

Department of Environmental Science
 M.Sc., Environmental Science
 Syllabus – Under Choice Based Credit System
 (With effect from August 2017)

Scheme

I Semester

Paper code	Paper Title	Credit/Hrs		Total	Marks		Total marks
		Th	Pr		IA	Th/Pr	
ES. HC-1.1	Multidisciplinary Nature of Environmental Science	4	2	6	25	75	100
ES. HC-1.2	Environment and Ecosystem	4	2	6	25	75	100
ES.SC-1.3	Environment for Development	4	2	6	25	75	100
ES.SC-1.4	Aquatic Ecology	4	2	6	25	75	100
ES.SC-1.5	Radiation and Environment	4	2	6	25	75	100
ES.PrHC-1.1	Based on HC-1.1	-	-			50	50
ES.PrHC-1.2	Based on HC-1.2					50	50
ES.PrSC	Based on softcore paper- ES.SC-1.3/1.4/1.5					50	50
Total					30		

II Semester

Paper code	Paper Title	Credit/Hrs		Total	Marks		Total marks
		Th	Pr		IA	Th/Pr	
ES.HC-2.1	Environmental Chemistry and Environmental Statistics	4	2	6	25	75	100
ES.HC-2.2	Environmental Pollution	4	2	6	25	75	100
ES.SC-2.3	Energy and Energy Resources	4	2	6	25	75	100
ES.SC-2.4	Solid Waste Management and Resource Recovery	4	2	6	25	75	100
ES.SC-2.5	Natural Resources and Conservation	4	2	6	25	75	100
ES.PrHC-2.1	Based on HC-2.1	-	-			50	50
ES.PrHC-2.2	Based on HC-2.2					50	50
ES.PrSC	Based on softcore paper- ES.SC-2.3/2.4/2.5					50	50
IDE				2	10	40	50
Total					26		

III Semester

Paper code	Paper Title	Credit/Hrs		Total	Marks		Total marks
		Th	Pr		IA	Th/Pr	
ES.HC-3.1	Environmental Engineering & Science	4	2	6	25	75	100
ES.HC-3.2	EIA and Environmental Microbiology	4	2	6	25	75	100
ES. SC-3.3	Global Environmental Changes & Natural Hazards	4	2	6	25	75	100
ES.SC-3.4	Water quality Science	4	2	6	25	75	100
ES.SC-3.5	Air Pollution Monitoring	4	2	6	25	75	100
ES.SC-3.6	Environmental Nano-Science	4	2	6	25	75	100
ES.PrHC-3.1	Based on HC-3.1	-	-			50	50
ES.PrHC-3.2	Based on HC-3.2					50	50
ES. Pr SC	Based on softcore paper- ES.SC-3.3/3.4/3.5/3.6					50	50
IDE				2	10	40	50
Total						26	

IV Semester

Paper code	Paper Title	Credit/Hrs		Total	Marks		Total marks
		Th	Pr		IA	Th/Pr	
ES.HC-4.1	Ecotoxicology	4	2	6	25	75	100
ES.HC-4.2	Occupational Health and Safety & Environmental Law	4	2	6	25	75	100
ES.PrHC-4.1	Based on HC-4.1	-	-			50	50
ES.PrHC-4.2	Based on HC-4.2					50	50
	PROJECT WORK			2			100
Total						12	

Total Credits- 94/Programme

List of Elective Papers

1. Environmental Education32 hrs
2. Drinking Water Resources, Quality and Management32 hrs

I SEMESTER

ENV.HC-1.1: Multidisciplinary Nature of Environmental Science....64 Hrs

Unit 1: *Introduction*: Multidisciplinary and interdisciplinary nature of environments; importance of various subjects; biology, physics, statistics, microbiology, bio-chemistry, geology, toxicology, engineering, economics, law and sociology in environmental studies.

- 8 hrs.

Unit 2: *Fundamentals of environmental chemistry and geochemistry*: Chemistry: Scope: of environmental chemistry, Stoichiometry, Gibb's energy, Chemical potential, Chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system. Geochemistry: Fundamental concepts, structure and components of geosphere; lithosphere, hydrosphere, and atmosphere. Energy budget of the earth. Climates of India.

- 12 hrs.

Unit 3: *Physical aspects of environment*: The solar system and meteorology: sun as a source of energy, nature of its radiation; heat budget of earth; earth's temperature and atmosphere. Meteorology fundamentals: pressure; temperature; wind; humidity; radiation; atmospheric stability; turbulence and diffusion. Radiation and environment: discovery of radioactivity- Units and definition of radioactivity. Radiation from cosmic origin; ionizing and non-ionizing radiations. Methods of radioactive measurements

-12 hrs.

Unit 4: *Environmental Biology*: Basic ecological principles and concepts; scope of ecology; principles and concepts of ecosystem; types of ecosystem; terrestrial and aquatic. Flow and energy fixation, construction of ecological pyramids. Primary succession, secondary succession and ecological climax, impacts of development of ecosystem, population, community ecology, predator and prey relationship. - 12 hrs.

Unit 5: *Social environment*: Social, economic, agriculture and industrial issues of environment; Socio cultural habits in human communities. Demand for food and environmental crises. Basic concepts of sustainable development, social environmental issues and urban problems related to energy. Water conservation, rain water harvesting and watershed management.

