The University of Burdwan

Syllabus for B.Sc.(Hons.)

in

Environmental Science

Under Choice Based Credit System

w.e.f. 2017-2018 onward

UG CBCS COURSE STRUCTURE FOR HONOURS ENVIRONMENTAL SCIENCE

CORE COURSES

Credits: 6 [Credit 1 for Tutorial (T) + 5 for Lecture (L)]/ [Credit 2 for Practical (P)+ 4 for Lecture]

Course Code	Course Title	Nature of Course			
		L	T	P	Credits
	SEM - I				
CC1	Fundamentals of Environment	4	0	2	4+2
CC2	Environmental Biology	4	0	2	4+2
	SEM - II				
CC3	Environmental Chemistry	4	0	2	4+2
CC4	Environmental Physics	5	1	0	5+1
	SEM - III				
CC5	Earth Science	4	0	2	4+2
CC6	Environmental Resources	4	0	2	4+2
CC7	Green Chemistry & Environmental Applications	5	1	0	5+1
	SEM - IV				
CC8	Ecotoxicology & Environmental Biotechnology	5	1	0	5+1
CC9	Environmental Laws, Policies & Environmental Impact Assessment	5	1	0	5+1
CC10	Natural Hazards & Management & Waste Management	5	1	0	5+1
	SEM - V				
CC11	Environmental Pollution	4	0	2	4+2
CC12	Environmental Engineering & Statistics	5	1	0	5+1
	SEM - VI				
CC13	Environmental Economics & Management	5	1	0	5+1
CC14	Wildlife Management & Conservation	4	0	2	4+2

DSE COURSES

Credits: 6 [Credit 1 for Tutorial (T) + 5 for Lecture (L)]/ [Credit 2 for Practical (P)+ 4 for Lecture]

Course Code	Course Title	Nature of Course	
		L T P	
DSE1	Environmental Pollution & Monitoring Techniques OR Disaster Management	5 1 0	5+1
DSE2	Environmental Health & Stress Physiology OR Social Environmental Issues	5 1 0	5+1
DSE3	Water & Water resources OR Atmosphere & Global Climate Change	5 1 0	5+1
DSE4	Environmental Biotechnology OR Solid Waste Management	5 1 0	5+1

GENERIC ELECTIVE COURSES - FOR OTHER PROGRAMMES/ SUBJECTS

Credits: 6 [Credit 1 for Tutorial (T) + 5 for Lecture (L)]/ [Credits 2 for Practical (P)+ 4 for Lecture]

	Course Title	Nature of Course	
		L T P	Credits
GE1	Environment & Society	5 1 0	5+1
GE2	Environmental Resources	5 1 0	5+1
GE3	Environmental Pollution	5 1 0	5+1
GE4	Green Technology	5 1 0	5+1

SKILL ENHANCEMENT COURSES

FOR DEPARTMENTAL STUDENTS

Credits: 2

Course Code	Course Title	Credits
SEC1	Analytical Techniques OR Remote Sensing & Geographical Information System (GIS)	1 + 1
SEC2	Conservation & Ecotourism OR Microbiological Techniques	1 + 1

ABILITY ENHANCEMENT COMPULSORY COURSES

ENVIRONMENTAL STUDIES

Credits: 4

Course Code	Course Title	Credits
AECC1	Environmental Studies	4

ABILITY ENHANCEMENT COMPULSORY COURSES

COMMUNICATIVE ENGLISH/ MIL

Credits: 2

Course Code	Course Title	Credits
AECC2	Communicative English / MIL	2

OUTLINE OF CHOICE BASED CREDIT SYSTEM

1. Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. Elective Course: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1 Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective.

2.2 Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

2.3 Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and *vice versa* and such electives may also be referred to as Generic Elective.

3. Ability Enhancement Courses (AEC): The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement; i. Environmental Science and ii. English/MIL Communication. These are mandatory for all disciplines. SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

3.1 Ability Enhancement Compulsory Courses (AECC): Environmental Science, English Communication/MIL Communication.

3.2 Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

DEPARTMENT OF ENVIRONMENTAL SCIENCE
THE UNIVERSITY OF BURDWAN, BURDWAN
Curriculum for B.Sc. General Course in Environmental Science
[Choice Based Credit System]

SEMESTER-I

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credits
				L	T	P	
1	Fundamentals of Environment		CC1	4	0	2	6
2	Environmental Biology		CC2	4	0	2	6
3	Any Discipline Other than Env. Sc		GE1	5	1	0	6
4	Environmental Studies		AECC1	4	0	0	4
Total Credit = 22							

SEMESTER-II

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credits
				L	T	P	
1	Environmental Chemistry		CC3	4	0	2	6
2	Environmental Physics		CC4	5	1	0	6
3	Any Discipline Other than Env. Sc		GE2	5	1	0	6
4	Communicative English / MIL		AECC2	2	0	0	2
Total Credit = 20							

SEMESTER-III

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credits
				L	T	P	
1	Earth Science		CC5	4	0	2	6
2	Environmental Resources		CC6	4	0	2	6
3	Green Chemistry		CC7	5	1	0	6
4	Any Discipline Other than Env. Sc		GE3	5	1	0	6
5	Analytical Techniques **OR** Remote Sensing & Geographical Information System (GIS)		SEC1	2	0	0	2
Total Credit = 26							

SEMESTER-IV

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credits
				L	T	P	
1	Ecotoxicology & Environmental Biotechnology		CC8	5	1	0	6
2	Environmental Laws, Policies & Environmental Impact Assessment		CC9	5	1	0	6
3	Natural Hazards & Management & Waste Management		CC10	5	1	0	6
4	Any Discipline Other than Env. Sc		GE4	5	1	0	6
5	Conservation & Ecotourism **OR** Microbiological Techniques		SEC2	2	0	0	2
Total Credit = 26							

SEMESTER-V

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credits
				L	T	P	
1	Environmental Pollution		CC11	5	1	0	6
2	Environmental Engineering & Statistics		CC12	5	1	0	6
3	Environmental Pollution & Monitoring Techniques **OR** Disaster Management		DSE1	5	1	0	6
4	Environmental Health and Stress Physiology **OR** Social Environmental Issues		DSE2	5	1	0	6
Total Credit = 24							

SEMESTER-VI

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credits
				L	T	P	
1	Environmental Economics & Management		CC13	5	1	0	6
2	Wildlife Management & Conservation		CC14	5	1	0	6
3	Water & Water resources **OR** Atmosphere & Global Climate Change		DSE3	5	1	0	6
4	Environmental Biotechnology **OR** Solid Waste Management		DSE4	5	1	0	6
Total Credit = 24							

