M. Sc. (Environmental Science)

EVS-501 (a): ELEMENTARY MATHEMATICS FOR ENVIRONMENTAL STUDIES
(For students with Biology background) Credit 0 (2-0-0)
Cartesian Co-ordinate system, equation of straight line, solving a linear system of equations, functions, limit, continuity, differentiation, Principle of maxima and minima, Integration-simple techniques of integration by substitution and by parts.

Reference Book:
1. Mathematics-Anton, Kolman & Averbach

EVS-501 (b): ELEMENTARY BIOLOGY FOR ENVIRONMENTAL STUDIES
(For students with Biology background) Credit 0 (2-0-0)
Organizational levels of environmental biology-cell to biosphere; Structure of cell in prokaryotes and eukaryotes, cell cycle, mitosis and meiosis, origin of life, molecular evolution, mechanisms of speciation, Principles of Mendelian inheritance.
Structure and function of Biomolecules- amino acids, polypeptides, proteins, carbohydrates, lipids, Nucleic acids.

Reference Books
1. Principles of Biochemistry-Lehninger
2. Biochemistry-Stryer
3. Biochemistry of Nucleic Acids Adams
EVS-502: ECOLOGY AND SYSTEMS ANALYSIS

Credit
4(4-0-0)

Introduction: Aims and scope of ecology, organizational levels of biosphere.


Community Organization: Analytic and synthetic characters, species diversity, biomes, concept of niche, keystone species, ecads and ecotypes, ecotone and edge-effect.

Ecological Succession: Types, trends and models, concept of climax.

Ecosystem: Structural components, ecological pyramids, food webs, trophic levels, energy transfers, ecological efficiencies, models of energy flow, energy budget, primary and secondary production, methods of measuring primary productivity, biogeochemical cycles, gaseous and sedimentary cycles-carbon cycle, nitrogen cycle, sulphur cycle and phosphorus cycle, Nutrient budget, Ecosystem stability, Cybernetics and ecosystem regulation, Gaia hypothesis.


Reference Books:
1. Basic Ecology- E.P.Odum
2. Ecology & Field Biology-R.L.Smith
4. Principles of Ecology-Ricklefs
EVS-503: NATURAL RESOURCES AND BIODIVERSITY
Credit 4(4-0-0)

**Physical Resources:** Renewable & non-renewable resources. Soil resources: soil type, soil profile and soil erosion. **Water resources:** Surface water, ground water, hydrological cycle.

**Mineral resources:** Types, their characteristics & uses, minerals from the sea.

**Energy resources:** Fossil fuels, nuclear energy, solar energy, wind energy, tidal energy, geothermal energy, hydropower. Hydrogen as a source of energy, energy from biomass, bioconversion technology, energy plantations and petro-crops. Environmental impacts of various forms of energy use.

**Biological resources:** forests, their importance, types, primary and secondary products, forest resources of India. **Range lands:** Types, significance, range lands in India.

**Biodiversity:** Its value & uses, gene pool, genetic variability, hot spots of biodiversity, threatened and endangered species, species extinction, threats to biodiversity, wild-life of India, National wilderness areas, biosphere reserves, biodiversity conservation strategies, in situ and ex situ conservation, gene banks, Convention on biodiversity.

**Reference Books:**

1. Natural Resources conservation-Oliver S Owen & Chiras
2. Living in the Environment –T.J.Miller
3. Environmental Science- Cunningham Saigo
4. Ecology of Natural Resources-Ramade
5. Global Biodiversity-W.R.L. IUCN
EVS-504: ENVIRONMENTAL CHEMISTRY

Credit 4(4-0-0)

**Thermodynamics:** First law of thermodynamics, enthalpy, adiabatic transformations, second law of thermodynamics, Carnot’s cycle, entropy, Gibb’s free energy, chemical potential, phase equilibria, Gibb’s Donnan equilibrium, third law of thermodynamics, enzyme catalysis, Michaelis-Menten equation.

**Soil Chemistry:** Chemical composition and chemical history of the earth, origin of mineral deposits and fossil fuels, major rock forming minerals, soil formation, soil properties, chemical & mineralogical composition of soils.