-10 hrs

Unit 6: *Institutions for environment conservation*: Bombay Natural History Society (BNHS). World Wide Fund for nature (WWF); Centre or Science and Environment (CSE), Centre for Environmental Education (CEE), Kalpavriksh, Salim Ali Centre for Ornithology

and Natural History (SACON); Wildlife Institute of India (WII), Botanical Survey of India (BSI), Zoological Survey of India (ZSI). - 10 hrs.

Practical:

1. Good Laboratory Practices- guidelines
2. Determination of Surface Tension and Density of water
3. Determination of Viscosity of water sample
4. Determination of Acidity, Alkalinity and pH of Water Samples
5. Normality; Molarity; Equivalent weight of elements and compounds
6. Acid Base Reaction
7. Instrumentation: pH meter, colorimeter, spectrophotometer, BOD incubator,
8. Turbidity meter, Portable Weather Station.

Reference (Latest Edition of the Following)

1. E. P Odum and G.W. Barret. Fundamentals of Ecology.
2. Chapman, JL and Reiss, MJ. Ecology principles and application. Cambridge University press.
3. Write R and Boorse, D. Environmental Science— Toward a Sustainable Future: International Edition.
4. Master, G Joseph. K, Nagendran R. Introduction to Environmental Science and Engineering. Pearson Education, Singapore.
5. Ronald A Bailey, Herbert M Clark, James P Perris, Sonja Krause, Robert L Strong. Chemistry of Environment, Academic Press.

ENV.HC-1.2: Environment and Ecosystem64 hrs

Unit 1: *Environment*: Definition of Environment; Development and environment; the pursuit of development. Basics of Structure and function of Environment; Ecology; environment; Ecosystem function-classification of environmental system- by function-isolated systems; closed systems and open systems; by degree of human disturbance-Natural system; modified system and controlled systems; Environmental limits; Environmental Crisis.12 hrs

Unit 2: *Energy in Ecological System*: Definition of ecosystem; abiotic and biotic components. Ecological relationships. Energy of life; sources of energy in the earth ecosystem; the first and second law of thermodynamics. Concept of productivity. The flow of energy through ecosystem; Food chain, food web and trophic levels; Producers, consumer and decomposers-Ecological pyramids.10 hrs

Unit 3: *Ecosystem and Living Things*: Interaction of living organisms: Niche, competitive exclusion, Limiting factors, co-evolution, symbiosis-Mutualism, Commensalism, Parasitism. Changes in communities over time- primary and secondary succession- pioneer community, climax community, climax community.10 hrs

Unit 4: *Ecosystem and the Physical Environment*: The cycling of material within ecosystem-biogeochemical cycle- the carbon cycle, Nitrogen cycle, Phosphorus cycle and Hydrologic cycle. Physical Environment; climate, sun-solar energy, wind- atmospheric circulation, Oceanic currents, types, patterns and importance.10 hrs

Unit 5: *Major Ecosystem of the World*: Geography of life. Salient features and characteristics of biomes; major terrestrial biomes- Tundra, Taiga, Temperate forest, Grasslands. Deserts, Savanna, Tropical Rain Forests. Aquatic Biomes and Life zones; Freshwater ecosystems- lentic and lotic. Estuaries, Marine.10 hrs

Unit 6: *Population and Biotic Community*: Concept of population, community, ecosystem, biosphere and ecosphere. Population density, abundance, indices. Population attributes- natality, mortality, emigration, immigration, distribution. Population growth form and concept of carrying capacity. Population regulation, dispersal, population energy flow. Allele's principle. Population interactions. Principles of Limiting factors; Liebig's law of minimum, Shelford law of tolerance. Ecological indicators. Human population explosion and consequences. Biotic community Concept, Intercommunity classification; Concept of Ecological dominance. Community analysis, Species diversity in communities, Patterns in communities. Ecotone and edge effect.12 hrs

Practical-

1. Primary productivity of Pond- light and dark bottle experiment
2. Producers and consumers of pond ecosystem- Enumeration
3. Relationship between producers and consumers of pond ecosystem- Number and biomass
4. Guild of biotic community- based on feeding (example fish)
5. Diversity indices- Shannon-wiener, Simpson and Brullion index.
6. Adaptation of organisms to swift flowing water (Example fish)
7. Identification of Benthic communities of River
8. Survey and Sampling techniques (quadrates, line transect) in forest

References: (Latest Edition of the Following)

1. Peter H. Raven, David M. Hassenzahl, Mary Catherine Hager, Nancy Y. Gift, Linda R. Berg. Environment. John Wiley and Sons, Inc. UK..
2. Eugene P. Odum: Fundamentals of Ecology. Cengage Learning
3. Hynes HBN. The ecology of Running Waters. Liverpool University Press
4. Begon M, Harper JL, Townsend CR. Ecology- Individuals, Populations and Communities. Blackwell Scientific Publications. London

Soft-core papers

ES. SC-1.3: Environment for Development64 hrs

Unit 1: *Our common future*: Link between development and Environment; Evolution of Ideas and action – Interrelationship among environment; economic and social issues; population and human resources; food security; species and ecosystem; energy; industry and urbanization. Remedy towards sustainable development - 10 hrs

Unit 2: *Agenda 21*: Comprehensive plan of action towards sustainable development- social and economic issues; poverty, human health and population; - conservation and management of natural resources – atmosphere; forests; biological diversity; wastes and toxic chemicals. Role of local authorities, women, farmers, children and youth, indigenous peoples, workers and trade unions, NGOs, the scientific and technological community, and business and industry in implementing sustainable development. Means of implementation- technology transfer; financing; science; education and public information.

