

Chaudhary Charan Singh University, Meerut



S YLLABUS *for* **Master in Science (M.Sc.)** (Under Choice Based Credit System)

Effective From
ACADEMIC SESSION 2021-22

Department of Environmental Science



Department of Environmental Science
Ch. Charan Singh University, Meerut-250004

M.Sc. Environmental Science Syllabus Effective From Academic Session 2021-22

The course curriculum in the Environmental Science has been developed from the growing public awareness and concern about environmental problems. It is also to cater the ever growing need of environmental education in the society. The present course contents have been designed in light of globally current environmental changes, and UGC-NET with the following objectives-

Objectives

1. To provide quality education and training in environment management.
2. To establish working linkages with industry and undertake research on environment related issues.
3. To foster environmental awareness and promote the principles and practices of sustainable development.

I SEMESTER				
PAPER CODE	COURSE	Credits		
		Theory	Practical	Total
	I. Fundamental of Ecology & Environmental Sciences	4	2	6
	II. Environmental Chemistry & Instrumentation	4	2	6
	III. Environmental Geosciences & Natural Disasters	4	2	6
	IV. Natural Resources & Their Management	4	2	6
	Practical based on Courses I-IV			
	Open Elective I (Hindi/English/Urdu/Sanskrit)			
II SEMESTER				
	V. Environmental Microbiology & Biotechnology	4	2	6
	VI. Environmental Economics & Sociology	4	2	6
	VII. Environmental Pollution & Monitoring	4	2	6
	VIII. Environment & Public Health	4	2	6
	Practical based Courses V-VIII			
	Open Elective II (Climate Change, Mitigation and Adaptation)	6		6
III SEMESTER				
	IX. Environmental Policies & Law	4	2	6

	X. Environmental Management & EIA	4	2	6
	XI. Fundamentals of Remote Sensing & GIS	4	2	6
	XII. Environmental Statistics & Computer Applications	4	2	6
	Practical based on Courses IX-XII			
	Open Elective III (Disaster Risk Reduction and Management)	6		6
IV SEMESTER				
	XIII. Research Methodology & Research Ethics	6	--	6
	Project Work/Dissertation (Outside the campus in Industry/Reputed Laboratories or NGOs)			18
	Total Credit			108

Members of the Board of Studies-

1. Prof. MK Gupta, Dean Faculty of Science, CCS University, Meerut
2. Prof. AK Chaubey, Coordinator, Department of environmental Science, CCS University, Meerut
3. Prof. JK Tripathi, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi
4. Prof. RP Singh, Department of Energy and Environment, BR Ambedkar University, Lucknow
5. Prof. SK Gupta, Law School, Banaras Hindu University, Varanasi
6. Dr. DK Sinha, Division of Epidemiology, ICAR-IVRI, Izatnagar, Bareilly
7. Dr. PV Malik (Retd. Principal), Sanjay Gandhi PG College, Sarurpur Khurd, Meerut

