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**Legend:**
- **HCT:** Hard Core Theory
- **SCT:** Soft Core Theory
- **OET:** Open Elective Theory
- **L:** Lecture
- **T:** Tutorials
- **P:** Practical
- **Sem. Exam:** Semester Exam
- **IA:** Internal Assessment

**Notes:**
- 4 Credits of Theory = 4 hours of teaching per week;
- 2 Credits of Practical = 4 hours per week.
Choice Based Credit System: Detailed Syllabus
M. Sc. Environmental Science

FIRST SEMESTER

HCT 1.1: Fundamentals of Environmental Science  \hspace{1cm}  64 hrs

Preamble: This paper introduces to students about concept of multidisciplinary facets of environmental Science. Disciplines associated with human ecology, environmental ethics, present and future challenges for sustainable development for environment and finally, it makes to students think for protection of environment and earth planet.

Unit 1: Understanding of Environment - Concept, multidisciplinary facets of environment; ideas and components of environment; historical root, nature and scope of environmental science, man - environment interrelationships, moral and ethical issues in Environmental science, environmental perspectives, sustainability. Environmental movements in India (Narmada Dam, Tehri Dam). \hspace{1cm}  -12 hrs

Unit 2: Origin and Evolution of atmosphere- Origin, evolution; Structural, physical and chemical properties of atmosphere. Basics of lithosphere, hydrosphere and biosphere. Effect of water substance and Green house gasses on atmosphere. Natural and Manmade hazards and its effects on environment; Thermodynamics and dynamics of atmosphere, Seasons and climate – earth-sun relationship. \hspace{1cm}  -13 hrs

Unit 3: Ecosystems: Development and evolution of the ecosystems- Geographical classification and zones, Biodiversity conservation and sustainable development. Biomes: Meaning of biomes, biome type, tropical evergreen rainforest biome, Monsoon deciduous forest biome, Savanna biome, Mediterranean biome, temperate grassland biome, Tundra biome, Marine biome \hspace{1cm}  -13 hrs


Unit 5: Development and socio-environmental issues: Resource and environmental problems & impacts, unintended consequences, cost-benefit analysis; Free market environmentalism with special reference to agriculture; Perception of risk, perspectives on our relationship with the environment; Real and potential responses to present and future challenges \hspace{1cm}  -13 hrs

Practical
Based on Theory paper

References
7. Enger & Smith, Environmental Science-. 7\textsuperscript{th} Den, McGraw Hill .
8. E.P. Odum, Fundamental of Ecology, W.B. Sauders Company, USA.
12. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkata
Preamble: This paper gives the information to students with the fundamental concepts of geo-science with improved understanding of the physical earth, geological processes, geological resources and environmental geology. Specifically, this will help to use of geologic information to solve conflicts in land use, to minimize environmental degradation, and to maximize the beneficial results of using our natural and modified environments and finally it enrich the students knowledge on the meteorology and climatology and other importance for the existence of life on earth.

Unit-1: Planet Earth: Definition, Formation, evolution and Structure of the Earth; Plate Tectonics Plate Boundaries. Earth’s Materials – Minerals and their definition. Distribution and abundance of elements in the major units of earth, Formation, Geochemical features and classification of Rocks. Mineral resources and environment. Resources and reserves, depletion trends of natural resources. Stratigraphy and Geologic time, Geological features of India & Karnataka.


Unit-3: Land resources & management: Soil-characteristics, formation of soil, role of soil organisms in soil formation, types of soils. Land resources, land degradation cycle, land-use pattern, land reform, land use plan, soil surveys in relation to land use planning; methods of site selection and evaluation.

Unit-4: Environmental Geochemistry: Concepts of major, trace and Rare Earth Elements (REE). Trace elements mobility and their Classification. Geochemical cycles; Biochemical factors in environmental health. World water balance, hydrogeology and geochemistry of surface and groundwater; water quality, use of water, conservation of water resources, climate change impacts on water resource management.

