. Shaw, 2005. Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring. Cambridge University Press.
3. A.E. Magurran, 1988. Ecological Diversity and Its Measurement. Princeton University Press, Princeton, New Jersey.
4. J.S Singh, S.P Singh, S.R. Gupta, 2006. Ecology Environment and Resource Conservation. Anamaya Publishers, New Delhi
5. Van Dyke, Fred, 2008. Conservation Biology: Foundations, Concepts, Applications, 2nd edition McGraw Hill, New York, USA

Peter J. Bryant, 2009, Biodiversity and Conservation, University of California, Irvine, USA

Course Outcomes:

- Know the principles of evolution, and wildlife and conservation biology and how they are used to manage wildlife and solve environmental problems; know the taxonomy,

ecology, and natural history of native flora and fauna, use contemporary tools and techniques for studying wildlife, habitat, and ecosystem processes; be familiar with a variety of laws and regulations that influence how natural resources are used and protected and the impacts of land use and environmental management decisions on ecosystems and society.

EVS-520N: Practical based on EVS512N, EVS513N, DSE I & DSE II **Credits:0+4**

Exercise based on vermiculture and vermicomposting
Statistical exercise
Exercise on natural resources, conservation and management.
Exercise on environmental monitoring and toxicology
Exercise on atmospheric and global climate change.
Exercise on environmental communication
Exercise on biodiversity and conservation
Viva- voice
Total marks

EVS512N, EVS13N: Demonstration of vermiculture: preparation of vermicompost from different biological waste products; Preparation of vermiwash from different vermicompost and earthworms; identification of different species of earthworms of Gorakhpur; small dissertation/Project/Seminar lecture on remote Sensing; Use of excel sheet for data processing; Simple experiments on probability; Sample data collection and calculation of mean, median and mode, variances and standard deviation.

EVS514N: Study on the solar radiation and its spectral characteristics; study on physio-chemical characteristics of coal, petroleum and natural gas; measurement of wind speed by anemometer; measurement of light intensity by luxmeter in different day time; measurement of rainfall by rain fall gauge; submission of small reports on any of the natural resources in adjoining area of Gorakhpur; Demonstration of hot spots of different natural resources on national map.

EVS515N: Project report or field survey based on the topics given theory paper.

EVS516N: Project reports based on any of the above topics. Out of these one should be based on long term data collected from India Meteorological Department (IMD) and National physical laboratory (NPL) on various atmospheric parameters and their analysis; visit to IMD to learn about real time monitoring and prediction of weather; Viva-Voice based on the above two project reports/ practical or seminar.

EVS517N : Study on environmental awareness in different locality, age, sex, education and job profile; study on the awareness of recent environmental issues of the world; Demonstration of certain Environmental problems in between the different groups of urban and rural area (South Pollution, Air Pollution, Soil Pollution and Water pollution); Educate different groups in remote areas about the biodiversity of native flora fauna and their conservation; use of print and audio visual media about the environment issues

EVS518 N: Submission of small Dissertation on the relationship between culture and environment in adjoining area of Gorakhpur.

EVS519 N: Measurement of species diversity (calculation of diversity Indices from data collected on plant species in the adjoining forest; Measurement of the diversity of Flora of University Campus; Study on the Biodiversity of Animal Species in Ramgarh Tal and Maheshra lake.

EVS-521N: Industrial Training/Survey/Research Project **Credit: 0+4**

EVS-522N: Environment Ethics and Philosophy **Credit:4+0**

Unit-1 An introduction to environmental ethics and philosophy: ethics in society; environmental consequence; responsibility for environmental degradation; theories of environmental ethics and philosophy; different types of school of thought vis-à-vis nature and environmental management. Values in modernity, anti-modernity, eastern and western cultures, nature and religion etc.

Unit-2 Eccentric theories of nature: deep ecology and animal rights theories, environmental rights, environmental racism: cross-cultural views on nature: the relationship between humans, nature and adaptation. Theoretical frameworks of cultural and social ecology; debates on cultures/nature divide.