Sd/-
(AK Chaubey)
Coordinator

Sd/-
(MK Gupta)
Dean Science

Compulsory Core Courses

I SEMESTER	
COURSE I: Fundamental of Ecology and Environmental Sciences [Credits: 4+2]	
Unit 1	Environment: Definition; Interaction between man and environment; Components of environment (atmosphere; hydrosphere; lithosphere and biosphere). Scope and Importance of Environmental Science.
Unit II	Population and Biotic Community: Characteristics of population; Population growth (<i>vis-a-vis</i> the concept of Carrying capacity); Concept and Characteristics of Biotic-communities (concept of habitat, niche, keystone species, dominant species, flagship species, ecotones, edge effect), Lotka-Voltera model, r-k selection
Unit III	Ecology: Definition, types,: Structure and components; Aquatic Ecosystems (Freshwater, Marine, Wetlands), Terrestrial ecosystem (Forest, Grassland, Agro & Desert); Energy flow in ecosystem; Biogeochemical cycles (Nitrogen, Carbon, Phosphorus, Water); Food Chain, Food Web and Ecological Pyramids, Self-Sustenance of Ecosystem: Homeostasis in natural ecosystems; Ecosystem stability and resilience
Unit IV	Community Ecology: Concepts, community attributes, species diversity, community coefficients, concept of ecological niche, morphological, & physical response of organism to temperature and water
Unit V	Ecological Restoration: Definition & concept; Disturbance causes and impact on terrestrial & aquatic ecosystem; Ecosystem Reconstruction Biodiversity and Conservation: Concept and value of biodiversity; Biodiversity at different levels (genetic, species and ecosystem); Threats to biodiversity; Hotspots of biodiversity; Biodiversity and ecosystem stability;
Recommended Books	
<ol style="list-style-type: none"> 1. <i>A Primer of Ecology, 4th edition</i> by Nicholas J Gotelli. Publisher: Sinauer Associates Inc. USA 2. <i>An Introduction to Sustainable Development</i> by Peter P Rogers, F Jalal Kazi & A Boyd John. Publisher: Earthscan. 3. <i>Ecology from Individuals to Ecosystems</i> by M Begon, CR Townsend, & JL Harper. Publisher: Wiley-Blackwell, USA. 4. <i>Ecology, 3rd Edition</i> by Michael L Cain, William D. Bowman & Saily D. Hacker. Publisher: Sinauer Associates Inc. USA. 5. <i>Ecology: Theories and Applications, 4th edition</i> by Peter Stiling. Publisher: Prentice Hall. 6. <i>Essentials of Conservation Biology, 5th Edition</i> by Richard B Primack. Publisher: Sinauer Associates Inc. USA 7. <i>Fundamentals of Ecology, 5th edition</i> by Eugene P Odum & Gary W Barrett. Publisher: Thomson Brooks/Cole. 8. <i>Fundamentals of Ecosystem Science</i> by Kathleen C Weathers. Publisher: Academic Press. 9. <i>Textbook of Biodiversity</i> by KV Krishnamurthy. Publisher: Science Publishers. 10. <i>The Sustainability Revolution: Portrait of a Paradigm Shift</i> by Andres R Edwards. Publisher: New Society. 	

I SEMESTER	
COURSE II: Environmental Chemistry & Instrumentation [Credits: 4+2]	
Unit 1	Environmental Chemistry: Concept and Scope; Fundamentals of chemical bonds; chemical reactions & equations molecules and compounds; Organic functional groups and classes of organic compounds; Free radical reactions, catalytic process; Solubility of gases in water, Radionuclides. Green Chemistry: Concept, Basic principles and tools, Zero waste technology.
Unit II	Water Chemistry: Concept of salinity; Composition and physico-chemical properties of water; Acid-base equilibrium; pH & buffers; Oxidation-reduction; Solution processes and solubility; Redox potential; Complexation and chelation reactions. Water quality & waste water treatment, water quality data processing and interpretation, role of soaps, detergents, fertilizers & pesticides in eutrophication,
Unit III	Soil: Soil formation; type and profile; erosion and weathering; element cycle (C, N, O, S, P) & their chemical characteristics and environmental significance Soil Chemistry: Inorganic and Organic components, mechanism of chemical wetting, pH, Nitrogen pathway and NPK in soil
Unit IV	Atmospheric Chemistry: Atmospheric constituents; Greenhouse gases & climate change; CFCs & their substitutes and its applications Chemical composition of atmosphere (particles, ions and radicals), Chemical processes for formation of inorganic and organic particulate matter, Chemical and photochemical reactions in the atmosphere: Photochemical smog, Acid rain and Ozone, combustion and environment implications
Unit V	Instrumentation: i. Instruments for Limnological analysis (pH meter, Turbidity meter, Conductivity meter, DO Analyzer) ii. Colorimetry iii. Spectrophotometry: Atomic absorption and Emission spectrophotometry, NMR, dielectrophoresis iv. Flame photometry v. Chromatography: Paper Chromatography, TLC, GLC, HPLC vi. High Volume Air Sampler, LASER, LIDAR, SODAR.
Recommended Books	
<ol style="list-style-type: none"> 1. <i>A Text Book of Environmental Chemistry and Pollution Control</i> by SS Dara. Publisher: S Chand Publications, New Delhi. 2. <i>Environmental Chemistry</i> by AK De. Publisher: New Age International (P) Ltd., New Delhi. 3. <i>Environmental Chemistry</i> by SK Banerji. Publisher: Prentice-Hall, New Delhi. 4. <i>Environmental Instrumentation and Analysis Handbook</i> by RD Down & JH Lehr. Publisher: John Wiley & Sons. 5. <i>Fundamental Concepts of Environmental Chemistry</i> by GS Sodhi. Publisher: Narosa Publishing House, New Delhi. 6. <i>Fundamentals of Bioanalytical Techniques and Instrumentation</i> by AK Srivastava & Sabari Ghoshal. Publisher: PHI Learning Pvt. Ltd. 7. <i>Fundamentals of Environmental Chemistry</i> by SE Manahan. Publisher: CRC Press, Inc., USA. 8. <i>Lehninger Principle of Biochemistry</i> by DL Nelson & MM Cox. Publisher: Worth Publishers. 9. <i>Principles of Environmental Chemistry</i> by JE Girard. Publisher: Johns & Bartlett Publishers. 10. <i>Spectrophotometry and Spectrofluorimetry: A Practical Approach</i> by Michael G Gore. Publisher: Oxford University Press. 	