**Atmospheric Chemistry:** Chemical composition of atmosphere-particles, ions and radicals, formation of particulate matter, Photo-chemical and chemical reactions in the atmosphere, smog, acid rain, chemistry of ozone layer depletion.

**Water Chemistry:** Water quality parameters, standards, chemistry of inland water bodies like lakes, streams, rivers estuaries and wetlands, solubility of gases in water, carbonate system.

**Reference Books:**

1. Environmental Chemistry-Mannahan
2. Fundamentals of Soil Science-Henry D. Futh
4. Environmental Chemistry-Sharma & Kaur
UCC-550-COMPUTER PROGRAMMING

Credit 3(3-0-0)


Fortran 90: Data types, control structures, arrays, pointers, subprograms, recursion.

Study and Programs for numerical and statistical methods: Matrices, solution of linear equations, interpolating a function, numerical integration, solution of ordinary differential equation, measures of central tendency, dispersion, regression analysis, correlation coefficient.

Internet: Definition, various activities on internet, tools and services of internet, browsing the internet.

References:

EVS-511: PHYSICAL ENVIRONMENT

Credits 4 (4-0-0)

**Atmospheric Environment**: Composition of atmosphere, vertical distribution of temperature in atmosphere, relationship of earth with sun, heat budget of the earth-atmospheric system, scales of meteorology, hydrostatic equilibrium, various kinds of lapse rates, vertical stability of atmosphere, cloud classification and formation, winds, Coriolis force, global pressure belt system, monsoons, El-nino

**Aquatic Environment**: Classification of aquatic systems, salient features of lentic, lotic & marine systems, ocean waves and currents, ocean deposits, marine biological and geological environments, coral reefs.

**Terrestrial Environment**: Primary differentiation and formation of core, mantle, crust, atmosphere and hydrosphere; igneous, sedimentary & metamorphic rocks: weathering, erosion, transportation and deposition of earth’s material by running water, wind glaciers, thermal, magnetic and gravitational fields of the earth.

**Global climate change**: History of climate change, Milankovitch’s theory of climate change, greenhouse gases and their effects, role of humans, climatic feedback mechanisms, possible impacts of global climate change.

**Reference Books:**

1. The atmosphere : An introduction- F.K. Lutgens
2. Atmospheric Science Wallace & Hobbs
3. Confronting Climate change- I.M. Mintzer
4. Atmosphere, weather & Climate- Navarra
5. Earth Science : A holistic approach- Conti, Thompson and Moses
6. Oceanography- Grand Gross
EVS -512: ENVIRONMENTAL POLLUTION

Credits 4 (4-0-0)

**Water Pollution:** Sources, consequences, ecological and biochemical aspects of water pollution, characteristics of domestic, industrial and agricultural wastes, their effects on water bodies, chemical and bacteriological sampling and analysis, water quality parameters, criteria and standards. Marine pollution: thermal pollution.

**Soil Pollution:** Soil pollution from use of fertilizers, pesticides, heavy metals, waste disposal, industrial effluents and surfactants. Detrimental effects of soil pollutants, Remedial measures for soil pollution, soil sediments as pollutant. Chemical methods of soil analysis- sample prepration and soil analysis. Radioactive pollution.

**Air Pollution:** Sources, classification and properties of air pollutants, behaviour and fate of air pollutants, effects of air pollution on human health & materials, sampling and analysis of air pollutants, SOx, NOx, CO, Ozone, hydrocarbons and particulate matter, meteorological aspects of air pollutant dispersion.

**Noise Pollution:** definition, sound pressure level, noise-spectra-octave bands, combining decibels, frequency weighting net-works, noise-monitoring-sound levelmeter, equivalent continuous noise level and other noise indices. Effects of noise pollution.

