

DEPARTMENT OF ENVIRONMENTAL SCIENCE
Ch. Charan Singh University
Meerut

Prescribed syllabus for M.Sc. degree in Environmental Science w.e.f. July, 2009

SEMESTER – Ist

- I Basic Ecology
- II Environmental and Natural resources
- III Population Ecology
- IV Biodiversity and Conservation Biology

SEMESTER – IInd

- V Climate and atmosphere
- VI Biogeochemistry and Hydrobiology
- VII Environmental Chemistry
- VIII Ecophysiology

SEMESTER – IIIrd

- IX Environmental and Public Health
- X Environmental Biotechnology
- XI Ecotoxicology and Environmental Safety
- XII Methods of Environmental Analysis

SEMESTER – IVth

- XIII Global Environmental Problems
- XIV Environmental Management
- XV Env. Policies and Law
- XVI Environment and Development

PRACTICAL:

- Ist Semester – 50 + 50
- IInd Semester - 50 + 50
- Field work
- IIIrd Semester – 50 + 50
- IVth Semester (Project work) – 100

Science of environment includes the understanding of entire natural world and its resources. This course will deal with fundamentals of environmental science. Main emphasis will be on ecological principles, major ecosystem of the world and interactions among different abiotic and biotic factors.

- Unit I.** Introduction, definition, history and scope of ecology, divisions of ecology, models in ecology, ecology in India.
- Unit II.** Principles of ecology, ecology and ethology, levels of organization, ecology today
- Unit III.** Living planet earth, origin and evolution of earth, land forms, volcanoes.
- Unit IV.** Forests-Boreal coniferous forest biome (Taiga), temperate forest biome, tropical rain forest biome, Indian forests
- Unit V.** Grassland biome, desert biome, desertification, frozen world, arctic and Antarctic systems, open oceans, margins of land
- Unit VI.** Concept of biosphere, biome, biological realms and biotic provinces, types of ecosystems, major ecosystems of the world (Tundra, Savanna and Steppe)
- Unit VII.** Fragile ecosystems-Himalayas, coral reefs, mangroves and polar regions
- Unit VIII.** Tropic structure of the ecosystem, productivity of the ecosystem, food chain, food web, ecological pyramids, models of energy flow in the ecosystem
- Unit IX.** Concept of limiting factors, law of minimum, law of tolerance, combined concept of limiting factors, role of temp, radiation, humidity, atmospheric gases, currents and pressure as limiting factors
- Unit X.** Species interactions-symbiosis, neutralism, commensalisms, amensalism, mutualism, protooperation, competition, parasitism, competitive exclusion principle

Suggested readings

- Allee, W.C. et. al. (1949), *Principles of Animal Ecology*, W.B. Saunders, Philadelphia.
- Andrewartha, H.G. (1961), *Introduction to the Study of Animal Population*, University Chicago Press, Chicago.
- Cloud, P. (1978), *Cosmos, Earth and Man*, New Haven Connecticut, Yale University Press.
- Dale, M.B. (1970), "System analysis and ecology," *Ecol.*, **51**:2-16.
- Elton, C. (1927), *Animal Ecology*, Sidwick and Jackson, London.
- Krebs, C.J. (1972), *Ecology*, Harper and Row, New York.
- Lovelock, J.E. and Margulis, L. (1973), "Atmospheric homeostasis by and for the biosphere," *The Gaia Hypothesis*, *Tellus*, **26**:1-9.
- Odum, E.P. (1969), "The strategy of ecosystem development," *Science*, **164**:262-270.
- Odum, H.T. (1971), "The world system", In: *Environment, Power and Society*, Wiley Interscience, New York.
- Prosser, C. Ladd (1965), "Levels of biological organization and their physiological significance", In: *Ideas in Modern Biology* (Ed.) J.A. Moore, pp. 359-388. Natural History Press, Garden City, New York.
- Smith, R.L. (1977), *Elements of Ecology and Field Biology*, Harper and Row, New York.

Nature provides different resources i.e. water, food, minerals and energy. Due to anthropogenic activities they are being gradually lost. There is an emergent need to assess the present status of all natural resources and develop strategies for their conservation. This course will first deal with a detailed knowledge on all natural resources and then with their conservation strategies.