I SEMESTER	
COURSE III: Environmental Geosciences & Natural Disasters [Credits: 4+2]	
Unit 1	Environmental Geology: Internal structure of earth-crust, mantle and core; surface features of the earth; types of rocks and rock cycle. Landforms: Created by running and underground water; wind, glacier; sea.
Unit II	Natural Disasters I: Landslides – Types; causes; control and mitigation measures and of landslide Earthquakes– Seismology; causes; intensity and magnitude; geographic distribution of earthquakes zones (seismic belts); nature of destruction; earthquake mitigation for buildings and dams, Tsunami. Volcanoes– Nature; types and extent; causes; volcanic materials; geographic distribution of volcanoes.
Unit III	Natural Disasters II: Floods – Types, causes, drainage basins and pattern, nature and frequency, flood hydrographs, flood management and control, Cyclones and anticyclone, Tornadoes, Typhoons. Snow Avalanches- Types and impact. Clouds– Formation & types; cloud burst and their impacts; Types of precipitation. Drought – types, assessment, impact and mitigation; drought proofing. Forest Fire– Causes; types; consequences; monitoring and mitigation.
Unit IV	Disaster: types, impact assessment, disaster trends and pattern, Vulnerability analysis, biophysical hazards, disaster aids slope stability Management: Management Cycle; Preparedness; Response; Mitigation; Rehabilitation, Community preparedness. National: Disaster Management Act 2005; National Guidelines and Plans on Disaster Management; National Disaster Management Authority (NDMA); State Disaster Management Authorities, National Disaster Response Force; Institutional arrangement during disasters; International: Agencies (International Space Charter, UNISDR); International Strategy for Disaster Reduction; Hyogo-Framework (2005- 2015); Sendai Framework (2015-2030).
Unit V	Risk – Definition; Analysis; exposure; assessment; characterization; basic steps; Environmental management: quantified risk assessment and dose response, Industrial accidents risk management programs and their applications to environmental management problems.
Recommended Books	
<ol style="list-style-type: none"> 1. <i>Atmospheric Science: An Introductory Survey</i> by John M Wallace & Peter V Hobbs. Publisher: Academic Press, New York. 2. <i>Engineering and General Geology</i> by Prabin Singh. Publisher: Kataria & Sons Publication. 3. <i>Environmental Geology</i> by James Reichard. Publisher: McGraw-Hill Higher Education. 4. <i>Environmental Geology</i> by KS Valdiya. Publisher: Tata McGraw Hills Publication. 5. <i>Environmental Geology</i> by W. Murk Barbar et al. Publisher: John Wiley & Sons, New York. 6. <i>Environmental Geology: An Earth Systems Approach</i> by Dorothy Merritts, Kirsten Menking, Andrew DeWet. Publisher: WH Freeman. 7. <i>The Dynamics of Disaster</i> by Susan W. Kieffer. Publisher: WW Norton & Co 8. <i>Fundamentals of Geology</i> by AB Roy. Publisher: Narosa Publishing House. 9. <i>Extreme Wildfire Events And Disasters : Root Causes and New Management Strategies 1St Edition</i> by Fantina Tedim Vittorio Leone Tara Mcgee, Publisher: Elsevier 10. <i>Geosciences, Environment and Man</i> by H Chamley. Publisher: Elsevier. 	