CORE COURSE

Sl. No.	Semester	Name of the Subject	Teaching Scheme in hour per week			Credits
			L	T	P	
1	I	Fundamentals of Environment	4	0	2	6
2		Environmental Biology	4	0	2	6
3	II	Environmental Chemistry	4	0	2	6
4		Environmental Physics	5	1	0	6
5	III	Earth Science	4	0	2	6
6		Environmental Resources	4	0	2	6
7		Green Chemistry & Environmental Applications	5	1	0	6
8	IV	Ecotoxicology & Environmental Biotechnology	5	1	0	6
9		Environmental Laws, Policies & Environmental Impact Assessment	5	1	0	6
10	V	Natural Hazards & Management & Waste Management	5	1	0	6
11		Environmental Pollution	4	0	2	6
12		Environmental Engineering & Statistics	5	1	0	6
13	VI	Environmental Economics & Management	5	1	0	6
14		Wildlife Management & Conservation	4	0	2	6
Total Credits = 84						

SEMESTER- I

CC1: FUNDAMENTALS OF ENVIRONMENT

CREDITS – 4+2 = 6

(Lecture – 4 :: Practical – 2)

Lecture: 4 Credits **Lectures - 60**

Concept of Environment: Definition and concept of environment; Types and components of environment (Lithosphere, Atmosphere, Hydropshere, Biosphere); Scope and multidisciplinary nature of the subject; Man-environment relationships; Public awareness – Earth Summits, recent Conventions on climate change (**15)**

Environmental Education: Goals of environmental education; Environmental education at primary, secondary and tertiary level; Green politics; Environmental movements – The Chipko movement, Silent Valley movement, Narmada Bachaao Andolan, Tehri Dam Conflict **(15)**

Cell and Genetics: Cell: Characteristics and types of Prokaryotic, and Eukaryotic cells; Concept of a gene, chemical nature of gene; Ultra structure and functions of plasma membrane, structure and function of Mitochondria, Ribosome, Golgi body, Chloroplast, Endoplasmic reticulum, Nucleus, Chromosome; Cellular reproduction: Stages of Mitosis and Meiosis **(22)**

Fundamentals of Genetics: Mendel's Law of inheritance and gene interaction; Darwinism and Modern Synthetic Theory of evolution; Gene pool, Genetic drift **(08)**

SEMESTER- I

CC1: FUNDAMENTALS OF ENVIRONMENT

PRACTICAL

Practical: 2 Credits :: 30 h (Class)

Major Experiments

a) Cytological preparation of Mitotic stages from onion root tips (*Allium cepa*)
b) Cytological preparation of Meiotic stages from grasshopper testis

SEMESTER- I

CC2: ENVIRONMENTAL BIOLOGY

CREDITS – 4+2 = 6

(Lecture – 4 :: Practical – 2)

Lecture: 4 Credits **Lectures - 60**

Taxonomy: Definition of taxonomy, systematic and classification; Morphological and taxonomical studies of flora and fauna **(10)**

Concepts of Ecology: Subdivisions of ecology; Ecological classification (hydrophytes, xerophytes, halophytes, *etc*.) and their morphological, physiological and biochemical adaptation; Ecological factors - climatic, edaphic, physiographic and biotic; Limiting factor and Shelford's Law, Liebig law; Concept of Biological clock, circadian rhythm **(15)**

Concepts of Ecosystem and Biomes: Structural and functional aspects of major ecosystems (with special reference to freshwater, mangrove and desert); Trophic levels, Ecological pyramids, food chain and food webs; Energy flow in ecosystem - Energy flow models
Biomes: Concept, types and characteristics of biome types **(20)**

Biotic Community: Characteristics of population and community; Basic ideas on ecotone and edge effect, habitat and ecological niche, ecotypes, ecophene, ecological indicators; ecological succession; biogeochemical cycles, *e. g.,* N, C, S, P **(15)**

SEMESTER- I
CC2: ENVIRONMENTAL BIOLOGY
PRACTICAL

Practical: 2 Credits :: 30 h (Class)
1) Major Experiments:

a) Estimation of water parameters — DO, Alkalinity, Acidity
b) Staining of zooplankton and Identification

SEMESTER- II
CC3: ENVIRONMENTAL CHEMISTRY
CREDITS – 4+2 = 6
(Lecture – 4 :: Practical – 2)

Lecture: 4 Credits **Lectures - 60**

Fundamental Concepts of General Chemistry: Molecular weight, equivalent weight, molarity, normality, valency, oxidation state and bonding, oxidation and reduction reactions; Metals and non-metals; Aromatic and aliphatic organic compounds; Saturated and unsaturated hydrocarbons; Free radicals **(15)**

Fundamentals of Biochemistry: Elementary ideas on carbohydrates, proteins, lipids and enzymes; Idea on structure of macro-molecules - DNA and RNA **(10)**

Chemical Equilibrium and Kinetics (Fundamentals): Stoichiometry, chemical equilibrium, chemical potential; Acid-base reactions (acidity, alkalinity, buffers and buffer capacity) **(10)**

Aquatic Chemistry: Principles of sedimentation, coagulation, precipitation; Concept of solubility product; Filtration and adsorption processes **(10)**

Atmospheric Chemistry: Composition and structure of the atmosphere; Properties of atmospheric gases, aerosols, SPM; Photochemical reactions in the atmosphere (photochemical smog) **(15)**

SEMESTER- II
CC3: ENVIRONMENTAL CHEMISTRY
PRACTICAL

Practical: 2 Credits :: 30 h (Class)

1) Major Experiments:

a) Estimation of Carbohydrate, Protein, and Chlorophyll from plant material

b) Estimation of Primary productivity, Hardness

SEMESTER- II
CC4: ENVIRONMENTAL PHYSICS
CREDITS– 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures - 75

Radiation Physics: Radioactivity, radioactive disintegration, units of radioactivity, half life, average life, decay constant, nuclear fission, nuclear fusion, application of radio- isotopes **(15)**

Dynamic Meteorology: First and second law of thermodynamics, entropy, enthalpy, heat transfer processes; Diffusion and transport of pollutants in air **(13)**

Biophysics: Free energy; Bioenergetics of coupled reactions; High energy phosphates-central role in energy capture and transfer; Energy yield, coupling factor theory, membrane transport, active transport, ATP driven active transport, ion driven active transport; Osmosis, osmotic pressure, plant cell as osmotic system and relationship with turgor pressure, wall pressure and osmotic pressure; Water potential concept, types; Osmotic relation in three physical states (ψ, ψs, ψp); Water potential changes in plasmolysis and deplasmolysis, imbibitions **(27)**

Analytical Physics: Lambert-Beer's law; Principle, instrumentation, application, limitations of Spectrophotometer, Flame photometry, Atomic Absorption Spectrophotometer; Separation technique: Principle, types, techniques, and application of Chromatography; Solvent extraction process **(20)**

SEMESTER- III
CC5: EARTH SCIENCE
CREDITS – 4+2 = 6
(Lecture – 4 :: Practical – 2)

Lecture: 4 Credits **Lectures - 60**

Earth Processes: Origin and evolution of earth; Big Bang theory, Geological time scale; Major rock types; Continental drift theory, Plate tectonic theory **(10)**