-12 hrs

Unit 3: *Environment as a foundation for development*: Human beings as centre of concerns for sustainable development and their relationship to a healthy and productive life in harmony with nature. Concept of good development- increasing the asset base and its productivity; empowering poor people and marginalized communities; reducing and managing risks; and long-term perspective for intra- and intergenerational equity. -10 hrs

Unit 4: *Human Wellbeing*: Health- complete physical, mental and social wellbeing; material need and ecosystem goods and services for ecofriendly livelihood; environmental security; Environmental change and human well-being. -10 hrs

Unit 5: *Environmental changes- pressures and drivers*: demographic changes, economic demand and trade, science and technology, institutional and socio-political frameworks - state of the environment with impacts on the environment itself, and on society and economic activity (changes in emissions, land use and resource extraction). -10 hrs

Unit 6: *Drivers of Environmental changes*: Massive population increase; Rapid technological innovation; explosion in energy use and economic integration. Affluence; Technology; poverty; market failure; policy/political failure; economic growth; nature of economic system; culture and values; forces of globalization. Consequences of degradation on environmental quality and sustainability. -12 hrs

Practicals

1. Study of Millennium Development Goal of UNEP
2. Collection and identification of herbs used by local community for medicine
3. Identification of local/indigenous wild fruits
4. Collection, identification and assessing the economic values of local food crops
5. Collection and identification of oil yielding native plant seeds
6. Estimation of Oil in native plant seeds
7. Isolation and estimation of active ingredients of herbs
8. People Biodiversity Register

References (Latest Edition of the Following):

1. Bill Adams. Green Development: Environment and Sustainability in a Developing World. Routledge Publisher. Oxon.
2. Diego Martino and Zinta Zommers. Environment for Development, UNEP

ES. SC-1.4: Aquatic Ecology64 hrs

Unit 1. *Aquatic Environment*: Introduction; Classification and structure of aquatic environments; Freshwater, marine and brackish water ecosystems; distinctive features and importance.10 hrs

Unit 2. *Aquatic Ecosystems: Freshwater Ecosystem*-Introduction; classification; lentic (lake, Reservoir, pond, Bog, Marsh, swamp, pool) and lotic system (River, tributaries, stream, glacial streams, nullahs, seepage streams); Salient features of each type. Origin of rivers. ***Marine ecosystem***: the marine environment, physico-chemical properties, Oceanic phenomenon of thermal current; thermohaline circulation. Stratification of marine habitat. ***Estuarine Ecology***: Definition and classification, nutrient and water current in estuary. Effect of Climate change on all aquatic ecosystems.-12 hrs

Unit 3. *Biodiversity of Aquatic ecosystems*: Plankton: Phyto and Zooplankton, Inter relationship: Macrophytes: Adaptation and succession. Types of macrophytes and their role in ecosystem; Important fauna and flora of lentic and lotic systems. Limiting factors controlling distribution of fauna and flora in lentic, lotic and estuarine environment. Primary and secondary productivity of aquatic ecosystem.10 hrs

Unit 4. *Wetlands*: Definition and classification of Wetlands; Fresh water wetlands, Marshes, Bogs, Swamps, Peat lands. Wetland Functions and Values; Nutrient cycling in aquatic systems. Productivity, trophic states and eutrophication. Marine wetland. Ecosystem services of wetlands10 hrs

Unit-5: *Wetlands Conservation and Wetland Management*: Threats to wetland; siltation, pollution, encroachment, urbanization, over exploitation of fauna and flora. Influence of climate change on Wetlands. Management of weeds, siltation, nutrient levels and control of overexploitation. Status of wetland biodiversity and conservation priorities. Criteria for wetland restoration, protection and management.12 hrs

Unit 6. *Wetland Conservation planning*: Ramsar Convention; Ramsar sites, criteria for Ramsar sites. World list of Ramsar sites and their uniqueness. Ramsar sites in India. Wetland conservation protocol-local regional and national; National Wetland Rules 2010. Other issues related to water: river linking project. Dams and diversion of river waters....10 hrs

Practicals

1. Estimation of physico-chemical parameters of water bodies
 - a) Transparency – sacchi disc,
 - b) Current velocity
 - c) Water sampling techniques- Kremmerer water Sampler, Bottle water sampler
 - d) Sediment sampling -using core sampler, grab sample
 - e) Processing and preservation of water and sediment sampling

2. Sampling of Phytoplankton, identification and enumeration
3. Sampling of Zooplankton, identification and enumeration
4. Sampling of aquatic macrophytes, taxonomic identification upto species
5. Sampling and identification of benthic invertebrates of river
6. Sampling and identification of freshwater fishes.
7. Bio-mapping techniques

References (Latest Edition of the Following):

1. Michael Kaill and John.K. Frey. Environments in Profile –An aquatic perspective.
2. Chapman JL and M.J. Reiss. Ecology- Principles and Applications.
3. Balasubramaniyan.A. Ecology Environment and pollution M/S Indira publishers, Mysore
4. Siddiqui, KA. Ecology and Environmental Biology. Kushal Publications and distributors.
5. Daniel Botkin. Edward Keller. Environmental Science-Earth as a living planet. John Wiley and Sons. New York.