I SEMESTER	
COURSE IV: Natural Resources & Their Management [Credits: 4+2]	
Unit 1	<p>Natural Resources: Definition, types (water, land, soil, minerals, plants & animals), renewable & non-renewable resources, Concept of endemic, extinct and threatened species</p> <p>Plants: general account with reference to timber, food & medicines. Animal: general account with reference to game, wildlife & food; Depletion of Animal resources: Causes & consequences.</p>
Unit II	<p>Water: Hydrological cycle, hydro-meteorology & climate (precipitation, evaporation, Eva-transpiration), Ecohydrology, urban-hydrology, Integrated Water Resource Management (IWRM), Water Resources and Management in India.</p>
Unit III	<p>Soil: Soil biota & nutrients; Role of agricultural practices in soil degradation and conservation; Mineral: Distribution; occurrence; prospects; types & uses of economic minerals; Exploitation and their impact. Mineral reserves: Ores mineral, coal, petroleum, natural gas, oil and conservation.</p>
Unit IV	<p>Energy Types: Coal, Oil, Natural gas and hydro, wind, tidal; solar, nuclear; Biogas, Petroplants, ocean's surface waves used as wave power, geothermal power. Biofuels (Energy from biomass, biodiesel, biofilters, biofuel cells).</p>
Unit V	<p>Resource Management: Ecosystems based management. Management of International Resources: Ocean and fisheries National and International Management Commissions</p>
<p>Recommended Books</p> <ol style="list-style-type: none"> 1. <i>Animal resources of India-Protozoa to mammalian- State of the Art</i> by MS Jairajpuri. Publisher: Zoological survey of India. XI-XXVII. 2. <i>Biodiversity of the Kashmir Himalaya</i> by GH Dar, RC Bhagat, MA Khan. Publisher: Anmol Publication, Pvt. Ltd., New Delhi. 3. <i>Energy & Environment</i> by HV Jadhav. Publisher: Himalaya Publishing House, Delhi. 4. <i>Energy & Environment in India- A study of Energy management</i> by KC Gupta. Publisher: Gyan Publishing House, New Delhi. 5. <i>Environmental Education for conservation & Development</i> by Desh Bandhu, & G Berberet. Publisher: Indian Environment Society, New Delhi. 6. <i>Global Biodiversity Assessment</i> by VH Heywood. Publisher: Cambridge University Press, UK. 7. <i>Management of India's forest resources</i> by AN Chaturvedi. Publisher: Khanna Bandhu, Dehradun. 8. <i>Natural Resources and Renewable Energy</i> by MP Singh. Publisher: Daya Publishing House, Delhi. 9. <i>Plant genetic resources. International Biological Programme-2</i> by OH Frankle & JG Hawkel. Publisher: Cambridge University Press London. 10. <i>Resource Geography</i> by A Gautam & S Rastogi. Publisher: International Publishing House, Meerut. 	

II SEMESTER	
COURSE V: Environmental Microbiology & Biotechnology [Credits: 4+2]	
Unit 1	Environmental Biotechnology & Biotechnological processes: Definition; history and scope of biotechnology; Bioconversion; Bioaccumulation; Biodegradation; Fermentation as a biotechnological process; Concept and Types of bioreactors.
Unit II	Biofertilizers; Biopesticides & Biofuels: Bacterial biofertilizers algal biofertilizers, aquatic fungi biofertilizers, vermiculture technology, biopesticides, and integrated pest management,
Unit III	Biotechnology and biodiversity- Biotechnology and biodiversity conservation Cryopreservation, seed banks, DNA banks, other types of gene banks, micro-propagation. GMOs (transgenic animals, plants & fish), Stress tolerant plants and their significance.
Unit IV	Environmental Microbiology: Introduction, history and scope of environmental microbiology; Microbial diversity: Major groups of microbes; Microbiology of Soil and soil fertility, water and air; Microbes of extreme environment; Microbial pathogens. Microbial toxins and environmental hazards.
Unit V	Applied Microbiology: Biodegradation of organic and inorganic pollutants and pesticides; microbial treatment of oil pollution; production of vinegar, lactic acid, citric acid, antibiotics, vitamins and vaccines; microorganism in bioassays, Techniques related to isolation, purification and culture of microorganism
<p>Recommended Books</p> <ol style="list-style-type: none"> 1. <i>Environmental Biotechnology</i> by Alan Scragg. Publisher: Oxford University Press. 2. <i>Environmental Microbiology</i> by R Mitchell & Gu Ji Dong. Publisher: Wiley Blackwell. 3. <i>Environmental Microbiology</i> by MM Raina. Publisher: Academic Press. 4. <i>Fundamentals of Microbiology</i> by Alcano. Publisher: Jones & Bartlett Publishers. 5. <i>Introduction to Environmental Biotechnology</i> by AK Chatterji. Publisher: Prentice Hall of India Pvt. Ltd., New Delhi. 6. <i>Microbial Ecology: Fundamentals & Applications</i> by RM Atlas & R Bartha. Publisher: Pearson International. 7. <i>Microbiology</i> by Roberts Nester. Publisher: McGraw Hill. 8. <i>Microbiology: Principles and Explorations, 10th Edition</i> by Jacquelyn G Black & Laura J Black Publisher: Wiley. 9. <i>Soil Microbiology: An Exploratory Approach</i> by Mark Coyne. Publisher: Thomson BusinessInformation. 10. <i>Textbook of Environmental Microbiology</i> by PK Mohapatra. Publisher: IK International Pvt. Ltd. 	