- Unit I.** Introduction to natural resources, reserve and resource, resource cycle, renewable and nonrenewable resources
- Unit II.** Mineral resources, coal, oil, hydrocarbons and natural gas, mineral resources of India, conservation of mineral resources
- Unit III.** Water resources, hydrologic cycle, water budget ground water potential, surface water resources, conservation of water resources, water harvesting
- Unit IV.** Marine resources, concept of EEZ, mangroves, food and drugs from marine plants and animals, resources of Antarctica
- Unit V.** Genetic resources agriculture and livestock resources of India
- Unit VI.** Wildlife, wildlife of India, important flora and fauna, endangered species of plants and animals
- Unit VII.** Conservation of genetic resources, international and national efforts
- Unit VIII.** Fish resources prawn fisheries, fish resources of India, endangered fishes of India, conservation of fish resources
- Unit IX.** Forest resources, Indian forests, national forest policy, conservation of forest resources
- Unit X.** Energy resources, renewable and nonrenewable energy resources, non conventional energy resources-solar, wind, water and tidal energy, energy from biomass, biogas, nuclear and geothermal energy

Suggested readings

- Agrawal, V.P. and Rana, S.V.S. (1985), *Environmental and Natural Resources*, Jagmander Book Agency, New Delhi.
- Hubbert, M.K. (1971), The energy resources of the earth, *Scientific American*, **224**, pp. 60–70.
- Kesler, S.E. (1976), *Our Finite Mineral Resources*, McGraw-Hill, New York.
- Lowenstam, H.A. (1981), Minerals formed by organisms, *Science*, 211, pp. 1126–30.
- Spurr, S.H. and Barnes, B.V. (1973), *Forest Ecology*, Ronald Press, New York.
- Statistical Handbook* (1993), Department of Agriculture and Cooperation.

Population is not only a social problem but a problem of environmental science as well. It is closely related to development, planning and management of human population. There will be a complete discourse on concepts dealing with population and development and community ecology.

- Unit I.** Definition and characters of a population natality, mortality, population age distribution, biotic potential of a population
- Unit II.** Meta populations, Metapopulation theory, Characters of metapopulation, Landscape and Metapopulation
- Unit III.** Growth of a population, different growth forms of a population, Factors regulating a population, population dispersal, emigration, immigration, migration
- Unit IV.** Human population dynamics, population projections population control and related demographic problems
- Unit V.** Community, concept of community, definition and characters of community
- Unit VI.** Classification of communities, community stratification, vertical stratification, horizontal stratification in aquatic community, stratification of terrestrial communities
- Unit VII.** Community metabolism, anabolism, catabolism
- Unit VIII.** Community succession, development of a community in hydrosphere
- Unit IX.** Climax community, climax theories, lithosphere, xerosere
- Unit X.** Communities of the past, ecological succession

Suggested readings

- Deevy, E.S. Jr. (1960), The human population, *Scientific American*, **203**: pp. 194–204.
- Desmond, A. (1962), How many people have ever lived on Earth, *Population Bulletin*, **18**: pp. 1–19.
- Ehrlich, P.R. and Ehrlich, A.H. (1972), *Population, Resources and Environment*, 2nd ed., W.H. Freeman, San Francisco.
- Haub, C. (1981), World Population Data-sheet, Washington, D.C., Population Reference Bureau.
- Kendeigh, S.C. (1974), *Ecology with Special Reference to Animals and Man*, Prentice-Hall of India, New Delhi.
- Krebs, C.J. (1972), *Ecology*, Harper and Row, New York.

This course will offer knowledge on biodiversity and its conservation. Loss of biodiversity is a global problem. Biowealth is the most important resource of a country. Each country has hotspots of biodiversity. Biodiversity has a function to perform in the ecosystem. Biodiversity needs to be conserved immediately. This course will deal with fundamental and applied aspects related to biodiversity conservation and management.

- Unit I.** Introduction, definition, type-species, genetic and ecosystem biodiversity, biodiversity of forests, grasslands desert, fresh water and ocean systems
- Unit II.** Evolution and genesis of biodiversity, biotic impoverishment, causes of loss of biodiversity, global and Indian scenario
- Unit III.** Biowealth- global species diversity, biowealth of India, values of species, genetic and ecosystem diversity
- Unit IV.** Hot spots of biodiversity, hot spots of India (North-east, Western Ghats, Andman and Nicobar islands), India's threatened ecosystems (forests, grasslands, desert, wetlands)
- Unit V.** Biodiversity and ecosystem function, biodiversity and productivity, biodiversity and ecosystem stability, biodiversity and soil fertility, effects of species removal and addition on an ecosystem
- Unit VI.** Conservation and management of biodiversity – *In situ* and *ex situ* conservation, elements of biodiversity conservation, scope of biodiversity conservation, ethnobiology
- Unit VII.** Protected areas-concept of biosphere reserves, national parks and sanctuaries and their functions, integrated protected area system
- Unit VIII.** Biosphere reserves-biosphere reserves of India, case studies of biosphere reserves-Nanda devi, Thar desert and Silent valley
- Unit IX.** World conservation strategy, national conservation strategy, special conservation projects-project tiger, project elephant, project hangul
- Unit X.** Biotechnology and biodiversity- *Ex situ* conservation, national and international scenario, biopiracy

Suggested readings

- Khoshoo, T.N. (1990), in *Indian Geosphere and Biosphere* (Eds. Khoshoo, T.N. and Sharma, M.), National Academy of Sciences, Allahabad.
- Reid, W.V. and Miller, K.R. (1989), *Keeping Options Alive: The Scientific Basis for Conserving Biodiversity*, World Resources Institute, Washington.
- Reid, W.V., in Whitemore, T., Sayer, J. (Eds.) (1992), *Tropical Deforestation and Species Extinction*, Chapman and Hall, London.
- WCMC (1993), *Global Biodiversity*, Chapman and Hall, London.