Climatology: Elements of climates; Spatial and temporal patterns of climate; Climate parameters in India and climatic classification (Koppen's classification) **(10)**

Earth Resources: Mineral resources--classification, Indian occurrences; Water resources (surface and groundwater), hydrological cycles, geological formation as aquifers, type and characteristics of aquifers; Groundwater plume; Darcy's law; Depletion of groundwater; Artificial recharging of ground water; Influence of land use on water resources **(15)**

Elementary Idea of Remote Sensing: Definition, source of energy, energy interactions with the atmosphere and Earth's surface materials; Principle of Remote sensing; Remote sensing platforms; Principle and function of sensors; Types of satellites; Latest Indian operating satellites and their utilities; Advantages and limitations of remote sensing; GIS **(25)**

SEMESTER- III
CC5: EARTH SCIENCE
PRACTICAL

Practical: 2 Credits :: 30 h (Class)

Major Experiments

a) **Interpretation of Satellite Imagery:** Identification of different surface features from toposheet**,** Visual interpretations of satellite imagery

b) **Measurement of Climatic Parameters:** Wind speed & direction, Relative humidity & temperature

SEMESTER- III
CC6: ENVIRONMENTAL RESOURCE
CREDITS– 4+2 = 6
(Lecture – 4 :: Practical – 2)

Lecture: 4 Credits **Lectures - 60**

Natural Resources: Current status of Water, Land, Forest, Food and Minerals resource (**05)**

Soil: Weathering processes and soil formation; Soil profile development; Basic concept of physical, chemical and mineralogical composition of soil; Soil types, porosity, permeability **(07)**

Energy Resources: Classification - conventional, non-conventional, renewable, non-renewable **(03)**

Fossil Fuels: Coal (composition, origin and classification); Petroleum (origin, mining, chemical composition, classification); Natural gas (concept on LNG, CNG, LPG); Oil (origin, utilization) **(10)**

Renewable Resources: Solar energy (PV cells, PG cells); Geothermal energy (origin, utilization); Ocean energy; Biomass energy; Hydroelectricity **(08)**

Alternate Sources of Energy: Process of energy extraction from waste; Basic concept of petro-plants, biofuel **(07)**

Biological Wealth: Biodiversity – Concept, value; Mega-diversity Hotspots, hotspots of biodiversity, Red Data Book; Conservation of biodiversity (International & National); Threats of biodiversity **(20)**

SEMESTER- III

CC6: ENVIRONMENTAL RESOURCE

PRACTICAL

Practical: 2 Credits :: 30 h (Class)

1. **Major Experiments**:

   Estimation of soil parameters: pH & Temperature; Soil porosity, Bulk density, Organic carbon

SEMESTER- III

CC7: GREEN CHEMISTRY & ENVIRONMENTAL APPLICATIONS

CREDITS– 5+1 = 6

(Lecture – 5 :: Tutorial:-1)

Lectures - 75

Green Chemistry: Concept, principles, applications of green chemistry, *e. g.*, use of CO_2, H_2O_2, TiO_2; Chitin; Concept of octane number and antiknock compounds; Directions in practising green chemistry **(15)**

Green Technology: Green technology in waste management, Integrated waste management (IWM), Supercritical water oxidation (SCWO) of wastes; Rhizosphere in biodegradation of organic wastes; Green techniques in water treatments: Deionization, Desalinizatation, Electrodialysis, Reverse osmosis; Green sources of energy; Green treatments of industrial effluents - Cyanide, Chromate **(25)**

Green Synthesis of Chemicals: Methyl methacrylate, polyurethane, paracetamol; Production of 3^{rd} & 4^{th} generation pest controller, Integrated Pest Management (IPM), biodiesel, biopolymers, degradable polymers, bioplastics; Alternative Fluorocarbons (AFCs) **(20)**

Instrumental Methods: Chemical analysis of environmental samples; Principles of AAS, X-Ray, Fluorescence spectrophotometer, Gas chromatography, HPLC **(15)**

SEMESTER- IV

CC8: ECOTOXICOLOGY & ENVIRONMENTAL BIOTECHNOLOGY

CREDITS – 5+1 = 6

(Lecture – 5 :: Tutorial – 1)

Lectures – 75

Ecotoxicology: Definition and Concept; mechanism of toxicity; Branches of toxicology; Types of interactions in toxicology; Concept of Dose-Response relationship, LD_{50}, LC_{50}, Threshold Limit Value (TLV), Therapeutic index; Basic concept on Bioaccumulation, Biomagnifications, Bio-concentration factor; Ames test, Bio assay technique **(35)**

Environmental Biotechnology: Concept on Environmental biotechnology, Fermentation techniques, composting, vermicomposting, bioleaching; Application of biotechnology in environmental field **(25)**

Biotechnological Approaches: Definition, types, applications and advantages of biofertiliser, biopesticide, biofuel, and biogas **(15)**

SEMESTER- IV

CC9: ENVIRONMENTAL LAWS, POLICIES & ENVIRONMENT IMPACT ASSESSMENT

CREDITS– 5+1 = 6

(Lecture – 5 :: Tutorial – 1)

Lectures – 75

Environmental Laws and Policies: Basic concept on law, rules, act, treaty; Public Policy and PILs; Environmental provisions in the Indian Constitution- Article 48A, 51A(g); Powers and Functions of Govt. Agencies for pollution control (CPCB & SPCB) **(20)**

Environmental Acts: Objectives & Principles of The Environment Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and Control of Pollution) Act, 1974; The Noise Pollution (Regulation and Control) Act, 2000; The Wild Life (Protection) Act, 1972; The Forest (Conservation) Act, 1980; The National Green Tribunal Act, 2010; The Biological Diversity Act, 2002; Public Liability Insurance Act, 1991 **(25)**

Environmental Impact Assessment (EIA): Basic ideas and definition; Goals of impact assessment, evolution of impact assessment, technology assessment; Environmental inventory; Techniques and methods of EIA **(30)**

SEMESTER- IV

CC10: NATURAL HAZARDS & MANAGEMENT & WASTE MANAGEMENT

CREDITS – 5+1 = 6

(Lecture – 5 :: Tutorial – 1)

Lectures – 75

Natural Hazards: Definition, concept and types; Causes, distribution, consequences and mitigation measures and for Earthquake, Tsunami, Cyclone, Flood, Drought and Landslide **(15)**

Disaster Management: Definition and concept, vulnerability, capacity and risk; Disaster management cycle **(10)**

Environmental Management: Concept on environmental management and Environmental Management System; Management of air, water, noise, soil and agricultural pollution
Strategies for sustainable Water Management; Drinking Water Standard; Ganga Action Plan (GAP), Yamuna Action Plan (YAP) **(25)**

Waste Management: Waste generation & characterization; Integrated Solid Waste Management; Hazardous waste management; Hazardous waste treatment technologies; Municipal Solid Waste Management; Biomedical waste management; Industrial Pollution Management **(25)**