ES. SC-1.5: Radiation and Environment -----64 hrs

Unit 1. *The Nuclear Environment:* Introduction; cosmic radiation; natural and anthropogenic sources of radioactivity and distribution in environment- rocks and soils, uranium and thorium ores, the atmosphere, water, food and building construction materials. Application of stable nuclides, radionuclides and ionizing radiations in the study of earth and its environment; diagnostic; medicine and other applications. Radiation physics; isotopes; radioactive elements; unit of radiation: Radiation detection and dosimetry. Nuclear energy and nuclear fuel cycle, effect of nuclear cycle on environment. — 10 hrs

Unit 2: *Effect of Radiation:* Radiation pollution; hazards of radio-active wastes; Radio isotopes and their applications: food; agriculture; medicine; industry. Industrial radiography. Radiation detection, measurements and radiation standards. Radioactive decay. Risk and benefits of radiation. 10 Hrs

Unit 3. *Introduction to radiation chemistry;* ionizing and non-ionizing, microwave and fallout radiation. Effect of radiation on plant and animal: Vascular, skeletal, nervous and reproductive system in plants-Gene mutation; carcinogenicity; teratogenicity; chromosome damage; abnormalities and population decline. 12 hrs

Unit 3: *Radiation protection and control measures:* Monitoring and preventive measures: prevention at source; nuclear reactor safety measures; nuclear power plant safety measures. Occupational radiation exposure; safety measures in industry and medicine.10 hrs

Unit 5: *Disposal of Radioactive Waste:* Characterization of radioactive waste, storage and disposal; Waste Storage of waste and disposal technologies: Calcinations; vitrification; crystalline ceramic forms of stages. Disposal: space disposal; ice disposal; partitioning and transmutation; offshore disposal of waste; Drilled emplacement; Ocean dumping. Radio-active Waste management programmes. Current practices disposal of radioactive wastes in different sectors12 hrs

Unit 6: *Radiation episodes:* Pattern of accidents and causes. Important episodes: Hiroshima and Nagasaki, Bikini atoll episode; Three Mile Island episode; Chernobyl accident; Fukushima (Japan) nuclear disaster 2011; Marcoule (France) Nuclear Accident 2011. 10 hrs

Practicals

1. Radiation counting using GM counter
2. Radiation Protective Devices-Identification and commenting
3. Natural Radioactive materials- Quartz, Silica, granite, marble etc., -Identification

4. Radiation detecting instruments- Identification and commenting
5. Calculations of half-life; radioactive decay and conversion of units.

References (Latest Edition of the Following)

1. Chandler, S. D. Radioactive waste control and controversies. Vol-3. Gordon and Bleach Science Publishers.
2. Murugesan, R. Modern Physics. S. Chand & company, Ltd
3. Miller, G.T. Environmental Science-An Introduction, Wadsworth Publishing Company, California
4. Kopkar, S. M. Environmental Pollution – Monitoring and Control. New Age International Ltd, New Delhi

II Semester

ES. HC-2.1: Environmental Chemistry and Environmental Statistics --64 Hrs

PART A: Environmental Chemistry (32 Hrs)

Unit 1: Atmospheric Chemistry: Introduction; chemical reactions in the atmosphere in troposphere and in stratosphere (Oxygen, Nitrogen Ozone, Water vapour, Photochemical smog, Volatile Organic Compound). Aerosol-types, production and distribution; Aerosols, atmospheric particles and radiation. Atmospheric turbidity and related environmental problems; Inversions, global climate and photochemical reactions. A brief account on Global warming; Greenhouse effect; Ozone depletion; Acid rain. - 10 hrs

Unit 2: Chemistry in Aqueous Media: Water cycle; Structure and properties of water- Density; melting point and boiling point; specific heat; heat of vaporization, surface tension and viscosity. Hydrogen bonding, clathrates and miscibility; ions; autoionization; weak acid bases and buffers. Co-ordination chemistry of water. Water as a solvent. Water Usage-Water pollutants; pathogens; oxygen demanding wastes; nutrients; salts; heavy metals; thermal pollution; pesticides; volatile Organic compounds. Emerging Contaminants; Endocrine disrupting agents (EDCs); Polybrominated biphenyl ethers (PBDEs); Perfluorocarboxylates (PFCAs). Status of Surface water quality; BOD; COD; NOD; and other parameters. - 12 hrs

Unit 3: Chemistry of Soil: Soil formation and composition of soil; weathering and solubilizing mechanisms; Micro and Macronutrients of soil. Soil contamination- Non-metallic compounds; heavy metals; Synthetic agrochemicals; industrial wastes. Bioremediation of surface soil. Bioindicators of soil contamination and soil health. Soil physico-chemical parameters- Moisture content; pH; redox potential; percolation; density; porosity; saturation capacity; particle fractionation; cation exchange capacity; total exchangeable bases; chemical parameters - 10 hrs

PART B: Environmental Statistics (32 Hrs)