Unit -5: Environmental Meteorology: Meteorological parameter –Temperature, Humidity, Rainfall, Wind speed and direction, Sunshine intensity, Atmospheric pressure, Clouds cover and characteristics, forecasting of meteorological information. Indian climate monitoring systems, Atmospheric stability, Adiabatic character; Fossil fuel, Air pollution and climate change, Turbulence and diffusion, Application of meteorology to air pollution study.

Practical
Based on Theory paper

References:
5. Environmental meteorology, B. Padmanabha Murthy, I.K. Interactional
7. Coping with natural hazards; Indian context, K.S. Valdiya, orient Longman.
Preamble: This paper exposing the students to the various aspects of ecosystem structure and functions and enables to understand the fundamental and applied aspects of environmental biology. Also, it emphasis on biological conversion of solar energy into chemical energy (food), its flow in ecosystems and the consequences on it’s desorption. From this paper students understand the importance of biodiversity conservation for sustainable earth’s homeostasis.

Unit-1: Ecosystems- Fundamental concepts and principles: Structure, functions and classification of ecosystems – aquatic (Fresh and Marine water) and terrestrial ecology; biotic and abiotic components of ecosystem, diversity and stability rule and Homeostasis. Ecological niche, special functional, ecological dominance; food web; food chain, types of food chain, Food chain disruption and consequences, modern concepts of ecosystem.

Unit -2: Primary and secondary productivity - Definition, measurement of biomass and productivity in terrestrial and aquatic communities. Productivity of terrestrial ecosystem; forest and grassland ecosystems. Ecosystem Pathways; basic laws of energy flow; Energy flow models, Lindeman model; Energetic relations in Ecosystems


Unit-5: Population ecology: Characteristics, population density, natality, mortality, age distribution, population growth, causes for population explosion, population control. Biological interactions- Interspecies and intraspecies interactions, types of interaction- neutralism, positive mutualism, commensalism, parasitism and predation

Practical

Based on Theory paper

References:
11. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkata
SCT 1.1: Natural Resources and Conservation                       64 Hrs

Preamble: This paper provides the students with the necessary knowledge and skills in the areas of natural resources, conservation and management. In particular, this paper emphasizs on the consequences of excessive and unscientific utilization of natural resources for human comfort and imparts the ways of their conservation, sustainable developments of healthy planet earth.

Unit-1: Natural Resources: Concept, Classification, current status of natural resources and their reserves. Oceans are new areas for exploration of mineral resources, ores and recycling of resources. Natural resources of India and their management; role of women in natural resource management.

Unit-2: Water and Soil Resources and Management - Concept and classification, current status, Integrated water resource management; Participatory watershed development; rain water harvesting recharging of resources. Soft water resources in coastal area and their conservation. Wetlands-concept, reclamation and management, sustainable development.


Unit-3: Biological resources and conservation: Concept, scope, types; Protection of Bio-resources and its rational use and Human resources for sustainable development. Convention of biological diversity (CBD) implementation in India.

Unit-4: Natural Energy Sources and conservation: concept, energy content in various conventional energy sources, Types; Principles of solar thermal energy conversion; Principles of generation of wave energy, tidal, ocean-thermal-energy conversion, wind and geothermal energy, Power generation from waste. Biogas plants - principles of generation, designs and application

Unit-5: Wildlife resource and conservation: Meaning and objectives. Relevance, threats and need for conservation of forest resources. Forest - land use changes in India - future demand of forestlands. Community forest management, Social forestry, agro-forestry, Eco-development committees & Eco-tourism. Gene pool management. In-situ and Ex-situ conservation of Biodiversity in India. Role of Non-Governmental Organizations in wildlife and forest conservation.

Practical Based on Theory paper

References:
Preamble: This paper introduces students about the new concept of climate change. The paper also provides the scientific background for research and other careers across a broad spectrum of meteorology-related science, focusing particularly on the links between the atmosphere and the land surface environment.

Unit-1: Climatology: Fundamentals of climatology, Elements of weather and climate, climatic controls, energy balance in atmospheric; elementary ideas about weather systems, climatic classifications; climates in India; monsoons of India. 14 Hrs.