SEMESTER- V
CC11: ENVIRONMENTAL POLLUTION
CREDITS – 4+2 = 6
(Lecture – 4 :: Practical – 2)

Lecture: 4 Credits **Lectures - 60**

Understanding Pollution (Fundamentals): Pollution, poverty, and population **(03)**

Air Pollution: Air pollutants—sources and effects of primary and secondary pollutants, particulate matters, indoor pollutants; Global climate change; Photochemical smog **(12)**

Water Pollution: Sources-direct and indirect sources and their impact on water bodies, *viz*., marine, coastal, wetlands; groundwater pollution; Eutrophication, Lake acidification, salt water intrusion **(15)**

Soil Pollution: Sources, types and effects of soil pollution **(03)**

Thermal Pollution: Definition, nature of pollutants, environmental effects of coal ash **(07)**

Vehicular Pollution: Characteristics of automobile emissions, effects of automobile pollutants **(10)**

Fireworks Pollution: Definition, characteristics, composition; Pollution and effects; Safety and laws **(10)**

SEMESTER- V
CC11: ENVIRONMENTAL POLLUTION
PRACTICAL

Practical: 2 Credits :: 30 h (Class)
Major Experiments

a) Estimation of Nitrate-nitrogen, Phosphate, Chloride from water sample
b) Measurement of Noise, Dust fall

SEMESTER- V
CC12: ENVIRONMENTAL ENGINEERING & STATISTICS
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures – 75

Environmental Engineering: Material cycling in ecosystems; Hydraulic gradient; Rain water harvesting, Water shed management; Municipal waste water and treatment processes; Point-source Gaussian Plume Model in air pollution; Global initiatives on atmospheric changes; Waste-to-Energy combustion **(20)**

Environmental Modelling: Mathematical models; Steps in modelling approaches; Limitations of model application, fate of chemicals, sophistication levels in modelling **(15)**

Statistical Concept: Concept of statistics, population, sampling, sampling area, sampling unit, types of data, types of sampling, advantages of sampling; Graphical representation of statistical data **(20)**

Measurement: Mean, Median, Mode; Mean deviation, Standard deviation, Standard error; Correlation and Regression; Estimation of sample size, basic information on probability, testing of hypothesis, Null and alternate hypothesis, Skewness, Kurtosis, t – test, chi – square test **(20)**

SEMESTER- VI
CC13: ENVIRONMENTAL ECONOMICS & MANAGEMENT
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures – 75

Environmental Economics: Concept, scope; Concept of supply and demand; Ecological economics; Environmental Kuznets's Curve; Economics of pollution control; Cost: Benefit analysis; Polluter's Pay Principle **(15)**

Environmental Accounting and Auditing: Environmental accounting--objectives, financial accounting, social accounting; Basic steps and process of environmental audit; Life cycle assessment **(10)**

Principles of Management: Definition and concept on environmental management; Environmental quality measurement (ISO:14000), Environmental management system; Implication of Agenda-21; Functions of management--forecasting, planning, organizing, motivating, coordinating, controlling, and communicating, leadership, directing, and decision making **(20)**

Management of Pollution: Management of air pollution, water pollution, noise pollution in respect to Indian scenario; Concept, types, importance of Desalination Process; Waste Water Treatment; Strategies for sustainable Water Management; Drinking Water Standard; Ganga Action Plan (GAP), Yamuna Action Plan (YAP) **(15)**

Waste Management: Integrated system for waste management: Municipal Solid Wastes (MSW); Biomedical wastes; Plastic wastes; Hazardous wastes; Radioactive waste; Biosafety Protocol **(15)**

SEMESTER- VI
CC14: WILDLIFE MANAGEMENT & CONSERVATION
CREDITS – 4+2 = 6
(Lecture – 4 :: Practical – 2)

Lecture: 4 Credits **Lectures - 60**

Wildlife Management: Need of environmental management; Wildlife conservation: moral obligation; Philosophy of wildlife management; Human wildlife conflicts; Role of government, wildlife biologists and social scientists **(15)**

Human Wildlife Coexistence: Symbiotic relationship between tribals and forest, forest and development; Community participation in forest management, case study of Chipko movement, sacred groves forests, India's Bishnoi community and their conservation practices; Ecological-

economic welfare and development; Man and biosphere programmes; Concept of conservation reserves and community reserves, importance of wildlife corridors **(20)**

Wildlife Conservation Laws in India: Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; Concept of core and buffer area in a protected range; Brief introduction to Wildlife Protection Act of 1972; Forest Act of 1927; Environmental Protection Act of 1986; and Forest Conservation Act of 1920; Tiger task force, Status of current protected areas in India **(25)**

SEMESTER- VI
CC14: WILDLIFE MANAGEMENT & CONSERVATION PRACTICAL

Practical: 2 Credits :: 30 h (Class)

1. Educational tour/ Field visit

DSE1: ENVIRONMENTAL POLLUTION & MONITORING TECHNIQUES
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures - 75

Radiation Pollution: Nature and types of radiation; Radiation hazards; Measurement of radioactivity; Nuclear accidents **(15)**

Pesticide Pollution: Sources, categories; Pesticidal effects in water; Elementary idea on IPML **(15)**

Metal Pollution: Metals in soil, food and water; Elementary idea on Lead and Cadmium pollution **(15)**

Analytical Techniques and Tools: Sampling, preservation and storage techniques; Principle, application and limitations of titrimetry, gravimetry and potentiometry; Ultrasound characteristics and Environmental applications of acoustic RADAR and LASER **(20)**

Bacteriological Examination of Water: Standard Plate Count and Coliform test with reference to IS: 1622 **(10)**

OR

DSE1: DISASTER MANAGEMENT
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures - 75

Understanding Disaster: Concept and definitions of disaster; Hazard, vulnerability, risk, capacity: Types, trends, causes and consequences and control of various disasters, *viz.*, Geological, Hydro-meteorological, Biological and Technological disasters **(25)**

Disaster Management: Vulnerability of natural hazards in India; Disaster management cycle; Activities associated with various stages of cycles **(15)**

Institutional Framework: Constitutional frameworks in India – Role of Governments, Non-Governments and State Government agencies **(15)**

Risk Assessment: Concept and evaluation of risk; Hazard identification; Exposure assessment; Hazard assessment; Risk characterization; Man-made Environmental degradation; Problems related to toxic wastes and chemicals and radioactive substance disposal **(20)**

DSE2: ENVIRONMENTAL HEALTH & STRESS PHYSIOLOGY
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures - 75

Environmental Health: Concept of health and disease; Principles of epidemiology and epidemiological methods, aims of epidemiology **(15)**

Diseases: Concept on air, water, vector borne diseases; Some communicable diseases-- Viral hepatitis, dengue, Leishmaniasis; Non-communicable diseases - cardiovascular, diabetes; Immunology-elementary ideas about antigens and antibody, autoimmunity; Immunodeficiency diseases; Allergy – Antibody-mediated hypersensitivity, hypersensitivity pneumonitis, allergic rhinitis, ingestant allergy, dermatitis, drug sensitivity **(30)**