Unit 4: Introduction: Statistics; statistical variables; data; independent and dependent variables; qualitative and quantitative variables; ordinal variable. Statistical Methods- Numerical measures, graphical methods-types of graphs and applications; Frequency distributions; grouped and cumulative frequency; frequency distribution diagrams; histograms; frequency polygons. - 10 Hrs

Unit 5: Descriptive statistics: The central tendency-mean; median and mode, types of arithmetic mean- weighted, harmonic and geometric mean- application and significance. Variability-Range; variance; standard deviation; standard error; confidence interval;

coefficient of variation. Exploratory data analyses-Scatter plots; frequency distribution histograms; stem and leaf plot; Box and Whisker plot. Probability theory; calculation of probability; binomial distribution. - 10 Hrs

Unit 6: *Inferential statistics and Ecological Models*: Statistical inferences- Hypothesis testing; null and alternate hypothesis; procedure for hypothesis testing; χ^2 test, student ‘t’ test, F test, Analysis of variance. Correlation and Regression-types and applications. Ecological models; types of models; Population growth models, Life history strategies, r/K concept; Lotka-Volterra models, Leslie’s matrix. Water and Air pollution models- Stream flow models and atmospheric dispersion models.12 Hrs

Practicals:

1. Air sampling techniques/ Emission Test
2. Estimation of LHV and HHV of selected fuels
3. Estimation of Heavy metals (Copper, Zinc, Lead and Mercury) in soil sample
4. Estimation of carbon-carbonate in soil sample
5. Descriptive statistics- Arithmetic mean, Weighted arithmetic mean, geometric mean, harmonic mean
6. Calculation of standard deviation, standard error, coefficient of variation for the given set of data
7. Calculation of correlation coefficient (Karl Pearson and Rank method)
8. Problems on Population Growth Models.

References (Latest Edition of the Following):

- Allan J. Cann. Maths from Scratch for Biologist. John Wiley and Sons, Ltd. Toronto.
- Rosner, B.. Fundamentals of Biostatistics. Daxbury Press. Boston.
- Begon, M and Mortimer, M. Population ecology. UBS Publishers. New Delhi.
- Spiro TG, Purvis-Roberts K, Stigliani WM. Chemistry of the Environment. Viva Books. New Delhi.
- Bailey RA, Clark HM, Ferris JP, Krause S, Strong, RL. Chemistry of the Environment. Academic Press, California.
- Masters GM and Ela WP. Introduction to Environmental Engineering and Science. PHI, New Delhi.

ENV. HC-2.2: Environmental Pollution

.....64 Hrs

Unit 1: *Water Pollution*: Introduction; water resources, sources and water pollutants; category and composition of waste water. status of surface water quality; BOD; The effect of Oxygen demanding wastes on water bodies; water quality index. Ground water pollution, Aquifers, Hydraulic gradient, Darcy's Law, Contaminant transport, Cone of depression, capture- zone curves, control of ground water plumes, contaminants in ground water. Waste water remediation technologies for surface and ground water. Effect of Water pollution on ecosystem and biota. ...12 Hrs

Unit 2: *Water Quality Control*: Introduction, municipal and waste water systems in India, BIS standard for Drinking Water, Water quality standards for irrigation, industry, fishery and other ventures. Water treatment systems; waste water treatments; hazardous waste in Indian water bodies; solid wastes, sewerage and sewage disposal technologies. Waste treatment technologies for industries and ETP ..12 Hrs

Unit 3: *Air Pollution*: Introduction; Overview of Emissions, Pollutant sources, characteristics, Primary and secondary pollutants, toxic air pollutants. Air quality standards. Motor Vehicle emissions and stationary emissions- composition and control. Formation of Aerosol and its effects. Indoor Air quality standards. Air Pollution and Meteorology. Air pollutant and pollution assessment technologies; Models to predict smoke and pollutant dispersal in Air, Box model, Gaussian Plume model. Effect of air pollution on biota ..12 Hrs

Unit 4: *Soil Pollution and Solid Waste*: Introduction; Sources of soil pollutants-Municipal, Agriculture, Aquaculture, poultry, industrial sources of soil pollutants. Other sources of Solid waste, Classification and characterization of solid waste; Hazardous solid waste, Biomedical waste, Leachate of solid waste, etc., Transboundary movement of wastes. Physical, chemical, biological treatment of waste, Disposal and recycling of solid waste. Effect of soil pollution on ecosystem and biota. **E- waste:** Introduction; Sources, characterization, Hazardous materials in e-waste, recycling of e-waste.10 Hrs

Unit 5: *Noise and Thermal Pollution*: Introduction, Noise and vibration; sources of noise pollution, Noise and Health, Noise level measurement, permissible levels, Sonic boom, Impulsive noise, Anechoic Chamber and Reverberating sound. Noise topography. Control of Noise (regulations). Effect of noise biota. Thermal Pollution: Introduction, sources of thermal pollution, effect of discharge of heat and effect of thermal pollution, Measurement

of thermal pollution, Effect of thermal pollution. Fly-ash and environmental Hazard. Effect of thermal pollution on ecosystem and biota.10 Hrs

Unit 6: *Status of Environmental Pollutions in India*: Prevention and control of generation, reuse and recycle of Waste. Acts and regulation to control pollution. National programme to control wastes. 8 Hrs