Climate change is the most burning issue threatening the entire human population. Climate change can cause damages to man, wild life, agriculture and other natural resources. It is a high time to understand the delicate relationship amongst man, animals, plants and their climate. This course will offer a detailed knowledge of world climates, a detailed knowledge on changing climates, natural disasters and their management.

- Unit I.** Introduction to atmosphere, composition of the atmosphere, vertical structure of the atmosphere
- Unit II.** Solar radiation, Earth-Sun relationship, mechanism of heat transfer, heat budget, nuclear and electromagnetic radiations
- Unit III.** Wind, horizontal movement of the air, global circulations, Land and sea breeze, mountain and valley breezes
- Unit IV.** Synoptic-motions, Jet streams, air-masses, different types of air masses, different types of fronts, cyclones-tropical and temperate, anticyclones, thunderstorms, tornadoes and hurricanes
- Unit V.** World climates-wet tropics, tropical wet and dry, the dry climates, the humid subtropical climate, the marine west coast climate, the polar climate, Monsoon
- Unit VI.** The changing climate, natural causes of climate change, impact of global climate change on man and environment.
- Unit VII.** Natural environmental hazards, earthquakes, seismic hazards, reservoir induced earthquakes, seismicity and Himalayan reservoirs
- Unit VIII.** Floods, types of floods, general characters of floods, adverse effects of floods, flood problem in India, flood management
- Unit IX.** Drought, drought classification, effects of drought on man, drought incidences in India
- Unit X.** El Nino – El Nino Southern Oscillation, El Nino and climate change

Suggested readings

- Barry, R.G. and Chorley, R.J. (1982), *Atmosphere, Weather and Climate*, 4th ed., Methuen, London.
- Critchfield, H. (1961), *General Climatology*, Prentice Hall, New Jersey.
- Koeppel, C.E. and De Long, G.C. (1958), *Weather and Climate*, McGraw-Hill, New York.
- Lutgens, F.K. and Tarbuck, E.J. (1979), *The Atmosphere*, Prentice Hall, New Jersey.
- Marsh, W.M. and Dozier, J. (1981), *Landscape Reading*, Addison Wesley, Mass.

This course deals mainly with the terrestrial ecology. Here a student will be taught different bio-geochemical cycles, aquatic ecology, the ecology of the sea, wetlands, coastal environments, and the modern practices of aquaculture. A student will be taught about soil erosion as well as soil conservation. The course will also discuss the most productive ecosystem of the world i.e. coral reefs.

- Unit I.** The geologic cycle, tectonic cycle, rock cycle, types of rocks, types of minerals.
- Unit II.** Soil, pedogenesis soil classification, soil types, soil profile, ecological relations of the soil
- Unit III.** Soil erosion, soil erosion in India, Soil conservation, Soil adaptations
- Unit IV.** Biogeochemical cycles, mineral cycles, oxygen cycle, nitrogen cycle, sulphur cycle, carbon cycle, phosphorus cycle
- Unit V.** Cycle of non essential elements, mercury cycle, arsenic cycle, silicon cycle, recycle pathways
- Unit VI.** Hydrosphere, hydrologic cycle, water budget, water budget of India, fresh water environment, lakes, ponds, rivers, estuaries, estuaries
- Unit VII.** Sea-the largest ecosystem, physicochemical aspect of marine environment, Oceanography
- Unit VIII.** Introduction to aquaculture, practice of aquaculture, environmental effects of aquaculture, introduction to mariculture, environmental effects of mariculture
- Unit IX.** Wetlands and coastal environment, problems of wetlands, coastal erosion
- Unit X.** Coral reefs, types of reefs, formation of coral reefs, destruction of coral reefs, conservation of coral reefs

Suggested readings

- Coker, R.E. (1954), *Streams, Lakes and Ponds*, University of North Carolina Press, Chapel Hill, USA.
- Das, S.M. (1989), *Handbook of Limnology and Water Pollution*, South Asian Publishers, New Delhi.
- Hutchinson, G.E. (1957, 1967, 1976), *A Treatise of Limnology*, Vol. I, *Geography, Physics and Chemistry of Lakes*, Vol. II, *Introduction to Lakes, Biology and Limnoplankton*, Vol. III, *Aquatic Communities and Energy Relationships*, Wiley, New York.
- Jhingran, V.G. (1991), *Fish and Fisheries of India*, Hindustan Publishing Corpn., New Delhi.
- Leopold, L.B. (1974), *Water: A Primer*, W.H. Freeman, San Francisco.
- Macan, T.T. (1963), *Fresh Water Ecology*, Wiley, New York.
- Mills, D.H. (1972), *An Introduction to Fresh Water Ecology*, Liver and Boyd, Edinburgh.
- Bormann, F.H. and Likens, G.E. (1967), Nutrient cycling, *Science*, **155**, pp. 424–429.
- Knowles, R. (1981), Denitrification, In: Paul, E.A. and Ladd, J.N. (Eds.). *Soil Biochemistry*, **5**, pp. 323–369, Marcel Dekker, New York.
- Larcher, W. (1975), *Physiological Plant Ecology*, Springer, Berlin.
- Odum, E.P. (1971), *Fundamental of Ecology*, 3rd ed., Saunders, Philadelphia.