Health Programs: Health Programs in India; Demography and family planning; Nutrition and health; Health education; World health report; Health impact assessment **(15)**

Environmental Stress Physiology: Concept and fundamentals; Photoinhibition and photoacclimation; Stress-agents like temperature, oxygen, salinity on plants **(15)**

OR
DSE2: SOCIAL ENVIRONMENTAL ISSUES
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures - 75

Man-Environment Relationship: History and relationship; Need for public awareness; Deep ecology; Equitable use of natural resources; Ecosystem services to society; Environmentalism, Environmental refugees; Ecofeminism; Environmental movements in India; International and national environmental organizations; Human population growth and problems, regulation of population, Green politics **(30)**

Social Issues: Global environmental issues; Wasteland reclamation; Unsustainable to Sustainable Development; Urban problems related to energy; Resettlement and rehabilitation of people: Citizens Actions and Action Groups; Environmental awareness; Environmental ethics; Women and Child welfare; Role of Information Technology in environment and human health **(25)**

Environmental Sustainability: Concept of sustainable city, urban planning, social responsibility; International treaties & Conventions [Wetlands (Ramsar)], International Trade in Endangered Species (CITES), Biodiversity (CBD), Transboundary Movements of Hazardous Waste (Basal), Climate Change (Kyoto Protocol) **(20)**

DSE3: WATER & WATER RESOURCES
CREDITS– 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures: 75

Water: Sources and types of water; Hydrological cycle; Precipitation, runoff, infiltration, evaporation, evapo-transpiration; Classification of water resources (oceans, rivers, lakes and wetlands) **(10)**

Properties of Water: Physical water: Temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: Major inorganic and organic constituents, dissolved gases, DO, COD, BOD, acidity and alkalinity, electrical conductivity, sodium adsorption ratio; Biological: phytoplankton, phytobenthos, zooplankton, macro-invertebrates and microbes **(20)**

Surface and Subsurface Water: Characteristics of surface and ground water; Surface and ground water pollution; Formation and properties of aquifers; Watershed and drainage basins; Importance of watershed and watershed management; Rain water harvesting in urban settings **(20)**

Water Resource in India: Demand for water (agriculture, industrial, domestic); Overuse and depletion of surface and ground water resources; Water quality standards in India; Hot spots of surface water **(15)**

Water Resources Conflicts: Water resources and sharing problems; Multi-purpose river valley projects in India and their environmental and social impacts; International conflicts on water sharing between India and her neighbours **(10)**

OR

DSE3: ATMOSPHERE & GLOBAL CLIMATE CHANGE
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures – 75

Earth's Atmosphere: Concept; Evolution and development; Atmospheric structure and composition **(05)**

Global Energy Balance: Earth's energy balance; Energy transfers in atmosphere; Earth's radiation budget; Green house gases (GHGs); Greenhouse effect; Global conveyor belt **(10)**

Atmospheric Circulation: Movement of air masses; Atmosphere and climate; Air and sea interaction; Southern oscillation; Western disturbances; *El Nino* and *La Nina*; Tropical cyclone; Indian monsoon and its development, effect of urbanization on micro climate **(15)**

Global Warming and Climate Change: Earth's climate through ages; Trends of global warming and climate change; Impact of climate change on atmosphere, weather patterns, sea level rise **(15)**

Ozone Layer Depletion: Ozone layer or ozone shield; Importance of ozone layer; Ozone layer

depletion and causes; Ozone depleting substances (ODS); Effects of ozone depletion; Mitigation measures and international protocols **(20)**

Climate Change and Policy: Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Convention on Climate Change **(10)**

DSE4: ENVIRONMENTAL BIOTECHNOLOGY
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures: 75

Structure and Function of Nucleic acid, Amino acid and Chromatin: DNA: structural forms and their characteristics (B, A, Z); Physical properties: UV absorption spectra, denaturation and renaturation kinetics; Synthesis - RNA: structural forms and their characteristics (rRNA, mRNA, tRNA), types of amino acids; Central dogma of biology; Chromosomal organization (euchromatin, heterochromatin - constitutive and facultative heterochromatin) **(20)**

Recombinant DNA Technology: Recombinant DNA: origin; Steps of preparation; Toolkit of enzymes for manipulation of DNA: Restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reverse transcriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase); Genomic and cDNA libraries: Construction, screening and uses; Cloning and expression vectors (plasmids) **(20)**

Ecological Restoration and Bioremediation: Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors; Treatment schemes for waste water; Specific bioremediation technologies: Land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wetlands, use of bioreactors for bioremediation; Phytoremediation; Degradation of xenobiotics in environment **(20)**

Ecologically Safe Products and Processes: PGPR: Biofertilizers, microbial insecticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel (**15**)

OR

DSE4: SOLID WASTE MANAGEMENT
CREDITS – 5+1 = 6
(Lecture – 5 :: Tutorial – 1)

Lectures: 75

Solid Waste: Sources and generation; Classification and chemical composition; Characterization of municipal solid waste; Hazardous waste and biomedical waste **(05)**

Effect of Solid Waste Disposal on Environment: Effect of solid waste and industrial effluent discharge on water quality and aquatic life; Mining waste and land degradation; Effect of land fill leachate on soil characteristics and ground water pollution **(15)**

Solid Waste Management: Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); Landfill (traditional and sanitary landfill design); Thermal treatment (pyrolysis and incineration) of waste material; Drawbacks in waste management techniques **(20)**

Industrial Waste Management: Types of industrial waste: Hazardous and non-hazardous; Effect of industrial waste on air, water and soil; Industrial waste management and its importance **(10)**

Resource Recovery: 4R- reduce, reuse, recycle and recover; Mechanical biological treatment; Green techniques for waste treatment **(10)**

Waste-to-energy: Concept of energy recovery from waste; Different WTE processes: Combustion,

pyrolysis, landfill gas (LFG) recovery; Anaerobic digestion; Gasification **(10)**

Integrated Waste Management: Concept of Integrated waste management; Waste management hierarchy; Methods and importance of Integrated waste management **(05)**

GENERIC ELECTIVES
For other Discipline(s)
GE1: ENVIRONMENT & SOCIETY
CREDITS – 5+1 = 6

Lectures - 60

Environment: Types of environment; Multidisciplinary nature and scope of environment; Components of environment; Environmental education **(10)**

Natural Resources: Definition, concept on natural resources – water, land, forest, food and mining; Biodiversity – concept, value, threats, conservation **(10)**

Ecology and Ecosystem: Definition and concept of ecology; Phases of ecology; Concept of ecosystem; Structure and functional aspects of ecosystem; Productivity concept of ecosystem; Food chain and food webs in ecosystem; Ecological energetic **(10)**