II SEMESTER	
COURSE VI: Environmental Economics & Sociology	
[Credits: 4+2]	
Unit I	Fundamentals of Environmental Economics: Definition; Concepts & Origin; issues and scope; monetary value of environmental degradation through pollution; Corporate Social Responsibility (CSR);
Unit II	Economic Tools: Valuing the environment and natural resources; Ecology and equity; Natural resource accounting, cost-benefit analysis; Life cycle assessment (LCA); Intellectual property rights (IPR) and environment.
Unit III	Fundamentals of Environmental Sociology: Definition, concept, issues and scope of Environmental Sociology; Concept of social groups, caste, tribe, clan, society, culture and social structure; Social and Cultural resources; Interaction of biosphere and Sociosphere/ Traditional Wisdom and Environment.
Unit IV	Social Issues and the Environment: Sustainable development; River rejuvenation, Resettlement and rehabilitation: Problems and concerns; National Policy for Rehabilitation and resettlement (NPRR, 2007); Major National and International environmental movements (Chipko, Appiko, Narmada Bachao Andolan, Tehri Dam conflicts and Silent valley movement, Nadi Bachao Andolan, Beej Bachao Andolan, Green Peace and WWF); Environmental Social Governance (ESG).
Unit V	Environmental Ethics: Definition and concept; Resource consumption patterns and need for equitable utilization; Anthropocentrism, biocentrism, egocentrism, cosmocentrism; Conservation ethic: traditional value system in India.
Recommended Books	
<ol style="list-style-type: none"> 1. <i>Concepts, Methods and Policies</i> by Dodo J. Thampapillai & Matthias Ruth. Publisher: EarthScan 2. <i>Environmental Economics: Theory, management & Policy</i> by CK Sharma. Publisher: Sri Padmavati Publicatios. 3. <i>Environmental Economics: A Textbook</i> by Dr. M Karpagam. Publisher: Sterling 4. <i>Environmental Economics</i> by Shunsuke Managi. Publisher: Taylor & Francis 5. <i>Environmental Economics: Concepts, Methods and Policies</i> by Dodo J. Thampapillai; Matthias Ruth. Publisher: CRC Press 6. <i>Environmental Economics: Theory and Applications</i> by Katar Singh and Anil Shishodia. Publisher: SAGE Publications India Pvt Ltd 7. <i>Environmental Sociology</i> by John Hannigan. Publisher: CRC Press 8. <i>International Handbook of Environmental Sociology</i> by M Redclift & G Woodgate. Publisher: Edward Elgar Publishing, GB. 9. <i>Principles of Environmental Sociology</i> by I Sundar. Publisher: Sarup Book Publishers, New Delhi. 10. <i>Sustainability through the Lens of Environmental Sociology</i> by Md Saidul Islam. Publisher: MPDI 	