Unit-2: Air temperature- warming and cooling of air near ground, measurement of temperature; Humidity- expressions of humidity, measurement of humidity; clouds classification and types; Precipitation- process, types of precipitation, measurement of precipitation-recording, non-recording, radar, satellite. Estimation of precipitation, averaging techniques- thiesen polygon and isohyets. Wind - forces affecting wind, types of wind and measurement of wind. 14 Hrs.

Unit-3: Climate change scenarios of India: impact of climate change on agriculture, forest, water resources, monsoon system of India. Boundary layer climates – effects of topography, energy and mass exchange, climates of vegetated surface, urban climatology. 12 Hrs.


Unit-5: Pollution Climatology: Preliminary concepts of climate change; seasons in India; Monsoons; El nino and ENSO; Enhanced greenhouse effect – global warming; GHGs in the atmosphere; Effects of global warming. 12 Hrs.

Practical
Based upon theory

References:
SECOND SEMESTER:

HCT 2.1: Environmental Chemistry  64 Hrs.

Preamble: This introduce to students with the dynamics and principles of environmental Chemistry and their toxicological effects on environment and human health. Also it provides a clear knowledge about the principle and working of various analytical technique used in the environmental analysis to the students so that they can work with these tools effectively.


-14 hrs


-10 hrs

Unit 3: Water chemistry: properties of water, water pollutants- types sources heavy metals metalloids-organic, biological and radioactive- types of reactions in various water bodies including marine environment. Chemistry of oil based and water based paints, physicochemical basis of redox processes.

-10 hrs

Unit 4: Chemistry of Environmental Contaminants –Air, Water: Pesticides in water, Biochemical aspects of As, Cd, pb, Hg, CO, O_{3}, PAN, Pesticides, Insecticides, MIC and Carcinogens in Air, Water and Soil. Chemical nature and properties of selected environmental contaminants; Polychlorinated biphenyls; chloroorganic compounds (Organochlorine : DDT and BHC, organo phosphate: parathion and malathion)

-14 hrs

Unit 5: Instrumentation and Analytical Techniques: Role and importance of analytical techniques in analysis of environmental samples. Titrimetry; Gravimetry, Conductometry, pH, Colorimetry, Spectrometry, UV-Vis and IR Spectrophotometer and AAS. Nephelometry, Flame Spectrometry and fluorimetry; Chromatographic techniques: Paper, Thin Layer, GCMS, LCMS, HPLC, X-ray florescence, X-ray diffraction, PCR, SEM, TEM.

-16 hrs

Practicals
Based on Theory paper

Reference Books:
HCT 2.2: Environmental Microbiology 64 hrs

Preamble: This Paper introduces to students about various microbial environments encountered in the area of soil, water and air and how they affect the cycling of nutrients. It emphasis on identification and enumeration of microbes in these environments and also providing a comprehensive insight of microbes as key players in the fields of medical, agricultural, industrial and various functions of the environment.

Unit 1: Introduction: Concepts and scope of environmental microbiology, microorganisms as components of ecosystem, Classification and characteristics of microorganisms based on their habitat. Microbial interactions with micro- and macroorganisms, Role of microorganisms in element cycles.

-10 hrs

Unit 2: Microbial diversity of environment: Microbes in air, water, wastewater and soil; Introduction, distribution, sampling and measurement techniques and identification. Microbes of extreme Environment. Mechanisms of adaptation by microorganisms to environmental extremes.

-12 hrs


-14 hrs

Unit 4: Microbes in the Degradation of Wastes: Bioremediation - Its role in Environmental management, advantages and disadvantages. Control of pests and diseases by microorganisms, Treatment of solid and liquid industrial wastes, Microbial degradation of pesticides. Microbes in metal extraction, mineral leaching and mining, microbes in petroleum product formation.