Environmental Pollution: Sources and effects of pollution (air, water, soil, noise and radiation); Ozone layer depletion; Global warming; Greenhouse effect; Acid Rain; *El-Nino*, *La-Nina*; ENSO **(10)**

Social Issues: Raising environmental awareness in India; Sustainable Development; Global environmental issues; Environmental legislation; Environmental movement in India; Human population and environmental problems: Role of information technology on environment and human health; Green business and green design **(20)**

GE2: ENVIRONMENTAL RESOURCES
CREDITS – 5+1 = 6

Lectures - 60

Natural Resources: Current status of Water, Land, Forest, Food and Minerals resources (**05)**

Soil: Weathering processes and soil formation; Soil profile development; Basic concept of physical, chemical and mineralogical composition of soil; Soil types, porosity, permeability **(10)**

Energy Resources: Classification - conventional, non-conventional, renewable, non-renewable **(05)**

Fossil Fuels: Coal (composition, origin and classification); Petroleum (origin, mining, chemical composition, classification); Natural gas (concept on LNG, CNG, LPG); Oil (origin, utilization) **(10)**

Renewable Resources: Solar energy (PV cells, PG cells); Geothermal energy (origin, utilization); Ocean energy; Biomass energy; Hydroelectricity **(10)**

Alternate Sources of Energy: Process of energy extraction from waste; Basic concept of petro-plants, biofuel **(10)**

Biological Wealth: Concept; Values; Mega-diversity Hotspots; Hotspots of biodiversity; Red Data Book; Conservation of biodiversity (International & National); Threats of biodiversity **(10)**

GE3: ENVIRONMENTAL POLLUTION
CREDITS– 5+1 = 6

Lectures - 60

Pollution: Fundamentals Pollution; Types of pollutants and pollution **(05)**

Air Pollution: Air pollutants—sources and effects of primary and secondary pollutants, particulate matters, indoor pollutants; Global climate change; Photochemical smog **(10)**

Water Pollution: Sources-direct and indirect sources and their impact on water bodies, *viz*., marine, coastal, wetlands; groundwater pollution; Eutrophication, Lake acidification, salt water intrusion **(10)**

Soil Pollution: Sources, types and effects of soil pollution **(10)**

Thermal Pollution: Definition, nature of pollutants, environmental effects of coal ash **(10)**

Vehicular Pollution: Characteristics of automobile emissions, effects of automobile pollutants **(10)**

Fireworks Pollution: Definition, characteristics, composition; Pollution and effects; Safety and laws **(05)**

GE4: GREEN TECHNOLOGY
CREDITS – 5+1 = 6

Lectures - 60

Green Chemistry: Concept, principles, applications of green chemistry, *e. g.*, use of CO_2, H_2O_2, TiO_2; Chitin; Concept of octane number and antiknock compounds; Directions in practising green chemistry **(15)**

Green Technology: Green technology in waste management, Integrated Waste Management (IWM); Supercritical water oxidation (SCWO) of wastes; Rhizosphere in biodegradation of organic wastes; Green techniques in water treatments: Deionization, Desalinizatation, Electrodialysis, Reverse osmosis; Green sources of energy; Green treatments of industrial effluents - Cyanide, Chromate **(15)**

Green Synthesis of Chemicals: Methyl methacrylate, polyurethane, paracetamol; Production of 3^{rd} & 4^{th} generation pest controller, Integrated Pest Management (IPM); Biodiesel, Biopolymers, Bioplastics; Alternative Fluorocarbons (AFCs) **(15)**

Instrumental Methods: Chemical analysis of environmental samples; Principles of AAS, X-Ray Fluorescence spectrophotometer, Gas Chromatography, HPLC **(15)**

SEC1: ANALYTICAL TECHNIQUES
CREDITS - 2

Lectures – 30

Basic Histological and Cytological Techniques: Fixation and Fixatives; Tissue-processing and Microtomy; Staining **(10)**

Microscopy: Components of microscope; Magnification and illumination; Types of microscope – Light, Electron, Phase, Polarised, Fluorescence **(10)**

Biological Analysis: Collection and preservation of plankton; Enumeration of net plankton, counting in Sedgwick Rafter cell **(10)**

OR

SEC1: REMOTE SENSING & GEOGRAPHICAL INFORMATION SYSTEM (GIS)
CREDITS – 2

Lectures – 30

Remote Sensing: Principles, properties; Electromagnetic radiation and its interaction with atmosphere; Spectral reflectance of Earth's surface features; Types and characteristics of different data acquisition platforms; Satellite geometry, sensors and resolutions; Data products and their characteristics; Basic principle of visual interpretation **(20)**

GIS: Concept of GIS; Spatial data model; Attribute data management; Process of GIS **(10)**

SEC2: CONSERVATION & ECOTOURISM
CREDITS – 2

Lectures – 30

Conservation: Concept of Wildlife Conservation - Reserves design, survey techniques of tiger, birds, deer, bison, elephants and insect; *In-situ* habitat management of wild animal; Concept of Zoo management; Nursery technology **(15)**

Ecotourism: Elementary idea of Mass tourism and its Impact on environment and culture; Concept of Ecotourism, Guideline and policy (National and International) of ecotourism; Types of Alternative Tourism, Elementary idea of Rural truism, Adventure tourism; Development, economical benefits and impacts of Ecotourism; Management of ecotourism **(15)**

OR

SEC2: MICROBIOLOGICAL TECHNIQUES
CREDITS – 2

Lectures – 30

Methodology: Preparation of solid and liquid media for bacterial culture (natural, synthetic medium); Sterilization; Aseptic technique; Inoculation and incubation; Preparation of slants; Pure culture techniques (spread plate, pour plate, streak plate) **(10)**

Techniques: Principle of staining; Simple, negative and differential staining (Gram staining); MPN technique for drinking water examination **(10)**

Instrumentation: Principle of autoclave, laminar air flow, incubator **(10)**

Suggested Books
SEM - I

1. Environmental Science: S.C. Santra, New Central Book Agency
2. Ecology and Environment: P.D. Sharma., Rastogi Publication.
3. Fundamental of Ecology: E.P.Odum,W.B.Sauders Company,USA
4. Agrawal, Sikdar and Deb (2002): A Text book of Environment; MacMillan
5. Botkin & Keller (1998): Environmental Science: Earth as a Living Planet; John Wiley & Sons
6. Elements of Ecology: Thomas M Smith & Robert Leo Smith; LPE, Pearson Education
7. Principles of Environmental Science: Inquary and Applications: William P Cunningham & Mary Ann Cunningham; The McGraw-Hill Companies, 4th Edn.
8. Textbook of Environmental Studies: Erach Bharucha; University Grants Commission; University Press2013
9. Fundamentals of Environmental Studies: Mahua Basu & S. Xavier; Cambridge University Press, 2016
10. Cell and Molecular Biology: Concept and Experiments, 3rd Edn, Gerald Karp, John Willey & Sons, INC, New York, 2002
11. Cell and Molecular Biology, EDP De Robertis, EMF De Roberts, Jr, 8th Edn, Lea & Febiger, International Edition, 1988
12. The Cell: A Molecular Approah: Geoffrey M Cooper, ASM Press, Washington DC & Sinauer Associates, Inc, Sunderland, Massachusetts
13. Molecular Biology of Cell, 5th Edn., Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter, GS, Taylor & Francis Group, 2008
14. Modern Trends in Environmental Biology: CBS: Tripathi G.