II SEMESTER	
COURSE VII: Environmental Pollution & Monitoring	
[Credits: 4+2]	
Unit 1	Environmental Monitoring: Concept and objectives; Global environmental monitoring system (GEMS); National Environmental Monitoring Programmes; Bioindicators and Biological monitoring
Unit II	Air Pollution: air quality criteria and standard, Air pollution indices, Sources and dispersal of air pollution; Methods of monitoring of SO _x , NO _x , CO, VOCs, PM ₁₀ , PM _{2.5} ; Methods of monitoring of Green Houses Gases; Effects of pollutants on human beings, plants, animals, and historical monuments; Indoor air pollution; Control of Air pollution. Bhopal Gas tragedy and its consequences, Gas leakage at Sterlite copper plant, Tamilnadu; Visakhapatnam Gas leak (LG Polymers chemical plant).
Unit III	Water Pollution: Major sources of water pollution; Water pollution and human health; Heavy metals and their impact on aquatic life; Sewage and wastewater treatment and recycling; Industrial effluent treatment (Primary, Secondary & Advance), Minamata disease, Arsenic poisoning in West Bengal, Lead poisoning In India, Oil spillage. Soil pollution: Impact of chemical fertilizers, insecticides, pesticides, industrial sewage, Waste disposal (Land filling), Deforestation, Acid rain on soil health and its consequences.
Unit IV	Radioactive, Thermal and Noise Pollution: Radioactive pollution – causes and consequences; Radioactive fallout, Chernobyl Accident; Three Mile Island accident, Fukushima; Radioactive waste management; Thermal pollution: Causes and consequences Noise Pollution: Sources, Measurement, Standards; Impact; Abatement and Control.
Unit V	Solid Waste Management: Types and major sources of solid waste; Solid waste and environmental problems; Integrated solid waste management of municipal waste; Management of industrial waste; E-waste and its management; Biomedical waste and its management.
Recommended Books <ol style="list-style-type: none"> 1. <i>Environment (Protection) Act, 1986.</i> Govt. of India. 2. <i>Environment (Protection) Act, 1986 amended up to Act 19 of 2010;</i> Environment (Protection) Rules, 1986 amended up to S.O. 4367(E), e-Book 3. <i>Environment and Pollution: An Ecological Approach</i> by RS Ambasht. Publisher: CBS Publication. 4. <i>Environmental Materials and Waste Resource Recovery and Pollution Prevention</i> by MNV Prasad. Publisher: ELSEVIER 5. <i>Environmental Pollution and Control</i> by PA Vesilind, et al. Publisher: Elsevier. 6. <i>Environmental Pollution and Control</i> by PR Trivedi. Publisher: APH Publishing. 7. <i>Environmental Pollution and Protection: An Introduction</i> by Dhandapani Alagiri & E Naveen Kumar. Publisher: ICFAI Books 8. <i>Environmental Pollution</i> by Narayanan. Publisher: CBS Publisher & Distributers 9. <i>Environmental Pollution Monitoring and Control</i> by S M Khopkar. Publication: New Age International 10. <i>Environmental Pollution-Monitoring and Control</i> by SM Khopkar, Publisher: New Age International (P) Ltd. 	

II SEMESTER	
COURSE VIII: Environment & Public Health	
[Credits: 4+2]	
Unit 1	Environmental Toxicants: Definition; Common environmental toxicants; Heavy metals: Sources and their effects on life and environment; Pesticides & Harmful Chemicals: Types, uses and harmful effect of pesticides; Mutagenic and Carcinogenic Chemicals, Polyaromatic hydrocarbons, nitrosamines, organic solvents, alcohol, carbon tetrachloride, anaesthetic (chloroform, ether, xylocaine); Tobacco chewing and smoking.
Unit II	Toxicity Assessment: Principles, Toxicity testing (Holistic and numeric approach), <i>in-vivo</i> and <i>in-vitro</i> toxicity assessment; Acute, sub-acute, sub chronic and chronic toxicity test; Neurotoxic; Reproductive; Mutagenic and Carcinogenic test; LD50, LC50, EC50 and IC50; Factors affecting toxicity.
Unit III	Systemic Toxicity: Absorption, Translocation and Excretion; Membrane permeability and Mechanism of chemical transfer; Absorption & translocation of Xenobiotics; membrane barriers, Binding & excretion of Xenobiotics; Neurotoxicity, Hepatotoxicity, Immunotoxicity, Cardio-vascular toxicity, Respiratory dysfunction and Hypersensitivity. Microbial toxicity: Food contamination.
Unit IV	Environmental Occupational Health: Concept; Indicator & Determinants of health (Physical, Chemical & Biological); Dust Diseases (Pneumoconiosis with reference to silicosis, asbestosis, anthracosis, bagassosis & byssinosis), Occupational hazards: lead poisoning (plumbism), Occupational cancer, Occupational dermatitis, Radiation hazards.
Unit V	Epidemiology: Definition; history and Scope, Epidemiology of selected communicable diseases, Water borne diseases (diarrhea, cholera, dysentery, typhoid), Foodborne disease (Salmonellosis, Campylobacteriosis, E. coli infection, Listeriosis, Clostridial infection and intoxication etc.), Vector borne diseases (Malaria, filariae, Dengue, Chicken guinea, etc.), Air Borne infections (tuberculosis, influenza, diphtheria, COVID-19), AIDS,.
Recommended Books	
<ol style="list-style-type: none"> 1. <i>Climate Change and the People's Health</i> by Sharon Friel. Publisher: Oxford University Press Oxford, New York. 2. <i>Current Occupational and Environmental Medicine 5th Edition</i> by Joseph LaDou; Robert Harrison. Publisher: McGraw-Hill Education. 3. <i>Environmental Health and Hazard Risk Assessment</i> by Louis Theodore; R. Ryan Dupont. Publisher: CRC Press 4. <i>Environmental Health Disparities</i> by I. Leslie Rubin & Joav Merrick. Publisher: New York : Nova Publishers 5. <i>Environmental Policy and Public Health</i> by Barry L. Johnson & Maureen Y. Lichtveld. Publisher: CRC Press 6. <i>Essentials of Environmental Health</i> by Robert H. Friis. Publisher: Jones & Bartlett. 7. <i>Global Occupational Health</i> by Tee L. Guidotti (Editor). Publisher: OUP, USA 8. <i>Handbook of Environment Health and Safety</i> by Herman Koren & Michel Bisesi. Publisher: Jaico Publishing House, Delhi. 9. <i>Introduction to Public Health 5th Edition</i> by Mary Jane Schneider. Publisher: VIVA 10. <i>Pesticides & Environment</i> by GS Dhaliwal & B Singh. Publisher: Commonwealth Publishers for Indian Ecological Society, Ludhiana. 	