-14 hrs


-16 hrs

Practicals:

Based on Theory paper

References:
2. Environmental Microbiology By, P D Sharma
3. Environmental bioremediation technologies. Shree N. Singh, Rudra D. Tripathi
4. Introduction to Microbiology. A. S. Rao
5. Microbiological examination of water and wastewater, Maria Csuros, Csaba Csuros.
8. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkata
9. Rein Heimer G., Aquatic Microbiology, Jhon Wiley, New Yaork
10. Mason C.F Biology of Fresh Water Pollution, Long Man, Scientific and Technology, UK
12. Ralph Mitchell, Environmental Microbiology Wiley Ciss, Newyork
16. APHA Standard Methods, American Public Health Asscosiation
17. Gabriel, Briton waste water microbiology, John Willey and Sons , Newyorjk
18. T.D Brock , Principles of Microbial ecology,
19. Presscott, Harlay and klein –Microbiology, Mac-Grow Hill Publication
SCT 2.1 Environmental Toxicology 64 hrs

Preamble: This paper provides an advanced, multi-disciplinary and current understanding of the effects of chemicals on human and environmental health. It throws light on nature and types of toxins and their sources and flow in the ecosystems and their effect on the living organisms. It also provides the knowledge about an assessment of toxins and effective control measures to minimize the concentrations, accumulation of toxins in environments and also their hazardous effect on living organisms.

Unit 1: Introduction to toxicology: scope of toxicology, subspecialties of toxicology, Description and terminology of toxic effects, factors influencing toxicity, drug toxicity, biochemical basis of toxicity – mechanism of toxicity and receptor mediated events, acute and chronic toxicity; Selective toxicity; Concentration and dose, synergism and antagonism.

Unit 2: Dose – Response relationships: Graded response, quantal response, Time action curves, Threshold Limit Value (TLV); LC50; Margin of safety; Toxicity curves; Cumulative toxicity and LD50 & CTF.

Unit 3: Toxicity testing: Acute Toxicity (single); Sub acute Toxicity; Chronic Toxicity; Teratogenicity, carcinogenicity and mutagenicity. Immunotoxicity, histotoxicity, cell toxicity. Bioassay – Definition, purpose, criteria for selection of test organism, methodology, estimation of LC50, Limitation and importance of Bioassay.

Unit 4: Bioaccumulation and Biomagnifications of toxic materials (Heavy metals) in food chain, Toxicology of major pesticides - Environmental impacts of pesticides, biotransformation, biomonitoring, programs and parameters of biomonitoring, concept of bioindicator, bioindicator groups and examples; Biomonitoring of toxic chemicals, concepts of bio indicators groups with examples; Basic concepts of Environmental forensics.

Unit 5: Bio-transformation of Xenobiotics (Selective Toxicity); Principles, Receptor sites, absorption and storage of xenobiotics; types of Bio transformations; microsomal oxidations, mixed function oxygenizes, conjugation, biotransformation of organo-chlorine and organo-phosphorous pesticides, Antidotal procedures in Toxicology. Environmental Epidemiology: Pollution related diseases and disorders, Health Hazards. Recent Advance in toxicology.

Practicals:

Based on Theory paper

Reference:
Preamble: This paper introduces to students about concept of Environmental biotechnology and information on how to improve the understanding, identification and prevention of environmental problems, remediation & restoration through biotechnological methods.

Unit-1: Introduction: Definition, principles, scope – role of biotechnology in environmental protection; Biotechnology and biodiversity conservation ex situ; utilization of biodiversity; biotechnology vs biodiversity. Biotechnology for solid waste management: sanitary land filling; Biocomposting – aerobic, anaerobic; vermicomposting; Biomethanation. 12 Hrs.

Unit-2: Bioremediation: Bioremediation: Concept, role of bioremediation in controlling various pollution problems e.g. solid water, sewage water, industrial effluents, heavy metals and radioactive substances. Phytoremediation - Abatement of different types of pollution using plants, types of phytoremediation, mechanism involved with case studies. Biosorption: Biotechnology and heavy metal pollution; Oil field microbiology; Improved oil recovery; Biotechnology and oil spills; Hydrocarbon degradation 13 Hrs.

Unit-3: Biodegradation: Factors affecting process of biodegradation; Methods in determining biodegradability; Contaminant availability for biodegradation. Xenobiotics: Persistence and biomagnification of xenobiotic molecules; Microbial interactions with xenobiotics; Phase I and Phase II reactions; Cyt P 450 mediated reactions; Xenobiotics and microbial biotransformation. Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation. 13 Hrs.