Suggested Books
SEM – II

1. Environmental Chemistry: A.K. De, New age (P) Ltd.
2. Chemistry for Environmental Engineering: Clair N Sawyer, Perry L. Mccarthy & Gene F. Parkin., Mc Graw - Hill lnc.
3. Methods for the Examination of Water and Wastewater 20th eds.; Lenore, S. Clesceri, Arnold E. Greenberg, Andrew D. Eaton; American Public Health Association
4. Clean technology, Johansson, A., Lewis Publishers.
5. Zero Pollution Industry, Nemerow, N.L. Wiley Intersciences
6. Industrial Pollution Prevention Handbook, Freeman, H.M., McGraw Hill
7. Landfill Waste Pollution and Control, Kenneth Westlake., Albion Publishing
8. Hazardous waste Management, Wentz, C.A., McGraw Hill
9. Biology of Wastewater Treatment, Oxford Gray, N.F., University

10. Biophysics; G. R. Chatwal, Himalaya Publishing House
11. Biochemistry: U. Satyanarayana; Books and Allied (P) Ltd.
12. Lehninger Principles of Biochemistry: D. Nelson and M. Cox. Low Price Edition
13. Principles of Industrial Analysis. Skoog, Holler; Nieman. Harbourt Asia Pte Ltd. Publisher International Company
14. Textbook of quantitative chemical analysis. G.H. Jeffery, J. Bassett, J. Mentham, R.C.Denny. Longman Scientific Technical. John Wiley and Sons.
15. Biochemistry. Debajyoti Das. Academic Publisher, Kol-73
16. Higher Mathematical Science. Baishnab and Ghatak; Publishing Syndicate, Mahtma Gandhi Road; Kol – 9
17. Pollution Prevention: Fundamentals and Practice Int. Ed.-2000, Paul L. Bishop, Mc Graw Hill
18. A text book of Environmental Chemistry and Pollution Control: S.S. Dara., S. Chand & Company Ltd.
19. Chemistry of the Environment, 2nd Edn., Thomas G Spiro &William M Stigliani; Prentice-Hall of India, New Delhi, 2003
20. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson & Jhon Walke
21. Atmospheric Chemistry (HB): Royal Society of Chemistry; Holloway
22. Phytoremediation: Methods & Reviews (HB): Springer Humana; Willey
23. Environmental Chemistry, 9e (HB): Taylor & Francis (CRC
24. Environmental Applications of Instrumental Chemical Analysis (HB), T&F CR

Suggested Books
SEM – III

1. Fischer (1984): Resources and Environment Economics, CUP
2. Dasgupta (1982): The Control of Resources; Basil Blackwell
3. Georgeacus-Roger (1971): The Entropy Law and Economic Process; HUP
4. Concard and Clerk (1987): Natural Resources Economics; CUP
5. Environmental Chemistry with Green Chemistry, Asim K Das, Books and Allied (P) Ltd., 2010
6. Geomorphology & Environment, Editors Savindra Singh, H S Sharma and Sunil K De,, ACB Publications, 2004.
7. Green Chemistry (PB): Nova; Luque
8. Textbook on physical geology, G.B.Mahapatra, CBS Publishers & Distributors
9. Fundamental of Physical Geography, Majid Husain, Rawat publications
10. General Climatology, Howard J. Critchfield, Pearson publisher
11. Atmosphere, Weather and Climate, Roger G.Barry and Richard J. Chorley, Routledge
12. Environmental Geology, Carla W. Montgomery, Mc Grew Hill
13. Environmental Geology, Andrew DeWet, Kirsten Menking, Dorothy Merritts , Macmillan Learning
14. Remote sensing and GIS, Basudeb Bhatta, Oxford publisher
15. Basic of Remote sensing and GIS, S.Kumar
16. Remote sensing and image interpretation, Lillesand, Kiefer and Chapman, Wiley publisher
17. Fundamental of Remote Sensing, George Joseph, University Press

Suggested Books
SEM - IV

1. Environmental Impact Assessment, Canter, L. McGraw Hill
2. Barrow (1997): Environmental and Social Impact Assessment: An Introduction, John Wiley & Sons
3. Canter (1996): Environmental Impact Assessment; McGraw-Hill, Inc
4. Casarett and Doull's Toxicology: The Basic Science of Poisons, 2nd Edn. John Doull, Curtis D Klaassen and Mary O Amdur; Macmillan Publishing Co. Inc. Canada
5. Environment and Pollution Laws: S K Mohanty, Universal Law Publishing Co. Pvt. Ltd., Delhi, 2005
6. Fundamental Toxicology, Ed by John H Duffus and Howard G J Worth, RSC Publishing, 2006
7. Fundamentals of Ecotoxicology, 3rd Edn., Michael C Newman, CRC Press, Taylor & Francis Group, London,, 2010
8. Principles of Biochemical Toxicology, 3rd Edn, Jogh Timbrell, Taylor & Francis , 2000
9. Environmental Toxicology, David A Wright, and Pamela Welbourn, Cambridge University Press, 2002
10. Environmental Impact Assessment: A Guide to Best Professional Practices (HB) Taylor & Francis (CRC)
11. Microbes & Microbial Technology (HB): Springer; Ahmad
12. Environmental Biotechnology (PB): CBS; Allen, K

13. Handbook of Media for Environmental Microbiology, 2e **Pub. Price: £111.00** (HB): Taylor & Francis; Atlas
14. Encyclopaedia of Environmental Microbiology, **6 Vol. Set:** John Wiley (Original); Bitton
15. Laboratory Manual in Biochemistry: Newage; Jayaraman
16. Environmental Toxicology: Biological and Health Effects Of Pollutants Ming-Ho-Yu
17. Natural disasters, Patrick L.Abbott., Mc Grew –Hill
18. Natural hazards, Edward Bryant, Cambridge
19. Natural Hazards and Disasters, Donald Hyndman, David Hyndman, Cengage learning
20. Frampton C., Hardwick and McNaught, 1999: Causes, Consequences and Management of Disasters, Hodder and Stoughton, London
21. Goel S. L., 2001: Encyclopaedia of Disaster Management, Vol. 1, 2 and 3, Deep and Deep Publications, New Delhi
22. Singh R. B. (ed.), 2006: Natural Hazards and Disaster Management: Vulnerability and Mitigation, Rawat Publications, New Delhi
23. Keller E. A. and Blodgett R. H., 2006: Natural Hazards: Earth's Processes as Hazards, Disasters and Catastrophe, Prentice Hall, New Jersey