This course deals with a different chemical process occurring in the environment including atmosphere, hydrosphere, and lithosphere. It deals with those chemical reactions occurring in the atmosphere leading to air pollution, acid rain, photochemical smog etc. Here a student will be taught chemistry of ozone depletion as well as water pollution.

- Unit I.** Energy, laws of thermodynamics, entropy, enthalpy, Gibb's free energy, energy and ecological homeostasis
- Unit II.** Osmosis, diffusion, chemical potential, chemical equilibrium, acid base reactions
- Unit III.** Heat transfer processes, scale of meteorology, pressure, temperature, precipitation, humidity, radiation and wind
- Unit IV.** Chemistry of air-particles, ions and radicals in the atmosphere, thermochemical and photochemical reactions, chemistry of oxygen and ozone
- Unit V.** Chemistry of water-concepts of DO, BOD, COD, sedimentation, coagulation, filtration, redox potential
- Unit VI.** Chemistry of soil-inorganic and organic components, nitrogen pathways
- Unit VII.** Chemistry of air pollutants- CO, CO₂, SO₂, SO₃, NO₂, NO₃, fly ash, CFCs and other organic compounds
- Unit VIII.** Chemistry of water pollutants- pH, colour, turbidity, alkalinity, nitrates, phosphates, heavy metals and pesticides
- Unit IX.** Smog and acid rain-components of acid rain, theory of acid rain, formation and dispersal of acid rain, components of smog, chemistry of smog, photochemical smog
- Unit X.** Chemistry of stratosphere, ozone formation and ozone depletion

Suggested readings

- Hamill, P. and Toon, O.B. (1991). Polar stratospheric clouds and the oxone hole. *Physics today* 44(12): 34-42. This is a good review article of the ozone problem and important chemical and physical processes related to ozone depletion.
- Jones, R.R. and Wigley, T. (1989). Ozone depletion: *Health and environmental consequences*. New York, John Wiley and Sons, Inc. Proceedings of the international conference on the health and environmental consequences of stratospheric ozone depletion, held at the Royal Institute of British Architects, London, November 28-29, 1988.
- Rowland, F.S. (1990). Stratospheric ozone depletion by chlorofluorocarbons. *AMBIO* 19(6-7): 281-912. This is an excellent summary article of stratospheric ozone depletion that discussed some of the major issues.
- Shea, C.P. (1989). Mending the earth's shield, *world watch* 2(1): 28-34. This article focuses on solutions to the ozone problem. It is primarily concerned with control strategies to stop ozone depleting chemicals from being emitted into the atmosphere.
- Toon, O.B. and Turco, R.P. (1991). Polar stratospheric clouds and ozone depletion, "*Scientific American* 246(6): 68-74. This article provides valuable information concerning polar stratospheric clouds and their importance in ozone depletion, it offers a good explanation of the formation of polar stratospheric clouds and the chemistry that occurs there.

This course deals with eco-physiology discussing relationship between the environment and important physiological processes like diffusion, transport, osmoregulation and nutrient cycles. The relationship between the soil organism and soil, similarly the relationship between aquatic organisms & water and the way they have adapted to their habitat will be taught to students.

- Unit I.** Introduction, osmosis, diffusion, and transport mechanisms, active transport, passive transport, phagocytosis
- Unit II.** Principles and mechanisms of osmoregulation in plants and animals, role of gills and kidney in osmoregulation
- Unit III.** Nutrients, trace elements, ion and metal tolerance in plants and animals, deficiency disorders in plants and animals
- Unit IV.** Influence of soil on plant physiology, plant responses of acidic and alkaline soils
- Unit V.** Influence of water quality on animal physiology, catadromous and anadromous fishes
- Unit VI.** Environmental adaptations, adaptations to fresh water and marine habitats, cold water adaptations
- Unit VII.** Adaptations to terrestrial habitat, desert adaptations
- Unit VIII.** Reproductive adaptations, effects of environment on reproduction
- Unit IX.** Migration, general idea of migration in fish and birds
- Unit X.** Breeding seasons, photoperiodism and reproduction