Practicals:

1. Estimation of BOD and COD for the given water Sample
2. Acid base reactions in effluent treatment system
3. Collection, classification and segregation of Household waste
4. Analysis of Phosphate and sulphate in waste leachate
5. Recording the noise using noise recorder
6. Construction of models to predict smoke and pollutant dispersal in Air- Box model and Gaussian Plume model
7. Collection, segregation and classification of biomedical waste
8. Isolation, identification of bioindicators of waste water

References (Latest Edition of the Following):

1. Gilbert M. Masters and Wendall, P. Ela. Introduction to Environmental Engineering and Science. PHI learning Pvt. Ltd.
2. Khopkar, S. M. Environmental Pollution- Monitoring and Control. New Age International Publishers, New Delhi.
3. William W Nazaroff and Lisa A Cohen. Environmental Engineering Science. Wiley Publishers.

ENV. SC-2.3: Energy and Energy-Resources64 Hrs

Unit 1: *Introduction to Energy Resources*: Growing Energy Need-Energy crises; factors influencing energy crises; Developmental strategies; energy supply-demand. Energy consumption in developed and developing countries. Resources of Energy; Non-renewable (fossil fuels; coal; natural gas; petroleum) and renewable (biomass; biogas, solar, nuclear, hydropower, wind and tidal, and geothermal). Concept of clean energy.10 hrs

Unit 2: *Fossil Fuels-Coal, Oil, Natural gas and Petroleum fuels*: Coal: formation of coal, forms of coal- peat, lignite, sub-bituminous coal, bituminous coal, steam coal, anthracite, graphite, chemistry and composition. Heat of combustion, thermal conductivity, specific and latent heat. Major Coal reserves. Advantages and disadvantages of coal energy. Fly ash and its consequences. Sub-terranean coal fire. Oil and Natural gas: Geological exploration for oil and natural gas, Status and reason for declining reserve of oil and natural gas. Global oil demand and supply. Environmental problem associated with oil and natural gas. Synfuels and other potential fossil fuels resources. Petroleum fuels: Composition, Chemistry of petroleum fuels; Empirical equations for thermal properties (Heat of combustion, thermal conductivity, specific and latent heat). Crude oil reservoirs and Unconventional oil reservoirs. Uses of petroleum fuels. Environmental effects of use of petroleum fuels; Ocean acidification, global warming, oil spills etc., Alternative to petroleum-for vehicle fuel, industry, electricity.20 hrs

Unit 3: *Biomass and Biogas*: Definition, Biomass sources. World resources; Food crops, woody crops, natural vegetation, commercial planting, genetically modified varieties. Biomass Conversion; Thermal, chemical, biochemical and electro-chemical conversion. Environmental impact of biomass fuel. Biogas production and techniques; landfill gas. Chemical composition of biogas. Benefits of biogas, Global development of biogas. Contribution of biomass and biogas to nature conservation. 10 hrs

Unit 4: *Nuclear Energy*: Fission and fusion reactions. Atoms and radioactivity. Conventional Nuclear fission. Production of electricity from nuclear power. Breeder Nuclear fission. Merits and demerits of Nuclear power over hydro thermal power plant and coal based power plant. Problems associated with nuclear power plants. Safety in nuclear power plant. Radioactive wastes and environmental problems.10 hrs

Unit 5: *Solar and wind Energy* : Solar energy definition; Harnessing of solar energy using technologies such as solar heating, photovoltaics, solar-thermal energy, solar architecture and artificial photosynthesis. Application of thermal energy associated with

solar- water heating, heating, cooling, ventilation, cooking, water treatment etc., Electricity production, photovoltaics, concentrated solar power. Solar energy equipment and ISO standards for solar energy equipment. Wind energy basics, equation for wind power. Wind farms. Small scale wind power productions. Environmental effects. Amalgamation of solar and wind power. Indian approach for solar and wind power.8 hrs

Unit 6: *Hydro-thermal, geothermal and tidal energy*: Energy generated hydro-power, geothermal and tidal. Generating methods; types and capacities; Advantages and Disadvantages. Environmental impact.6 hrs

Practicals

1. Comparison of density, surface tension, viscosity of Diesel and Kerosene
2. Comparison of density, surface tension, viscosity of vegetable oil and crude oil.
3. Ash estimation of crude oil and vegetable oil
4. Estimation of Ash content of peat and charcoal
5. Calculation of HHV and LHV of Methane and Butane
6. Photovoltaic cell
7. Determination of surface albedo
8. Visit to Wind mill.

References (Latest Edition of the Following):

1. Richard S Stein and Joseph Powers. The Energy Problem. World Scientific Publishing Co. Pte. Ltd. Singapore.
2. John Twidell and Tony Weir. Renewable Energy Resources. Taylor and Francis, New York.
3. Gilbert M. Masters and Wendall, P. Ela. Introduction to Environmental Engineering and Science. PHI learning Pvt. Ltd.