Suggested Books
SEM – V
1. Introduction to Environmental Engineering and Science: Gilbert M Masters; Pearson Edition, 2007
2. Textbook of Environmental Biotechnology: Pradipta K Mohapatra, I K International Publishing house, Bangalore, 2006
3. Water Technology: An Introduction for Environmental Scientist and Engineers: N F Gray,, Viva Books Pvt. Ltd., New Delhi, 2000
4. Park's textbook of Preventive and Social Medicine, 18th Edn., K Park, M/s Banarsidas Bhanot, Jabalpur, 2005
5. Modern Food Microbiology: James M Jay, CBS Publishers & Distributors, New Delhi, 2005
6. Fundamental of Statistics S. Gupta

Suggested Books
SEM – VI
1. The Economic Approach to Environmental & Natural Resources, James R. Kahn., George Proval
2. Economics of Environment, Dorfman and Dorfmann
3. Pearce and Turner (1991): The Economics of Natural Resource and Environment, Harvester & Wheatsheaf
4. Dasgupta and Heal (1979): Economic Theory of Exhaustible Resources; CUP
5. Kneese & Sweeny (1993): Handbook of natural Resource and Energy Economics/3 Volumes; North-Holland
6. Crooper & Dates (1992): Environmental Economics: A survey/OEL
7. Dorfman & Dorfman (1994): Economics of Environment/3
8. Parikh (1993): Natural Resources Accounting: A Framework for India
9. Charles D Kolstad (2000): Environmental Economics, Oxford University Press
10. Park (2005): Preventive and Social Medicine; M/S Banarsids Bhanot
11. Kolstad (2000): Environmental Economics; OUP
12. Hazardous Waste Management, M.D.Lagrega et al., McGraw Hill
13. Fundamentals of Microbiology and Immunology: Banerjee and Banerjee; New Central Book Agency (P) Ltd.
14. Microbiology: Prescott, Harley and Klein; Mc Graw Hill Publisher
15. Microbiology: Pelzar, M.J.,Chan, E.C.S. and Kreig, N.R., Mc Graw-Hill Publishing Company
16. Wastewater Microbiology; Bitton, G.,John Wiley, NY
17. Tourism and Hotel Industry: Manohar Puri & Gian Chnad, Pragun Publications, New Delhi, 2006
18. Environmental Management Systems Marguglio
19. Water Quality: Indicators, Human Impact and Environmental Health (HB) Wang Barbooti
20. Environmental Pollution and Human Health: CBS; Bhargava S.K.
21. Handbook of Environmental Management &Technology, 2e (PB): John Wiley Original), Burke
22. Handbook of Water and Wastewater Treatment Technologies (HB): Elsevier Science (Reprint Technical Sc. & Eng); Cheremisinoff
23. Solid and Hazardous Waste Management (PB): CBS; Cherry, PM
24. Bansil, P.C. 2004. *Water Management in India*. Concept Publishing Company, India.
25. Brebbia, C.A. 2013. *Water Resources Management VII*. WIT Press.

26. CEA. 2011. *Water Resources and Power Maps of India*. Central Board of Irrigation & Power.
27. Grumbine, R.E. &Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science* **339**: 36- 37.
28.Loucks, D.P., Stedinger, J.R. &Haith, D. A. 1981. *Water Resource Systems Planning and Analysis*.
29. Englewood Cliffs, NJ, Prentice Hall.
30. Mays, L.W. 2006. *Water Resources Sustainability*. The McGraw-Hill Publications.
31. Schward& Zhang, 2003. *Fundamentals of Groundwater*. John Willey and Sons.
32. Souvorov, A.V. 1999. *Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource 33. Management*. Elsevier Publications.
34. Vickers, A. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press.
35. Barry, R. G. 2003. *Atmosphere, Weather and Climate*. Routledge Press, UK.
36.Lal D.S. 2006, *Climatology*, Sharda Pustak Bhawan, Allahabad
37. Singh S. 2009, *Climatology*, Prayag Pustak Bhawan, Allahabad
38. Siddhartha K. 2005, *Atmosphere, Weather and Climate*, Kisalaya Publications Pvt. Ltd, New Delhi
39. Gillespie, A. 2006. *Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations*. MartinusNijhoff Publishers.
40. Hardy, J.T. 2003. *Climate Change: Causes, Effects and Solutions*. John Wiley & Sons.
41. Harvey, D. 2000. *Climate and Global Climate Change*. Prentice Hall.
42. Manahan, S.E. 2010. *Environmental Chemistry*. CRC Press, Taylor and Francis Group.
43. Maslin, M. 2014. *Climate Change: A Very Short Introduction*. Oxford Publications.
44. Mathez, E.A. 2009. *Climate Change: The Science of Global Warming and our Energy Future*. Columbia University Press.
45. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. *Climate Change and India*. Universities Press, India.
46. Philander, S.G. 2012. *Encyclopedia of Global Warming and Climate Cha*nge (2nd edition) Sage Publications
46. Asnani, P. U. 2006. Solid waste management. *India Infrastructure Report 570.*
47. Bagchi, A. 2004. *Design of Landfills and Integrated Solid Waste Management*. John Wiley & Sons.
48. Blackman, W.C. 2001. *Basic Hazardous Waste Management*. CRC Press.
McDougall, F. R., White, P. R., Franke, M., &Hindle, P. 2008. *Integrated Solid Waste Management: A Life Cycle Inventory*. John Wiley & Sons.
49. US EPA. 1999. *Guide for Industrial Waste Management*. WashingtonD.C.
50. White, P.R., Franke, M. &Hindle P. 1995. *Integrated Solid waste Management: A Lifecycle Inventory*. Blackie Academic & Professionals.
51. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. *Improving Municipal Solid waste Management in India.* The World Bank, Washington D.C.
52.Evans, G.G. & Furlong, J. 2010. *Environmental Biotechnology: Theory and Application* (2nd edition). Wiley-Blackwell Publications.
53. Jordening, H.J. & Winter J. 2005. *Environmental Biotechnology: Concepts and Applications*. John Wiley& Sons.
54. Lordish, H.F., Baltimore, D., Berk, A. Zipursky, S.L. Matsudiara, P. & Darnell, J. 1995.
Molecular Cell Biology. W.H. Freeman.
55. Nelson, D.L. & Cox, M.M. 2013. *Lehninger's Principles of Biochemistry*. W.H. Freeman.
56. Rittman, B.E. & McCarty, P.L. 2001. *Environmental Biotechnology. Principles and Applications.* McGraw-Hill, New York.
57. Scagg, A.H. 2005. *Environmental Biotechnology*. Oxford University Press.
58. Snustad, D.P. & Simmons, M.J. 2011. *Principles of Genetics* (6th edition). John Wiley&Sons.
Wainwright, M. 1999. *An Introduction to Environmental Biotechnology*. Springer.