Suggested readings

- Allee, W.C. (1961), *Cooperation among Animals with Human Implications*, Henry Schuman, New York.
- Andrewartha, H.G. and Birch, L.C. (1954), *The Distribution and Abundance of Animals*, Univ. Chicago Press, Chicago.
- Boucher, D.H., James, S. and Keeler, K.H. (1982), The ecology of mutualism, *Ann. Rev. Ecol. System*, **13**, p. 315.
- Hardin, G. (1962), The competitive exclusion principle, *Science*, **131**, pp. 1292–1297.
- He Slop-Harrison, Y. (1979), Carnivorous plants, *Sci. Amer*, **238**, pp. 104–115.
- Huxly, C. (1980), Symbiosis between ants and epiphytes, *Biol. Rev.* **55**, pp. 321–340.
- Margulis, L. (1981), *Symbiosis in Cell Evolution*, Freeman, San Francisco.
- Odum, E.P. (1971), *Fundamentals of Ecology*, 3rd ed., Saunders, Philadelphia.

Health and environment are very closely related subjects. Man is affected by air pollution, water pollution, noise pollution, radioactive pollution, and industrial pollution. This course will teach the students the health effects of these pollutants not only on man but also on animals and plants. It will be focusing on epidemiology as well as occupational health.

- Unit I.** Epidemiology, definition, history of epidemiology, aims of epidemiology, descriptive epidemiology, analytical epidemiology, cohort studies
- Unit II.** Epidemiology of selected communicable disease malaria, tuberculosis, filariasis, AIDS
- Unit III.** General introduction to bacteria, bacteriophage, virus, viroids, protozoan pathogens
- Unit IV.** Pollution- types of pollution, pollution sources and events, priority pollutants, environmental mobility of pollutants, environmental compartments, transport through compartments, transfers, transformations
- Unit V.** Air pollution- Classification and properties of air pollutants, photochemical smog, acid rain, effects of air pollution and human health, indoor air pollution
- Unit VI.** Water pollution- origin of wastewater, domestic water pollution, industrial water pollution, agricultural water pollution, solid waste pollution, thermal pollution, oil pollution, toxic water pollutants and their effects, groundwater pollution
- Unit VII.** Noise pollution- Sources of noise pollution, industrial noise pollution, domestic noise pollution, traffic noise, other sources of noise pollution effects of noise pollution in man
- Unit VIII.** Radioactive and thermal pollution- Sources of exposure to radiation, biological effects of radiation, famous incidents of radioactive pollution
- Unit IX.** Occupational health- occupational hazards, occupational diseases, pneumoconiosis, preventive measures, lead poisoning (plumbism), occupational cancer, occupational dermatitis, radiation hazards, occupational hazards of agricultural workers, health problems due to industrialization
- Unit X.** Industrial pollution and human health- persistent organic pollutants (POPs), dirty dozens, major POPs, Aarhus protocol

Suggested readings

- Ambur, M., Doull, J., and Klaasen, C.D. eds 1991. *Casarett & Doulls Toxicology: The basic Science of Poisons*, 4th ed. Pergamon Press. Comprehensive and more advanced coverage of toxicology.
- Carson, R. (1962). *Silent spring*. Boston: Houghton Mifflin Company. A classic book on problems associated with toxins in the environment.
- Travis, C.C. and Hattemer-Frey, H.A. (1991). Human exposure to dioxin. *The science of the total environment*. 104: 97-127. An extensive technical review of dioxin accumulation and exposure.

Recent developments of biotechnology offer several technologies to deal with environmental problems. There are concepts of bioremediation, biofertilizers, biopesticides, bioenergy and biotechnological applications to conserve biodiversity. This modern course is expected to provide simple knowledge on the management of environmental problems using biotechnological methods.

- Unit I.** Introduction to Environmental biotechnology- Definition, history and scope of biotechnology, Genetic engineering, cloning, methods of molecular cloning.
- Unit II.** Biotechnological processes- Bioconversion, bioaccumulation, biodegradation, Fermentation as a biotechnological process, Concept of bioreactors, Types of bioreactors.
- Unit III.** Biodegradation- Non-biological degradation of pollutants, biodegradation by bacteria, biodegradation of organic pollutants, biodegradation of pesticides and carbamates.
- Unit IV.** Bioremediation- Bioremediation of organic contaminants, inorganic contaminants, Bioadsorption of metals, bioreduction, phytoremediation, advantages of bioremediation and phytoremediation.
- Unit V.** Biotechnology and waste water treatments- Oxidative ponds, aerobic ponds, facultative ponds, activated sludge treatment, the percolating filter, waste water treatment by biofilms, case study of a paper industry-effluent treatment.
- Unit VI.** GMOs, Transgenic animals- Transgenic plants, Transgenic fish, Stress tolerant plants and their significance.
- Unit VII.** Biofertilizers & Biopesticides, Integrated Pest Management- Bacterial biofertilizers algal biofertilizers, aquatic fungi biofertilizers, biopesticides, and integrated pest management.
- Unit VIII.** Energy and biofuels- Energy from biomass, biodiesel, biofilters, biosensors and biochips, biofuel cells, endorphins.
- Unit IX.** Biotechnology and biodiversity- Biotechnology and biodiversity conservation, cryopreservation, seed banks, DNA banks, other types of gene banks, micropropagation.
- Unit X.** Biotechnology and solid waste management-Sanitary land fills, Aerobic treatment of solid waste (Composting), Composting systems, Vermicomposting, Sewage treatment.