**Reference Books:**

1. Industrial Noise Control- Bell & Bell
2. Introduction to Environmental engineering & Science- Gilbert Masters
EVS-513: INSTRUMENTATION FOR ENVIRONMENTAL ANALYSIS

Credit 3 (3-0-0)
Method of collection of Air, Water & Soil samples. Principles and applications of Spectrophotometry (UV-Visible spectrophotometry, flame photometry, Atomic Absorption spectrophotometry); X-Ray diffraction, Colorimetry and polarimetry, Fluorometry, Microscopy-Phase contrast, fluorescent, polarization, SEM, Chromatographic techniques (Paper chromatography, thin layer chromatography, Gas liquid chromatography, High pressure liquid chromatography, Ion exchange chromatography, Column chromatography)

Reference Books:
1. Undergraduates Instrumental Analysis- James W. Robinson

EVS-514 ENVIRONMENTAL MICROBIOLOGY

Credits
4 (4-0-0)
Aquatic Microbiology-Microbes in aquatic systems, pathogens in water, biomass determination, biofilms.; Soil microbiology- microbial interactions, decomposition and mineralization, mycorrhiza and their environmental significance; Microbial degradation of naturally occurring compounds- cellulose, lignin, hydrocarbons; Biodegradation of pesticides; Sewage sludge treatment using microbes; Bioremediation processes

Reference Books:
1. Microbiology- J.G. Black
2. Microbial Biotechnology-A.N. Glazer
4. Microbiology- Pelczar
EVS-515: BIO SYSTEMATICS & ECONOMIC BOTANY

Credits 4 (4-0-0)
Biosystematics: Principles of Systematics, Binominal Nomenclature, Significance of floral biodiversity; important flora of arid and semi-arid regions.
Economic Botany: Origin of Cultivated Plants, Cereals and pulses, Sugar yielding plants, sugarcane, sugarbeet Fibre, Oil and rubber, yielding plants, Spices & Condiments, Beverages, Timber Yielding Plants, Medicinal Plants, Petrocrops.

References:
1. Economic Botany-Scherry
2. Plant taxonomy-Subramaniyam

EVS-516: ENVIRONMENTAL GEOLOGY

Credit
4 (4-0-0)
Introduction; the geologic cycle (tectonic cycle, rock cycle, hydrologic cycle, biogeochemical cycles). Surficial processes: Ice and wind
Special problems of time and scale in geology, scientific methods in geology, key concepts in the history of geology time, origin of the universe and earth, basic concepts of plate tectonics.
Geological aspects of environmental health, trace elements and health, chronic disease and geologic environment, radioactivity and radon gas. Global change and earth system science, tools for studying global change.
Minerals and human use, geology of mineral resources, environmental impact of mineral development, recycling of mineral resources.

Reference Books:
1. Environmental geology by Edward A.Keller
2. Physical geology by C.W. Montgomery
EVS-517: ENVIRONMENTAL MODELING

Credit 4 (4-0-0)


Reference Books:

1. Dynamics of Environmental Bioprocesses- Modeling & Simulation – Snape & Dunn
2. Environmental Modelling- Jorgensen

EVS-521: RESOURCE CONSERVATION & MANAGEMENT

Credits 4(4-0-0)


Biological Resource Management: Management of forests, effects of deforestation, desertification, range management, management of wetlands and fresh water ecosystems, wildlife management, conservation efforts for threatened species in India, CITES.


Remote Sensing: Principles of remote sensing, Photointerpretation, application of remote sensing in vegetation mapping, management of water, mineral resources, wild-life & pollution monitoring.
EVS-522: ENVIRONMENTAL BIOTECHNOLOGY

Credits 4(4-0-0)

Basic Techniques in genetic engineering: Restriction end nuclease, Gene identification and isolation. Introduction of cloned genes into new hosts using plastid and phage vector systems, RFLP, Chemical synthesis of DNA, DNA ligation, transformation and screening of transformations, expression of genes in new host, chromosome walking, southern blotting and hybridization, gene transfer methods in bacteria and plants, polymerize chain reaction, DNA sequencing.

Applications: Biosensors for the detection of pollutants; genetic control of industrial pollution through natural and genetically engineered micro-organisms for distillery effluent, pulp-paper industry, heavy metal pollution, Bioremediation of metal contaminated soils, removal of spilled oil and grease deposits, fermentation technology (Bioreactors), reducing environmental impacts of synthetic pesticides, viral pesticides, biotechnology in forestry and wasteland development.

Biotechnological approaches for preserving biodiversity: gene banks, germ plasm banks and their management.