Unit-3 Environment and business ethics: foundation of environmental ethics for business, corporate environmental ethics, environmental disclosure, social and ethical issues for sustainable development, business ethics and corporate environmental performance; environmental ethics and issues of national and international governance; changing nature of environmental ethics in relation to international and national paradigms of environmental governance.

Unit-4 Resource consumption patterns and the need for equitable utilization; equity disparity in the northern and southern countries; urban – rural equity issues; need for gender equality; preserving resources for future generation; the ethical basis of environmental education and awareness; the conservation ethics and traditional value system of India.

Suggested literature:

1. Aggarwal Anil & Narain Sunita, 1991, Global warming in an unequal world: A case of Environmental colonialism, Centre for Science&Environment.
2. Cooper, D.E. & Palmer, J.A., (ED.), 1992, The Environment in question: Ethics &Global basics, London, Routledge.
3. Jardius, J.R., 2001, environmental ethics: An invitation to Environmental philosophy (3rd Ed.), Wadsworth Publ., Belmont, California.
4. Girim. John. A., 2001, Indigenous Traditions and Ecology (Ed), Harvard University press.
5. Dnsouurd. J.B. & Schilizzi, S.G. M., 2001, the environment incorporate management: New directions & Economic insides, Edward Elgar, U.K.
6. Vandeveer,, D.C.P and Vandeveer, D., 2002, The Environmental Ethics and Policy book : Philosophy, Ecology, Economics (3rd Ed.,), Wadsworth publishing , California.

Course Outcomes:

- To provide students with a thorough theoretical understanding of the challenge of sustainability, with an emphasis on cultural perspectives and environmental values.
- To introduce students to the complexities of interdisciplinary research.
- To develop student's skills in, and knowledge of, philosophical argumentation, historical processes and cultural understanding of environmental problems.
- To use the ongoing case studies provided by researchers in order to provide practical training to the students who may go further in research and policy areas.

EVS-523N: Disaster Management **Credit: 4+0**

Unit-1 Overview of disaster management; emergency, disaster, type of disaster, implication of disaster on your region and environment, catastrophic geological hazards, study of floods, draught, earthquakes, landslides, avalanche and volcanoes, prediction and perception of hazard and adjustment to hazardous activity; disaster management cycle: mitigation (structural construction and non-structural activities). Preparedness (disaster risk reduction and emergency operation and plan), response, recovery, role of technology, media, education and public awareness in disaster management, physical and socio-economic impact of disaster, emotional impact of disaster, vulnerable groups in disaster.

Unit-2 Volcanoes: nature, extent and causes of volcanism. Types of volcanoes, volcanic materials, geographic distribution of volcanoes, case study; earthquakes: cause, intensity and magnitude of earthquakes, geographic distribution of earthquake zones, seismic waves, travel time and location of epicentre, prediction and perception of hazard, implications of the environment, action plan for earthquake disaster mitigation, vase study; Uttarkashi earthquake(implication and lesions), Latur (killer) and Gujarat earthquake experiences.

Unit-3 Land slides, mud flow and avalanche: cause, human activities and landslides, implication on the environment, prevention, mitigation plan, case study; floods: cause, nature and frequency of flooding, nature and extent of flood hazards, urbanization and flooding, effect of flooding, flood mitigation methods, case study, draught: causes, implication on the environment, drought management through anticipatory multi dimensional approach, case study.

Unit-4 Coastal hazards: tropical volcano and Tsunamis: cause, nature and implication on the environment, coastal erosion, sea-level changes and its impact on coastal areas, case study, disaster associated health issues: causes, communicable diseases according to disaster. Action plan to monitor evaluate and control health issues.