Unit-4: Mutation and Environmental mutagens: Occurrence, kinds of Mutation, spontaneous & induced Mutation, Mutagens, detection of Mutation, Lethal Mutations, Phenotypic effects of Mutation, Mutation rate, Significance & Practical applications of Mutation. Molecular basis of Mutation, mutagenic agents -physical, chemical, biological. Effect on genetic material, Repair mechanisms. 13 Hrs.

Unit-5: Biotechnology for Management of Resources: Role of environmental biotechnology in management of resources; Reclamation of wasteland; Biomass production; Biogas and biofuel production; Microorganisms in mineral and energy recovery and fuel and biomass production. Application of Biotechnology in Environment. 13 Hrs.

Practical
Based upon theory Paper

References
OET 2.1: Natural Resources and Management     64 Hrs.

Preamble: This paper will provide basic knowledge about the natural resources, their sources and reserves on the planet earth, their role in homeostasis of environment and ecosystem and the consequence on their exploitation. It imparts the knowledge on the importance of conservation of natural and nonrenewable resources for the sustainable normal life on the earth. It also throws light on human’s role and methods of water, soil, minerals, forest and energy conservations.

Unit-1: Natural Resources-Classification, concepts and approaches of natural resource conservation. Natural resources of India. Role of women in natural resource. 8 Hrs

Unit-2: Water and Forest Resources Management - Concept and classification, Integrated water resource management; Participatory watershed development; rain water harvesting. National Lake and River Conservation Programmes. Wetland management; Forest resource Management: Relevance, threats and need for conservation of forest resources. Forest management – meaning and objectives. Forest - land use changes in India - future demand of forestlands. Community forest management, Social forestry, agro-forestry. 14 Hrs


Unit-4: Conventional and Non-conventional Energy Sources: Energy content in various conventional energy sources. Types; Principles of solar thermal energy conversion; Principles of generation of wave energy. tidal, ocean thermal energy conversion, wind, geothermal energy, nuclear - fission and fusion; magneto hydrodynamic power. Power generation from waste. Biogas plants - principles of generation, designs, application of biomass technology to increase the hydrocarbon chain. Pyrolysis. Biogas from solid waste. Biofuels. 14 Hrs


References:
THIRD SEMESTER

HCT – 3.1 Environmental Engineering and Technology

64 hrs

Preamble: This paper providing to students to acquire knowledge on the technology and principles behind the processes and techniques related to the reduction of emissions to air, land and water and the effects of pollution. Also Engineering solutions to major environmental problems will be explored.


Unit-3: Wastewater Treatment - Primary, Secondary and advanced treatment: Classification and application of physical Unit processes with principles and process analysis, Design and layout of Industrial and Municipal wastewater treatment systems, Wastewater Disposal and Reuse.

Unit- 4: Air Pollution control – Air pollution Standards, control by dilution, its limitations, control by process changes, control by engineered systems for fixed sources. Control of particulate emissions - settling chambers, centrifugal collectors, wet collectors, fabric filters and Electrostatic precipitators, their principles, techniques and devices. Control of gaseous contaminants - Adsorption and Absorption techniques. Condensation and combustion techniques. Control of Automobile emissions. Noise pollution control- Standard value for noise pollution and methods for their measurements - control at source, along sound transmission path and at receiver.


Practicals
Based on Theory paper

Reference:
HCT 3.2 Environmental Law and Audit 64 hrs

Preamble: This paper introduces students to the legal structure of India and fundamentals of environmental legislation and policy making. Each unit will help the students to develop basic concepts of Environmental auditing in Government and Non-Government sectors.

Unit-1: Environmental protection: issues and problems. International and national efforts for environmental protection. Environmental Policies: Need for policies; different policies. Environmental policy resolution. Public policy - strategies in pollution control. -08 hrs


Unit-4: Environmental Audit and EMS: Definition, Concept of EA, Types of EA, Benefits of Environmental Audits, Scope and Objectives, Procedural Requirements of Conducting EA, Pre-Audit, on-Site Audit and Post Audit Activities, Water Audit, Raw Materials Audit and Energy Audit, -16 hrs


Practicals: Based on Theory paper

Reference
Preamble: This paper enlightens the students on Environmental analysis of scanning, monitoring, analyzing and forecasting the variables of the environment. The paper also provides a clear knowledge about the working principles and applications of various analytical techniques used in the environmental analysis to the students.