Reference Books:

1. Gene V – Levine
2. Plant Cell & tissue culture – J.W. Pleared (Ed.)
3. Molecular Biology – H.D. Kumar
4. Environmental Biotechnology – S. N. Jodganel
5. Environmental Biotechnology – Sayler & Fox
6. Genetic Manipulation – Old & Primrose
EVS-523: ENVIRONMENTAL PHYSIOLOGY

Basic concepts: Stress and strain, principles of plant and animal responses to environment.

Plant responses to physico-chemical environment: Photoperiodism, Circadian rhythms and biological clock, phytochrome responses; plant responses to UV radiations, high temperature and low temperature stress, water stress; responses to drought and flooding; plant responses to enriched CO2 environment, ecologic significance of different CO2 fixation pathways; modeling photosynthetic responses to environment; salt stress responses in halophytes and non-halophytes; mechanisms of salt tolerance, metal toxicity and metal tolerance in plants. Physiological responses of plants to air pollutants- SOx, NOx, Ozone.

Animal response to stress environments- Osmoregulation in fish, water conservation in desert animals; diapause, hibernation and aestivation, animal responses to high altitude and deep sea environment.

Reference Books:
1. Physiological Plant Ecology- Encyclopedia (Vol. I-IV) Springer Verlag
2. Plant Physiology- Salisbury & Ross
3. Plant Ecophysiology – Prasad

EVS-524: AGRICULTURE AND ENVIRONMENT


Crop Production: Synthetic fertilizers, Nitrogen fertilizers & alternate sources, biofertilizers, crop residue management, vermicomposting. Weather & crop productivity, impact of global warming on agriculture and food security; Green-Revolution-environmental implications.

Reference Books:
1. Sustainable Agriculture – H.R. Sharma
2. Global Climate Change – Pary Martin
3. Allelopathy – S.S. Narwal
4. Environmental Chemistry – Mannahan
5. Soils – Miller and Donhau
6. Environment and Agriculture – Dhaliwal, Jairath and Hansra

EVS-525: NATURAL DISASTERS

Credits 3 (3-0-0)

Hazards as Natural processes, Evaluation of Hazards, Human response to hazards, Global climate and Hazards, Population increase, land-use change and natural hazards. Rivers and flooding, Landslides, Snow avalanche, subsidence, Earthquakes and related phenomena Tsunami, Volcanic activity, Coastal hazards- tropical cyclones, tidal floods, Coastal hazards and engineering structures, Human activity and coastal hazards.

Reference Books:
1. Environmental geology by Edward A. Keller
2. Physical geology by C.W. Montgomery
EVS-531: POLLUTION MANAGEMENT

Credits 4(4-0-0)

Waste water management: Primary treatment methods – screening, grit removal, primary sedimentation, secondary treatment methods, Activated sludge process, trickling filters, rotating biological contactors, oxidation ponds and lagoons. Advance waste water treatment-removal of nutrients and solids. Waste water re-use and sludge disposal,

MINAS


Noise Pollution Control: Absorbing materials, barrier materials, damping materials, acoustical enclosures, Reactive silencers and filters; Active noise control methods.

Solid Waste Management

Reference Books:

1. Environmental Engineering – Peary
2. Introduction to Environmental Engineering and Science – Gilbert Masters
3. Air Pollution and Control – K.V.S.G. Murlikrishnan
4. Industrial Noise Control – Bell & Bell

EVS-532: ENVIRONMENTAL IMPACT ASSESSMENT AND RISK ANALYSIS

Credits 4(4-0-0)

Environmental impacts of mining industry; nuclear power plant; textile industry; pulp and paper industry; petroleum refining; pesticide manufacturing industry; fertilizer industry; Case study – EIA of some dam.