Suggested literature:

1. Bell. F.G.E & FN Spon, 1999, geological hazards: their assessment, avoidance and mitigation. E books der ULB Darmstadt.
2. Bonon. I, Kates. R.W. & white. G.F., 1993, Environment as hazard Guilford press.
3. Casate. R & Margottini. C. (Ed.), Springer, 2004, Natural disaster and Sustainable development.
4. Sellar. Edward. A, 1996, Introduction to Environmental Geology, prentice hall, upper Saddle river., New Jersey.
5. Smith keith, 2001, environmental Hazards: Assessing risk and reducing Disaster,
6. Henrry J.G. and Heinke, G.W., 2004 environmental science and engineering, Pearson education delhi, India

Course Outcomes:

- Capacity to integrate knowledge and to analyze, evaluate and manage the different public health aspects of disaster events at a local and global levels, even when limited information is available.
- Capacity to describe, analyze and evaluate the environmental, social, cultural, economic, legal and organizational aspects influencing vulnerabilities and capacities to face disasters.

- Capacity to work theoretically and practically in the processes of disaster management.
- Capacity building for disaster management (disaster risk reduction, response, and recovery) and relate their interconnections, particularly in the field of the public health aspects of the disasters.

EVS-524N: Environment Economics, Policies and Law **Credit:4+0**

Unit-1 Environmental statement (ES), ES of government of India and its contents; introduction of environmental audit, guidelines and methodology, purpose and needs, natural resource accounting for Indian condition. Economic development and environmental impact, joint forest management for optimal property rights. Chipko experience and directives of economies and environment irrigation projects and environmental costings, some analytical techniques and policy, economic values of India's forest stock and economics of forest production in India.

Unit-2 Convection on conservation of Antarctic marine (1980) and mineral resources. Treaty on principles governing the activities of state in the exploration and use of outer space (1967), the citizens convention on biodiversity /biological diversity (1992), international convention on the high seas and fishing and living resources (1958) and intervention of oil pollution causalities (1969).

Unit-3 Environmental policies and laws: introduction to international environmental law (Stockholm conference). introduction to national Law, (Constitution and other revenant statutes), Air act 1981(prevention and control of Air pollution), water (prevention and control of pollution) act 1974, as amended 1988 and rules 1975, convention of international trade in endangered species of wild fauna and flora (CITES), motor vehicle act, 1988.

Unit-4 Forest act 1927; forest conservation act, 1980; environmental protection act, 1986 and rules 1986; wildlife protection act1972; public liability insurance act 1991; national environmental tribunal act 1995.

Suggested literature:

1. Principle of environmental economics , A.Hussen
2. Issues in Environmnetal economics , N.Hanley & C.J. Roberts
3. Environmental Economics, M S Randhawa
4. Environmental protection law and policies in India, K.Thakur.
5. Environmental Law, G. Kaur
6. Environmental Laws in India, A.K Tiwari

Course Outcomes:

- The primary learning outcome is to sensitize the students towards human activities that adversely affect the environment and the need for regulation of such activities.
- Students will develop a thorough understanding of practice and procedure followed by various environmental law enforcing agencies/bodies.
- Students will be able to pursue environmental litigation before the National Green Tribunal and assist the Tribunal as a researcher or in any other capacity.
- Students will be able to assist industries and projects in obtaining environmental clearance and compliances with other environmental laws.

EVS-525N: Environmental Monitoring and Toxicology **Credit:4+0**

Unit-1 Air Pollution Monitoring. Air Quality Standards, Sampling Methods, Instruments, Duration Of Sampling Period, Location of Sampling Sites, Air Sampler Operation, Stack Sampling Technique, Control of Gases Contaminants, Combustion, Adsorption, Adsorption Recovery System.

Unit-2 Physiochemical and bacteriological sampling and analysis of water quality. Waste treatment, primary, secondary, and tertiary treatment, criteria for the application of aerobic and anaerobic biological treatment. Types of biological treatment, treatment for various industrial effluents with reference to distillery, paper and pulp, textile and dyeing wastes, industrial pollution abatement.