Unit 1: Air Sampling: Objective and Criteria of Air Sampling, Selection of Sampling Location, Sampling Methods (Sedimentation, Filtration, Centrifugal and Impingement Method), Instrumental Techniques used in Estimation of Atmospheric Air Pollutant, Dust Fall Jar, SPM and RSPM using Respirable Dust sample/High Volume Air Sampler.

- 12 hrs

Unit 2: Water Sampling: Necessity of Water Sampling, Objectives, Selection of Sampling Site, Types of Water Samples, Sampling Equipment, Collection methods, Handling and Preservation, Classification of Water Quality Parameters (Inorganic, Organic and Nutrient), Parameters analyzed on the Spot, (Field Parameters) Data Interpretation, Basic Concept, Significance and Measurement of DO, BOD, COD, Phenol, Pesticides and Polynuclear Aromatic Hydrocarbon (PAH) in Water and Wastewater.

- 12 hrs

Unit-3: Soil and Solid Waste Sampling: Objectives of Soil and Solid Waste Sampling, Site Selection Criteria, Collection and Handling of Soil and Solid Waste Samples, Preparation of Soil Samples for Analysis, Physico-Chemical Parameters and their Significance (Quality and Productivity).

- 08 hrs


-16 hrs

Unit 5: Sampling theories and Hypothesis testing: Sampling theories, techniques and experimental designs. Testing hypothesis: Significance level and $X^2$, t and F test; Correlation, regression and ANOVA: Analysis of variance: One way and two way ANOVA, MANOVA. Regressions: Defining the fit, Correlation, polynomial regression, Multiple regression.

-16 hrs

Practicals
Based on Theory paper

Reference:
SCT-3.2: Environmental Pollution and Control 64 hrs

Preamble: This paper deals with different aspects of environmental contamination, which have adverse effects on human health. It will lay emphasis on understanding mechanisms of pollutants impacting human health by developing an understanding of different types of pollutants, their sources and mitigation measures.


Unit 2: Air sampling and monitoring techniques - settle able and suspended particulate matter - Dust fall jar and Impingement Method, RDS/HVS samplers (Ambient Air monitoring); Stack gas/dust Sampling technique and other techniques of air monitoring for pollutants. Automobile pollution in Indian cities. Monitoring and control of exhaust emissions. Noise Pollution: Definition, Sources and Terminology; types of noise; Measurement of noise; Noise indices; Effect of meteorological parameter on noise propagation. Noise exposure level and Standard Impact on biota and inanimate objects. Noise control and abatement measures.

Unit 3: Aquatic Pollution: Definition; Sources and classification of aquatic pollutants. Cause and consequences of pollution on surface, subsurface and marine water sources. Coastal water intrusion. Oil leakage and industrial effluents. Water quality indices. Thermal pollution: Sources, causes and effects. Preventive and Control measures.

Unit 4: Soil Pollution: Definition, sources and classification of soil pollutants and their impacts on physico-chemical and biological properties of soil, plants, animals and man. Physico-chemical and bacteriological analysis of different soil. Industrial waste effluents and heavy metals, their interactions with soil components. Integrating of soil pollution control Measures-Physical, Chemical and biological etc.,


Practicals:
Based on Theory paper

Reference:
13. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkata
Preamble: This paper provides an overview of the basic concepts of solid wastes, their generation and hazards on environment and living organisms. Students will learn Characteristics and collection system of different solid wastes, their separation, processing, conversion and disposal methods. This throw lights on kinds of hazardous wastes and their management.