III SEMESTER	
COURSE IX: Environmental Policies & Law	
[Credits: 4+2]	
Unit 1	Environmental Protection under Indian Constitution : Definition, Fundamental rights and duties i. Constitutional Provisions: Protection under Article 21, Article 48A, Article 51A (g) and related Articles. ii. Judicial Approach: Meaning and relevance of “Precautionary Principle”, “Polluter Pays Principle”.
Unit II	Environmental Protection and Indian Legislations – I: The Water (Prevention and Control of Pollution) Act 1974 and Judicial approach; Air (Prevention and Control of Pollution) Act 1981 and Judicial approach; The Environment (Protection) Act 1986; Judicial approach on these legislations.
Unit III	Environmental Protection and Indian Legislations – II: Indian Forest Act 1927, and Forest (Conservation) Act 1980; Wildlife Protection Act 1972 as amended in 1991; Judicial approach on these legislations. National Green Court
Unit IV	Indian Rules and Regulations on Environmental Protection: Biomedical Waste (Management and Handling) Rules, 1998; Hazardous Waste (Management and Handling) Rules, 1989; New Plastic Waste (Management and Handling) Rules, 2011; Environmental Protection (Fifth Amendment Rules), 2014.
Unit V	Current National Environmental Policies relating to protection of air, water, and forest- National and International environmental Issues & Efforts: Stockholm Conference, Rio Conference, Montreal and Kyoto Protocol, Ramsar Convention, CITIES, World Summit on Sustainable Development, 2002, Sustainable Development Goals (S D G)

Recommended Books

1. *Air Pollution and Environment Protection* by Kumar Naresh. Publisher: Mittal Publications.
2. *Environment Administration, Law and Judicial Attitude: Studies on Environment Protection, Leading Cases* by D Paras & P Diwan. Publisher: Deep & Deep Publications.
3. *Environmental Law* by PS Jaswal. Publisher: Allahabad Law Agency
4. *Environmental Law* by DS Senger. Publisher: PHI Learning Pvt. Ltd.
5. *Environmental Law* by Gurdip Singh. Publisher: Macmillan India.
6. *Environmental Law Handbook. 22nd Ed* by CL Bell, FW Brownell, et al. Publisher: Bernan Press.
7. *Environmental Laws in India: Contribution of the Supreme Court* by AK Tiwari. Publisher: Deepand Deep Publications.
8. *Environmental Pollution & Development* by Chandra Pal. Publisher: Mittal Publications.
9. *Environmental Protection & Law* by PR Trivedi, & UK Singh. Publisher: Commonwealth Publisher.
10. *Handbook on Environmental Law* by PB Sahasranaman. Publisher: Oxford University Press.