Unit-3 Pollution control in petroleum refineries and petro-chemical unit. Odours of petroleum products and their control. Threshold concentration oxidation, water supply management: introduction, demand of water, need of water supply. Treatment of ground water, pollution, control in petroleum refineries and petrochemical unit, oil spills. Sources and generation of solid-waste and its control. Sewage treatment, physico-chemical and bacteriological samplings as analysis of soil quality, control of soil pollutants, remedial measures of soil pollutants, protection and control from radiation, disposal of radio-active wastage, control of thermal pollution.

Unit-4 Toxicology: introduction, basic concepts of toxicology, toxicants of health hazards (Lead. Mercury, Cadmium, Arsenic, Vanadium, Cyanide, Cobalt, Iron), Xenobiotics (absorption, transport, and execution of chemicals). Biological magnificent, biomonitoring of toxic chemicals. Bioindicators, environmental carcinogens and their impact on health.

Suggested literature:

1. Toxicology by Earnest Hodgson
2. Environmental Pollution and Management by G.R. Pathade, P.K. Goel
3. Pollution by A.D. Stern
4. Pollutants and their determination by Greyson
5. Assessment and management of carbon, nitrogen, and sulphur, by P.A. Debarry

Course Outcomes:

- Ability to identify air pollution problems and interpret criteria for air quality data.
- Ability to recognize various environmental transformation processes of pollutants under extreme weather condition.
- Ability to interpret meteorological data and develop capability to assessment of project proposal, air quality pollution index for any region.
- Skill to monitor and assess the functioning and status of various aquatic systems and devise management strategy to control the identified problems.
- Systematic and Eco-toxicology: Problem and approach to environmental distribution of chemicals in air, water, sediments, soil and biota; effect of toxicant on ecosystem.

EVS-526N: Practical based on EVS522N, EVS523N, EVS524N & EVS525N **Credit:0+4**

Exercise based on environment ethics and philosophy
Exercise on disaster management.
Exercise on environment economics, policies and law.
Exercise on environmental monitoring and toxicology
Viva- voice
Total marks

EVS-522N: Report on Project/field survey on topic given in theory paper.

EVS-523N: Case study on a disaster in vicinity, report and mapping of disasters that can affect your area, Preparation of Do's and Don't cards to spread awareness about disaster in your area.

EVS-524N: Project/report/field survey on environment economics and its effects on the society. Preparation of record/ file of different policies and laws related to environment.

EVS-525N: Effect of UV radiations on animals/plants; effects of certain toxicant on alkaline phosphate activity in the nervous tissue of snail/fish, Estimation of LC 50, LC10, and LC90 measurement of selected toxicants for selected organism. Determination of upper and lower confidence limits, slope with value of each study; analysis of heavy metals in water/air/soil by atomic absorption spectrometer. Study of selected pollutants on the behaviour of animals.

EVS-527N: Industrial Training/Survey/Research Project **Credit: 0+4**

EVS-530N: Waste Management and Environmental Protection **Credit:4+0**

Unit I Solid Waste: Types and sources, municipal (e.g., residential, institutional, and commercial), **agricultural** and **special** (e.g., construction and demolition, household hazardous, sewage sludge, and non-hazardous industrial) wastes. Solid waste **characterization,** components **minimization, collection, separation,** transportation (container systems -hauled and stationary), **treatment,** and **disposal.** Generation rates, proximate and ultimate analyses of solid wastes.

Unit II Solid waste processing and recovery: Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermin-composting, bio-methanation of solid waste.

Unit III Disposal of solid wastes: Sanitary land filling and its management, incineration of solid waste. Hazardous waste: Types, characteristics and health impacts. Hazardous waste management methods: neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal

Unit IV E-waste: classification, methods of handling and disposal, Fly ash: sources, composition and utilization. Plastic waste: sources, consequences and management.

Suggested Readings:

4. Solid *Wastes Management* by Stephen Burnley.
5. Sustainable Solid *Waste Management* by Ni-Bin Chang
6. Food and Agricultural Wastewater Utilization and *Treatment* by Sean X. Liu.

Course Outcome: This course will help students to come up with ability to classify waste and plan its management in eco-friendly way. This will also help them to spread awareness and come up with new research proposals.