Unit 1 -- Introduction: scope and concept of solid waste management; definitions, kinds of wastes and their sources, characteristics and composition; solid wastes generated per capita- Global and National scenario. Introduction to Solid Waste management. 12 Hrs

Unit 2 -- Municipal solid wastes: Introduction and definition, solid wastes: generation, sources, collection, Storage, segregation and transportation. Disposal methods-sanitary landfills and types, composting, vermin-composting, aerobic and anaerobic digestion, incineration, types of incineration, pyrolysis. 13 Hrs

Unit 3 -- Industrial and Agricultural solid wastes: Introduction, characteristics, sources and classification; collection, segregation, storage and transportation; Reuse, recycling, treatment and disposal methods. E-wastes: definition, sources, segregation, recycling, reuse, storage and methods of disposal. Classification of hazardous waste and handling of hazardous solid wastes. Radioactive wastes- sources, pollution, types of radioactive waste and its control and management. 13 Hrs

Unit 4 - Biomedical wastes: Concept and scope of medical waste; Definition, sources, classification of medical solid wastes; Mode of collection, segregation at source and transportation to disposal points; awareness, education and training for generators and handlers of medical wastes; Advances in handling disposal of biomedical waste and their disposal. 13 Hrs

Unit 5 -- Solid Waste management – waste minimization program, typical material recovery facility (TMRF) operation, Reuse and recycling of paper, glass, metals, plastic and rubber. Advanced techniques for conversion of waste to wealth. Plastic waste status in India, effect of plastic wastes on environment, management of plastic waste. Bring awareness in the public on generation and disposal of solid wastes and 4R’s concept. 13 Hrs

References
13. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkata
FOURTH SEMESTER

HCT 4.1: Occupational Health and Environmental Impact Assessment 64 hrs

Preamble: It explains the students with the concepts of occupational health hazards and occupational diseases and their prevention and control. This also enlightens the students on methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare environmental management plan. It provides knowledge related to the various procedures for environmental impact assessment to predicting and managing human health risks.


Unit 2 : Health Protection: Measures for health protections of workers, preservation of occupational diseases medical measures, engineering measures Human health problems due to pollution, public health programs, food poisoning- types of food poisoning prevention and control, indicators of health. -10 hrs

Unit 3: Occupational Health Management: Evaluation and control of occupational health hazards; occupational health surveillance, Control programmes in the context of Indian Factories Act - case studies. Epidemiology and Public health - Principles of Epidemiology, Epidemiology and control of diseases caused by important microbes in water, air, milk and soil. Status of communicable diseases in India. Administration of public health in India. -14 hrs

Unit 4: Environmental Impact Assessment: Definition, Basic Concepts and Principles of EIA. Nexus between Development and Environment, Need for EIA, Elements of EIA, Environmental Attributes, Nature of Impacts- Primary, Secondary, Tertiary, Short Term, Long Term, Reversible and Irreversible Impacts. Overview of Impacts, Directly and Indirectly Measurable Impacts of Air, Noise, Water, Land, Biological and Socio-Economic Elements. -14 hrs


Activities: Visit to Pollution control board to study the role of PCR on EIA

Practicals:
Based on Theory paper

References

Preamble: Every human activity ends up in the generation of unwanted waste product. This paper throws light on the current scenario of solid and hazardous waste generation and problem in its handling and management. It also deals with the different governmental policies that explain proper transportation, handling and disposal of solid and hazardous waste to minimize its effect on environment. Also it provides knowledge on methods for conversion of waste to wealth.


Practicals:
Based on Theory paper

References
SCT-4.1: Remote sensing and GIS 64 hrs

Preamble: This curriculum introduces the students to various computer-based and statistical methods used for study and management of natural resources and the environment. The students are expected to learn about remote-sensing techniques, physical principles, sampling, statistics and image-analysis methods.