Suggested readings

- Khoshoo, T.N. (1990), in *Indian Geosphere and Biosphere* (Eds. Khoshoo, T.N. and Sharma, M.), National Academy of Sciences, Allahabad.
- Reid, W.V. and Miller, K.R. (1989), *Keeping Options Alive: The Scientific Basis for Conserving Biodiversity*, World Resources Institute, Washington.
- Reid, W.V., in Whitemore, T., Sayer, J. (Eds.) (1992), *Tropical Deforestation and Species Extinction*, Chapman and Hall, London.
- WCMC (1993), *Global Biodiversity*, Chapman and Hall, London.

All eco-compartments of environment are saturated with chemicals and toxins today. They are causing wide spread problems in major ecosystems. They include metals, pesticides, and other poisons. They can cause problems to man like environmental carcinogenesis and other serious diseases. This course will discuss how to protect the environment from toxicological problems.

- Unit I.** Ecotoxicology, Examples of ecotoxicology, Scientific approach to ecotoxicology, Entry, movement and fate of pollutants in ecosystems.
- Unit II.** Natural toxins, Animal toxins, Snake venoms, Toxins, of other animals, Plant toxins.
- Unit III.** Environmental factors affecting metabolism of toxins: Physical factors- Temperature, Ionizing radiation, Light, Moisture and Altitude.
- Unit IV.** General description of toxicants- Metals, Pesticides, POPs, Portals of their entry and toxic effects.
- Unit V.** Metabolism of toxicants- Phase I reactions, Oxidation, Reduction and hydrolysis of toxic compounds.
- Unit VI.** Metabolism of toxicants- Phase II reactions, Conjugation, methylation, acylation of toxic compounds.
- Unit VII.** Genetic poisons, Cytostatic agents, Chromosome damage, Gene mutation.
- Unit VIII.** Ecological risk assessment, Cause effect relationship for DDT, Acid rain and chloro floro carbons.
- Unit IX.** Environmental carcinogenesis, Chemical carcinogenesis, Organic carcinogens, Metal carcinogens, Occupational cancer.
- Unit X.** Environmental Safety: General information on environmental protection agency, WHO, National institute of Environmental Health Sciences (NIEHS), Occupational safety and health association.

Suggested readings

- Ambur, M., Doull, J., and Klaasen, C.D. eds 1991. *Casarett & Doulls Toxicology: The basic Science of Poisons*, 4th ed. Pergamon Press. Comprehensive and more advanced coverage of toxicology.
- Carson, R. (1962). *Silent spring*. Boston: Houghton Mifflin Company. A classic book on problems associated with toxins in the environment.
- Travis, C.C. and Hattemer-Frey, H.A. (1991). Human exposure to dioxin. *The science of the total environment*. 104: 97-127. An extensive technical review of dioxin accumulation and exposure.

Environment needs to be monitored and assessed using suitable analytical techniques. There are a variety of modern technique available to measure air pollution, water pollution, soil pollution and noise pollution. However, a student is to be taught the basic principles involved in their management. Therefore, this course will offer a detailed knowledge on spectrophotometry, chromatography, gravimetry, luminometry, and even the remote sensing.

- Unit I.** General methods of environmental analysis: Methods for quantitative analysis; Gravimetric method; volumetric methods; Ultraviolet and visible spectrophotometry; Infrared and Raman spectroscopy; Light scattering techniques; Molecular luminescence methods.
- Unit II.** Air pollution analysis: Sampling of gaseous pollutants; Analysis of aerosols; Analysis of gaseous pollutants; Sulphur dioxide analysis; H₂S analysis; NO-NO_x analysis; Ozone analysis; NH₃-analysis; Organic gases and vapour analysis.
- Unit III.** Monitoring of ambient air pollution: Air pollution monitoring instruments; Meteorological instruments; Monitoring of sulphur dioxide; Monitoring of NO-NO_x; Monitoring of CO, CO₂; Monitoring of hydrocarbons (HC) and ozone; Monitoring of suspended particulate matter.
- Unit IV.** Water pollution analysis: Physical examination of water; Turbidity; Hardness; Chemical characterization of water; Biological investigation of water; Biological water quality assessment-Importance, objectives and scope; Biological water quality criteria (BWQC); Steps involved for bio-monitoring of surface water bodies in problem areas in the country.
- Unit V.** Soil pollution and pesticide analysis: Role of micronutrients in soil; analysis of micronutrients in soil; Trace elements analysis in soil; Pesticides and pollution; Pesticide analysis; Chromatographic characterization of pesticides; Polarographic analysis of pesticides; Spectroscopic analysis of pesticides.
- Unit VI.** Noise pollution measurement: Noise measurement; Noise mapping; Anechoic chamber; Environment and noise measurements.
- Unit VII.** Spectrophotometry, Principles of spectrophotometry, Beer-Lambert relationship; Instrumentation; Applications of spectrophotometry; Atomic spectroscopy; Flame emission photometry; Atomic absorption spectropotometry.
- Unit VIII.** Chromatography: Liquid-solid chromatography; Liquid-liquid chromatography; Paper chromatography; High performance liquid chromatography (HPLC); Gas-liquid chromatography; Applications of GLC.
- Unit IX.** Remote sensing: Principles of remote sensing; Applications of remote sensing in environmental analysis (Forest, wild-life, soil and atmosphere).
- Unit X.** Statistical methods: Measurement of central tendencies (Mean, mode, media and range), standard deviation, standard error, significance difference, Z-test, t-test.