**Reference Books**:
1. Environmental Impact Assessment – John Glasson
2. Methods of Environmental Impact Assessment – Morris & Therivel
4. Chemical Principles of Environmental Pollution – Alloway & Ayers
5. Industrial Environment – Assessment and Strategy – S.K. Aggarwal
6. Introduction to Environmental Engineering and Science – Gilbert Masters

**EVS-533: ENVIRONMENTAL AWARENESS, PLANNING & LAW**

**Credits 4(4-0-0)**

Environmental awareness approach, current environmental issues, role of media in environmental awareness, role of NGOs, public participation in environmental movements international environmental initiatives-the Club of Rome Report, Stockholm Declaration, Convention on protection of environment, Ramsar convention on wetlands, outer space treaty, Vienna convention & Montreal Protocol, Kyoto Protocol, Earth Summit. Agenda 21, Environmental ethics-anthropocentric vs. ecocentric world view, ecomark. Basic concepts of environmental planning; integrated land-use planning; land use patterns; urban planning-impact of population growth. Major issues related to Himalayan ecology, deserts & mangroves.


Reference Books:
1. Economics and Environment – Good Steie
2. Environmental Planning, Policies & Programmes in India – K.D. Saxena
3. Land – Use and Environment – S.M. Mujtava
4. Environmental Administration and Law- Paras Diwan.

EVS-534: ENVIRONMENTAL HEALTH AND TOXICOLOGY

Credits 4 (4-0-0)

Pollution and human health: Trace element deficiency and disorders, occupational health hazards, biogeochemical factors in environmental health, epidemiological issues-goiter, fluorosis, arsenic poisoning.

Transmissible diseases: Symptoms, epidemiology and control of vector borne diseases-amoebiasis, trypanosomiasis, filariasis, leishmaniasis, schistosomiasis, life cycle of Plasmodium, control of Malaria, tuberculosis and AIDS. Waterborne diseases: Jaundice & diarrhea.

Principles of toxicology: Toxic chemicals in the environment and their effects, heavy metals-Pb, Cd, Hg; Pesticides DDT, HCH, eldrin, dieldrin, malathion, carbaryl. Mode of entry of toxic substances, biotransformation of xenobiotics, detoxification, indices of toxicology.

Genetic Toxicology: Mutagens, teratogens, teratogenesis and teratology testing, Environmental mutagen testing- Bacterial mutagenesis assays, gene mutation and
chromosome damage assays, DNA damage and repair assays, Strategies for protection of man from toxicants. Monoclonal antibody technology (hybridoma), Elisa. 

**Carcinogenesis:** Carcinogens, chemical carcinogenicity, mechanism of carcinogenicity, molecular toxicology and genetic basis of carcinogenesis- oncogenes and their mode of action, tumour suppressor genes. Model of oncogenesis, Environmental carcinogenicity testing.

**Reference Books:**

1. Environmental Hazards and Human Health – R.B. Phillip
2. Toxicology – Principles and Applications- Niesink, John de Vries & Holligner
3. Progress in predictive toxicology- Clayson, Munro, Shubik & Swender (eds.)
4. Parasitology- Chatterjee
5. Parasitology - Chatterjee
6. Preventive and Social Medicine- Perk

**EVS-535: ECOTECHNOLOGY**

**Credits 4(4-0-0)**

Basic concepts of ecosystem dynamics, eco-designing, ecotechnological approaches, applications of ecotechnology for societal welfare and sustainable development

Wetland ecosystems-ecological significance, natural purifying potential, Constructed wetlands-their design, structure, functioning, Applications.

Decontamination of polluted sites-phytoremediation technology, phytostabilisation, phytovolatilisation; Bioremediation of waste waters.

Restoration of degraded ecosystems using ecological approach: mined areas and waste lands

Building resilience of ecosystems- soil fertility management.

**References:**

EVS-536: Solid Waste Management

Credit 4(4-0-0)

Sources and classification of solid wastes.

Solid waste management options: Sanity Land filling, Recycling, Composting, Vermicomposting, Incineration, Energy recovery options from organic waste,

Solid waste management plan, Municipal Solid Waste (Management and Handling) Rules, 2000

Hospital waste management, Biomedical Waste (Management and Handling) Rules, 1988


Hazardous waste management: Sources and classification, Hazard communication, Physico-chemical properties of hazardous waste needed in management.

Hazardous waste control, treatment and management


References:

1. Solid Waste Management Manual CPCB, New Delhi
2. Ecotechnology for Pollution Control and Environmental Management by Trivedy R.K. and Arvind Kumar
3. Basic Environmental Technology Nathanson, J.A.
4. Environmental studies- A compulsory course for undergraduate students.