ENV. SC-2.4: Solid Waste Management and Resource Recovery ...64 hrs

Unit 1: *Solid waste: Definition of solid waste:* sources, classification and types of solid wastes: Municipal waste, agricultural waste, biomedical waste and industrial waste, E-Waste Characteristics. Solid waste Problems - impact on environmental health – Concepts of waste reduction, recycling and reuse. 12 hrs

Unit 2: *Urban Solid waste collection, segregation and transporting methods:* Handling of residential, commercial, market waste. Collection and storage methods: Transportation systems- 8 hrs

Unit 3. *Biomedical and hazardous waste management:* Biomedical waste: Definition, sources, classification, collection, segregation, Treatment and disposal. Hazardous Wastes: Hazardous waste definition: Sources and characteristics: handling, collection, storage, transport and treatment, Physical and biological routes of transport of hazardous substances –Sampling and analysis of hazardous wastes12 hrs

Unit 4: *Disposal of municipal solid waste (MSW):* Open dumps impacts on environment, health and environmental effects. site selection, design, and operation of sanitary landfills; Leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation. Regulatory aspects of municipal solid waste management.12 hrs

Unit 5: *Solid waste management solutions: Source reduction:* Industrial, commercial and residential areas. Solid waste processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: Waste reuse and recycling- Paper, plastics, Glass, Scrape metals. Biodegradable waste - composting methods Microbial and vermicomposting methods and uses.10 hrs

Unit 6 *E-Waste and Management:* Waste characteristics, generation, collection, transport and disposal Public policy of waste management: Sustainable solid waste management- Regulatory perspectives, integrated waste management.10 hrs

Practicals:

1. Classification and composition of solid wastes
2. Density and moisture content of municipal solid waste
3. Visit to biomedical waste treatment plant
4. Hospital waste disinfecting methods/ Incineration Unit

5. Leachate collection and analysis- pH, BOD, Chloride, Phosphate, Nitrate.
6. Waste management techniques; Sanitary landfills construction techniques
7. Quantification of solid waste
8. Vermicomposting Techniques

References (Latest Edition of the Following):

1. Charles A. Wentz. Hazardous waste management. McGraw Hill International.
2. George Tchobanoglous, Hilary Theisen & Sammuel A. Vigil. Integrated solid waste management, McGraw- Hill.
3. CPCB guidelines. Criteria for hazardous waste landfills.
4. Anjaneyulu. Hazardous waste management. Allied Publishers Ltd.
5. Daniel B. Botkin and Edward A. Keller. Environmental Sciences. Wiley Intercedence student Edition.
6. Harry M. Freeman. Standard handbook of Hazardous waste treatment and disposal. McGraw Hill.
7. Botkin, D. and E. K. Future. Environmental Science – Earth as a living planet.
8. Sindhu, P. S. Environmental chemistry. New Age Int. Publishers
9. Wright R. T. and B. J. Nebel. Environmental science – Towards sustainable future. Prentice Hall India Pvt. Ltd. New Delhi
10. Abbasi, S. A. and E. Ramasami. Biotechnological methods of pollution control.
11. Cunningham, W. P. and M. A. Cunningham. Principles of Environmental Science. Tata McGraw Hill Publ. New Delhi
12. Trivedi, P. R. and G. Raj. Solid waste pollution. Akshadeep Publishing House, New Delhi

ENV. SC-2.5: Natural Resources and Conservation64 Hrs

Unit 1: *Earths Natural Resources*: Introduction: Ecological services of major ecosystems of the world. Renewable and Non-renewable; Continuous and extrinsic resources. Natural resources and associated problems -- 10 Hrs

Unit 2: *Forest Resources*: Composition; function; Economic and Environmental benefits; energy; medicine and life supporting resources. deforestation; causes of deforestation-timber extraction, dams, habitat fragmentation. Anthropogenic influence on forest resources; over exploitation, encroachment, habitat quality depletion, grazing etc., - 10 Hrs

Unit 3: *Water Resources*: Hydrosphere; proportion of different types of water; lentic and lotic water; ground water. Use and over exploitation of surface and ground water. Problems associated with water resources- flood, drought and pollution-conflict over water. Status of water resources in India. - 10 Hrs

Unit 4: *Land and Mineral Resources*: Land degradation; landslide; soil erosion; overgrazing, mining, desertification, pollutions and their consequences on habitat quality. Mineral-Kinds of minerals, structure and properties; metal and metallic compounds, rare earth metals, non-metals, building materials, gems etc., noble metals and fossil fuels. Mineral resources of India 10 Hrs

Unit 5: *Food Resources and Energy Resources*: Introduction, types, characteristics. World food problem; Agriculture and over grazing; Modern agriculture and environmental effect. Agro-chemicals; soil salinity; status of food resources and food contamination in India. Growing energy demand; energy resources; renewable and non-renewable. Status of energy resources in India. Approach to fulfil the demand, new policy and schemes. 12 Hrs

Unit 6: *Natural Resources and Conservation*: Problems associated with overexploitation of natural resources, consequences on environmental quality and life supporting systems of the earth. Role of human communities and conservation, lifestyle, resource sharing and sustainable development. 12 Hrs

Practicals:

1. Identification of mineral resources
2. Identification of biofuel resources and biofuel important parts
3. Estimation of energy and crude ash of biofuels
4. Collection, categorization of forest resources

5. Soil character (water holding capacity) of different types of soil
6. Estimation of total soil salinity
7. Estimation/identification of food contaminants in Vegetables and Fruits
8. Identification of wildfood resources

References (Latest Edition of the Following):