Suggested readings

- Rana, S.V.S. (2007). Biotechniques theory and practices, Rastogi Publications, Meerut.
- Grasshoff, G. (1975). Methods of sea water analysis. Verlag-Chemie, Weinheim (1975).
- Burrell, D.C. (1974). Atomic spectrometric analysis of heavy metal pollutants in water. Ann Arbor Science Publishers, Ann Arbor.
- APHA. (1981). Standard methods for the examination of water and waste water. 15th ed.
- Samant, H.S. (1973). Methods for chemical analysis of water and waste water. Surveillance report EPSS. AR. 73-12. Canada.
- Marr, I.L. and Cresser, M.S. (1983). Environmental chemical analysis. International Textbook Co., 'Environmental pollutants: Selected Analytical methods SCOPE'. 6 (1975). Butterworths, London.

Environment does not know political boundaries. Therefore, the entire biosphere is suffering from some common problems. These problems include green house effect, ozone depletion, loss of biodiversity, land degradation, and pollution of different eco-compartments. They are to be studied from global perspectives. It is very essential for a student of environment science to know these problems in order to manage them. Therefore, this course becomes very attractive from environmental management point of view.

- Unit I.** Introduction to global environmental problems, global warming, global warming and climate change, environmental effects of global warming
- Unit II.** Green house effect, green house gases, differential green house effect, green house gases and climate change
- Unit III.** Ozone umbrella, ozone depletion over Antarctica, Anthropogenic damage to ozone, ozone depleting substances (ODS)
- Unit IV.** Health effects of ozone depletion and increased UV-B radiation
- Unit V.** Montreal protocol, saving the ozone layer conference London, Declaration of Hague, Kyoto protocol
- Unit VI.** Biotic impoverishment, loss of biodiversity at global and natural level, biodiversity convention
- Unit VII.** Land degradation, deforestation and desertification drought
- Unit VIII.** Marine pollution, marine pollution in India, global water crisis
- Unit IX.** Important international events-UN conference on Human environment 1972, Earth Summit, 1992, Brudland Commission report, Kyoto Conference, 1997
- Unit X.** El-Nino, its effects on global climate, climate change, IPCC

Suggested readings

- Diaz, H.F. and Markgraf, V. (eds), 1992. *El Nino: Historical and Paleoclimatic Aspets of the Southern Oscillation*. Cambridge University Press, 476 pp.
- Philander, S.G.H. 1990. *EL Nino, La Nina, and the Southern Oscillation*. Orlando, Fla.: Academic Press.
- Houghton, J.T., Jenkins, G.J. Ephraums, J.J. (eds), 1992. *Climate Change: The IPCC Scientific Assessment*. Cambridge University Press.
- Baum, R.M., 1982. Stratospheric science undergoing change. *Chem. Eng. News*. **70**, 21.

The answer to all environmental problems is its management. It should be scientific and economical. It should follow the international rules and be acceptable to all countries. Therefore, this course introduces the common concept of environmentalism. Moreover, the practical aspects like EIA, environmental auditing and sustainability will be taught in this course. The contents of the course include management of atmosphere, water, soil, solid waste, forest, wild life, aquatic resources, agricultural resources and even the ocean. Modern concept of environmental management including remote sensing will be studied in this course.

- Unit I.** Concepts of environmentalism, carrying capacity and sustainable development, need for sustainable development, the relationship between socioeconomic system and ecosystem, sustainable future
- Unit II.** Environmental impact assessment – Definition, History of environment impact assessment, Content of EIA, Methods of EIA, and Limitations of EIA
- Unit III.** Environmental auditing – Methods of environmental auditing, implementation of audit policy, environmental auditing as a component of environmental management system
- Unit IV.** Management of atmosphere – Air quality, monitoring, monitoring methods and instruments
- Unit V.** Water management – Water resources and hydrological cycle, water quality and pollution, sustainability of water resources, eutrophication
- Unit VI.** Soil and solid waste management – Reclamation of soil, management of soil erosion, soil management, bramage and irrigation, soil management and plant nutrition, prevention and elimination of hazardous wastes, policies and techniques of waste management
- Unit VII.** Sustainable agriculture – From natural ecosystem to agri ecosystems
- Unit VIII.** Sustainable forest management – Ecological problems of the forests, Sustainable management of forest
- Unit IX.** Sustainable fish management – The economic fisheries multidimensional fish management, fish biology to fish ecology
- Unit X.** Management of ocean management – Coastal areas, CZR, marine resources, sustainable use and conservation of marine resources, coral reefs and mangroves.