Unit 1: Satellites and their characteristics – Geo-stationary and sun synchronous, Earth resource Satellites-Indian Space programme. Basics of remote sensing: Definition, concepts and principle of energy interactions with environmental components. Fundamental of aerial photographic systems; Principle: Types of aerial cameras, aerial photos; ground coverage; radiometric characteristics, Interpretation principles and techniques and Applications of aerial photos. -12 hrs

Unit 2: Sensors and Scanners- Profiles and geometry of scanners, different types of sensors, their characteristics; Multispectral and thermal scanning. Thermal and Microwave sensing; basic concepts, profiles; SAR, SLAR operations, characteristic of RADAR signals; earth surface characteristics influencing RADAR returns interpretation of microwave data. -12 hrs

Unit 3: Digital image processing: Basic concepts and principles; image enhancement; edge enhancement; band rationing classification-supervised and unsupervised classification. Smoothing and filtering techniques; post classification smoothing classification accuracy enhancement; data merging; scale effects. -12 hrs


Unit-5: Application of Remote Sensing, GPS and GIS for Environmental Planning and Management: Vegetation cover, Agriculture, Surface and Ground water, Watershed, Marine resources, Coastal zones, Wild life Ecology, Mining and Quarrying; Agriculture and range land application; earthquakes and flood mapping assessment. -12 hrs

Prcticals:

Based on Theory paper

Reference :  
20. Santra S.C., Environmental Science, Central Book Agency Ltd., Kolkata
SCT-4.2: Disasters and Management

Preamble: This paper introduces the scientific knowledge among the students about various natural and man-made disasters through the teaching of policies, programs, administrative actions and operations undertaken. This will train them to cope with the different disaster management activities like preparedness, prevention and thereby to reduce or avoid the human, physical and economic losses suffered by individuals, by the society, and by the country at large.

Unit-1: Basic concept of disaster- definition of hazard, vulnerability, risk, disaster; Causative factors of disaster; Classification of disasters- Natural and Man Made. 12 Hrs.

Unit-2: Disaster Management: Definition of disaster management; components of disaster management cycle- crisis management & risk management; Crisis management-quick response & relief, recovery, development; Levels of disasters in India; Causes, perception, management of various natural disasters like flood, landslides, earthquakes, tsunami, coastal erosion, cyclones, volcanism, forest fire etc. 13 Hrs.

Unit-3: Risk management- Risk identification & risk reduction- preparedness, prevention and mitigation. Important sectors in disaster management- health and medical care, communications, insurance, social work, NGO’s, media, fire services, police and paramilitary services, armed forces etc. 13 Hrs.

Unit-4: Risk analysis and assessment: basic concept: Purpose of risk analysis; Analytical techniques; Tools of risk assessment - Toxicology, epidemiology, exposure modeling, significance of risk, risk characterization, communication and management; Role of Remote Sensing and GIS in disaster management. 13 Hrs.

Unit-5: Evaluation of likelihood of major accidents in industrial processes; assessing risk to ecosystem and human health from genetically modified organisms, waste water treatment and disposal, epidemiology, exposure modeling, assessing risk to human health from chemicals; Psychology of risks, the economic and evaluation of risks. 13 Hrs.

Practical
Based upon theory

References:
Scheme of Examination

I/II/III/IV Semester M. Sc. Examination, ……MONTH ……YEAR
(Scheme CBCS)
Environmental Science

Max Marks: 80

Duration: 3 Hrs

Instruction: Answer both Sections. Section- A is compulsory and Any four from the Section-B

SECTION – A

Q. 1. Answer any TEN of the following. 10 X 2 = 20

a. 
b. 
c. 
d. 
e. 
f. 
g. 
h. 
i. 
j. 
k. 
l. 
m. 

SECTION – B

(Answer any four from the Following)

Q.2 : 08
   a. 
   b. 07

Q.3 : 05
   a. 
   b. 05
   c. 05

Q.4 : 08
   a. 
   b. 07

Q.5 : 05
   a. 
   b. 05
   c. 05

Q.6 : 08
   a. 
   b. 07
**Scheme of Examination**  
**Practicals**

**Duration:** 3 Hrs  
**Max. Marks:** 40

Q.1. Conduct the given Major Experiment; Write Aim, Principle, Procedure and Tabulation, calculations and results. 08

Q.2. Conduct the given Minor Experiment; Write Aim, Principle, Procedure and Tabulation, calculations and results 07

Q.3. Identify and give critical comments on (Specimens / Spotter): 5 X 3 = 15
   - A.
   - B.
   - C.
   - D.
   - E.

Q.4. Viva-Voce 05

Q.5. Class records 05