1. Andrew S. Goudie. The Human Impact on the Natural Environment: Past, Present and Future. Wiley-Blackwell Publ.
2. John Walther. Earth's Natural Resources. Jones and Bartlet Learning.
3. Tiwari G.N. and Ghosal M.K., Renewable Energy Resources, Narosa Publ.
4. Chauhan, D. S and S. K. Srivastava. Non-conventional energy resources, New Age International Publisher, New Delhi

Interdepartmental Elective Courses

ES. IDEC. 1. Environmental Education

32 Hrs

Unit 1. *Introduction:* Scope of Environmental Education; Man, and Environment; Population and Economic growth; industrialization; urbanization; consumerism; environmental ethics. ----- 4 hrs

Unit 2. *Drivers of Environmental Degradations:* Historical causes of environmental changes – massive population increase; technological innovations; explosion in energy use; Economic integration and environmental changes. Environmental Degradations: Population and resource consumption; Affluence and poverty; policy; technology and economic growth and forces of globalization. ----- 6 hrs

Unit 3. *Environment and Sustainable Development:* importance and approaches- public awareness; national and international perspectives; Environmental conservations- Conventions, Public awareness and participation, Regional Best practices towards sustainable development ----- 6 hrs

Unit 4. *Environmental Awareness Programmes:* Scope and Importance and objectives of environmental awareness and training; formal and non-formal environmental education programmes; national green corps. ----- 4 hrs

Unit 5. *Formal and Non-Formal Environmental Education:* Formal Environmental Education in schools; appreciation courses; environmental management studies; centers for environmental studies. Non-formal environmental educations- National Environmental Awareness Campaign (NAEC); Eco-clubs (National Green Corps); Global Learning and Observations to Benefit the Environment (GLOBE); Mass awareness programmes. ...6 hrs

Unit 6. *International and National Initiatives:* UN Decade of Sustainable Development; Focal points; Citizen Science (CS); Education for Sustainable Development (ESD); Science Education (SE); Climate Change Education (CCE). Stockholm Declaration; Belgrade Charter; Tbilisi Declaration. Environmental Awareness in University Education in India; Role of MOEFCC; Institutions and NGO's. Women and Environmental Education. ----- 6 hrs

References (Latest Edition of the Following):

1. Beatty. A. Climate Change Education. Washington, DC: The National Academies Press
2. Palmer, J.A. Environmental Education in the 21st Century: Theory, Practice, Progress, and Promise. Routledge.

ES. IDEC. 2: Drinking Water Resources, Quality and Management 32 Hrs

Unit 1: *Sources of drinking water*: Surface water, under river flow, ground water, frozen water. Water uses; agriculture, industrial, domestic, recreation, environmental uses and their consequences on drinking water availability. 4 hrs

Unit 2: *Water Stress*: Water stress for domestic use; factors contributing to water stress: population growth, expansion of urbanization, climate change, depletion of aquifers, water pollution and contamination. 6 hrs

Unit 3: *Drinking water quality*: Importance of the good quality water; health implication; water borne diseases and water washed diseases. Drinking water quality criteria; BIS and WHO recommended Physicochemical and biological parameters to ensure the quality. 6hrs

Unit 4: *Drinking water treatments*: Pre-chlorination; aeration; Coagulation; flocculation; sedimentation; filtration; disinfection, storage and public distribution. Household water treatment: Filtration system; water softeners; distillation systems; disinfection and storage. 6 hrs

Unit 5: *Drinking Water Domestic Supply System*: Community storage for potable water; water distribution network; Pipelines, pressure vessels and underground cistern; pipeline network; components to convey water to domestic uses. Quality of water distribution network and quality of potable water. Water supply management. .6 hrs

Unit 6: *Status of Drinking water in India*: Major sources of drinking water in India. Quality and contaminant in drinking water; Total water availability v/s per capita requirement, water conflict with special references to drinking water sources. Drinking water quality and management systems in India. Rainwater Harvesting-importance and method 4 hrs

References (Latest Edition of the Following):

James K. Edzwald. Water Quality and Treatment: A Handbook on Drinking Water. McGraw-Hill.

Drinking Water Specification. Bureau of Indian Standards. Publication Unit, BIS, New Delhi.

World Health Organization. 2011. Guidelines for drinking-water quality. WHO Press, World Health Organization, Geneva, Switzerland.

MODEL QUESTION PAPER

M.Sc., Degree Examination.....Year

I/II/III/IV Semester (CBCS Scheme)

Title of the paper:

Time: 3 Hrs

Max. Marks: 75

SECTION-A

Answer All Questions. All questions carry equal marks 6 x 2½ = 15 marks

1. Question from the Unit-1
2. Question from the Unit-2
3. Question from the Unit-3
4. Question from the Unit-4
5. Question from the Unit-5
6. Question from the Unit-6

SECTION-B

Answer All Questions. All questions carry equal marks 6 x 10 = 60 marks

7. a) Question from the Unit-1
OR
b) Question from the Unit-1
8. a) Question from the Unit-2
OR
b) Question from the Unit-2
9. a) Question from the Unit-3
OR
b) Question from the Unit-3
10. a) Question from the Unit-4
OR
b) Question from the Unit-4
11. a) Question from the Unit-5
OR
b) Question from the Unit-5
12. a) Question from the Unit-6
OR
b) Question from the Unit-6