Suggested readings

- Atchia, Michael and Shawna Troop, eds. *Environmental Management; Issues and Solutions*. New York: Willey, 1995.
- Fien, John, et al., eds. *Environmental Education: A pathway to sustainability*, New York: St. Martins, 1993.
- Schramm, Gunter, and Jeremy J. Warford. *Environmental Managemetn and Economic Development*. Baltimore: Johns Hopkins, 1989.
- Welford, Richard, *Environment Strategy and Sustainable Development: The corporate challenges for the Twenty-first Century*, New York: Routledge, 1995.

Environment is a global concern. Therefore, several countries have developed respective environmental policies and legislative measures to deal with the local problems under the global umbrella. India to has national environmental policies, national forest policies and a full set of environmental laws to combat air pollution, water pollution, noise pollution, industrial pollution and the laws to protect fish and wild life. These policies equip the person to deal environmental problems at a local level.

- Unit I.** Environmental protection, issues and challenges at Global level and national level, Environmental protection in India, Environmental protection Act, Provisions in constitution of India.
- Unit II.** Acts and rules regarding air pollution control and protection in India.
- Unit III.** Acts and rules regarding water pollution control and protection in India.
- Unit IV.** Indian Forest act and its provisions
- Unit V.** Indian Fisheries act and its provisions
- Unit VI.** Wild Life protection act and its provisions
- Unit VII.** Aims and objectives of Department of Environment, Forests and Wild Life (Govt. of India)
- Unit VIII.** Important National and International NGOs and their role in Environmental Education and Protection-UNEP, IUCN, EPA, WWF
- Unit IX.** Environmental auditing, principles and methods of environmental auditing
- Unit X.** Case studies on environmental protection, Chipko movement, Apiko movement, Bishnoi Community, Save Narmada Project

Suggested readings

Agarwal, A., Narayan, S., Sharma, A. (1999), Green Politics, Centre for Science and Environment, New Delhi.

Helge Ole Bergesen et al. (1998), Yearbook of International Co-operation on Environment and Development 1998/9, Earthscan Publications Ltd, London.

Agarwal, K.C. (1995), Environmental Pollution and Law, Agro Botanical Publisher, Bikaner.

The last course of environment and development is directly related to human development. The course content include environmental economics, environmental politics, environment and food, environmental tourism, environmental sociology, environmental education and also introduces the newly emerging environmental challenges. It is expected that by going through these courses a student will be able to manage all environmental problems in totality.

- Unit I.** Relationship of man with nature – Major human cultural changes, Agricultural revolution, Industrial revolution.
- Unit II.** Environment and Economics – Economic system, Types of economic system, Economics and environmental quality, Economic sustainability.
- Unit III.** Environment and politics – Global environmental policy, National environmental policy, Environmental policy in United States of America, Environmental groups.
- Unit IV.** Environment and Human health – Biological hazards, Human diseases in developed and developing countries, Different systems of medicine, Social and preventive medicine.
- Unit V.** Environment and food – Sources of food, Ecological perspectives of agriculture, World food supply, Aquaculture and Mari culture.
- Unit VI.** Environment and tourism – Ecological importance of wilderness and landscapes, Landscape as an ecosystem, Landscape planning and management, Sustainable tourism.
- Unit VII.** Environmental sociology – Environmental ethics, Anthropocentrism, Judeo-Christian ethic, Traditional Env. Ethics, Biocentrism, Ecocentrism, Gandhian concept of ecology.
- Unit VIII.** Environmental education and communication – Objectives of environmental education and communication, Instruments of environmental education, Environmental education management.
- Unit IX.** Human ecology – History of human ecology, Ethnobiology, Ethnozoology, Disappearing human ecosystems.
- Unit X.** Environmental challenges – Population explosion, Biotic impoverishment, Deforestation, Water crisis, Emerging human diseases, natural disasters.

Suggested readings

- Atchia, Michael and Shawna Troop, eds. *Environmental Management; Issues and Solutions*. New York: Willey, 1995.
- Fien, John, et al., eds. *Environmental Education: A pathway to sustainability*, New York: St. Martins, 1993.
- Schramm, Gunter, and Jeremy J. Warford. *Environmental Managemetn and Economic Development*. Baltimore: Johns Hopkins, 1989.
- Welford, Richard, *Environment Strategy and Sustainable Development: The corporate challenges for the Twenty-first Century*, New York: Routledge, 1995.