III SEMESTER	
COURSE X: Environmental Management & EIA	
[Credits: 4+2]	
Unit 1	Introduction to EIA: Definition; Scope and development; Purpose, Objectives and Basic principles and Types; Strategic Environmental Assessment (SEA); History of EIA in India - EIA Gazette Notification, 1994 & 2006 – Category A & Category B Projects, Prior Environment Clearance (EC) requirements and stages.
Unit II	Screening- Criteria; Prohibited zones; Identification of Valued Environmental Components (VEC); Impact Identification- Checklists, matrices, qualitative methods, networks and overlay maps.
Unit III	Prediction and Assessment of impacts on water, air, land, biological and socio-cultural environment.
Unit IV	Case studies: EIA of thermal power plant; Pulp and paper mills; River Valley Projects, Mining projects; Urbanization and Linear development; Ports and Harbour.
Unit V	Impact Mitigation, Monitoring & Audit : Mitigation Methods and Approaches; Appraisal, review; Decision making; Public Consultation and Participation; Monitoring and auditing in EIA process; Various forms of audit; Environment Management System (EMP) - ISO 14000; Environmental Impact Statement (EIS), Post-clearance Monitoring Protocol; Comparison of EIA in different countries
Recommended Books	
<ol style="list-style-type: none"> 1. <i>A Handbook of Environmental Management</i> by Jon C. Lovett & David G Ockwell. Publisher: Edward Elgar. 2. <i>Environment Impact Assessment</i> by AK Shrivastava. Publisher: APH Publishing. 3. <i>Environment Impact Assessment</i> by Larry W Canter. Publisher: McGraw-Hill. 4. <i>Environmental Impact Analysis Handbook</i> by GJ Rau & CD Weeten. Publisher: McGraw Hill. 5. <i>Environmental Impact Assessment</i> by CH Eccleston. Publisher: Taylor & Francis. 6. <i>Environmental Impact Assessment Methodologies</i> by Y Anjanvelu. Publisher: B.S. Publications. 7. <i>Environmental Impact Assessment: Practical Solutions to Recurrent Problems</i> by DP Lawrence. Publisher: John Wiley and Sons. 8. <i>Environmental Impact Assessment: Theory and Practice</i> by Peter Wathem. Publisher: Taylor & Francis 9. <i>Handbook of Environmental Impact Assessment: Volume 2: Impact and Limitations</i> by Petts Judith. Publisher: John Wiley & Sons. 10. <i>Introduction to Environmental Impact Assessment</i> by John Glasson, Riki Therivel and Andrew Chadwick. Publisher: UCL Press, Philadelphia, USA 	

III SEMESTER	
COURSE XI: Fundamentals of Remote Sensing & GIS	
[Credits: 4+2]	
Unit 1	Remote Sensing – Electromagnetic Radiation as Remote Sensing Medium; General Mechanism of Remote Sensing Data Recording; General Characteristics of Remote Sensing Platforms; General Characteristics of Remote Sensing Sensors; Indian Remote Sensing Satelites and Sensors.
Unit II	Platforms and Sensors: Aerial and space borne platforms, orbits, sensors types – optical (multispectral, hyper-spectral), thermal and microwave, resolutions, Landsat, SPOT, IRS, ERS, Radarsat, RISAT, and other operational remote sensing satellites.
Unit III	Data Analysis: Visual interpretation – Scale, maps and map projections, interpretation keys; image characteristics, media and formats of digital images, image enhancement, image transformations, classification – unsupervised and supervised classification, classifiers, statistical reparability, accuracy estimation, change detection, 3-D visualization.
Unit IV	Geographical Information System (GIS): Introduction, GIS definition and terminology, data types, raster and vector data, GIS database design, spatial database creation – digitization, scanning; processing of data, GIS implementation and project management. Commercially available remote sensing and GIS software. Satellite based Navigation Systems (GPS, Gallelio, Glonass, IRNSS): concepts and applications; Map projections and datum, coordinate systems; Survey of India topographical maps types and numbering system, Terrestrial and extra-terrestrial satellites in Remote sensing.
Unit V	Geospatial techniques in Environmental Management: Ecosystem inventory and monitoring – case studies on agriculture, forestry, wetlands, urban planning, snow and glaciers, coastal zone management, protected area management, climate change, air and water pollution; disaster management; remote sensing and GIS in international conventions and protocols (Ramsar, CBD, Kyoto).
Recommended Books	
<ol style="list-style-type: none"> 1. <i>Advanced Remote Sensing</i> by Shunlin Liang & Jindi Wang. Publisher: Acad Pr 2. <i>Concepts and Techniques of Geographic Information Systems</i> by CP Lo & Albert KW Yeung. Publisher: PHI Learning. 3. <i>Fundamentals Of Satellite Remote Sensing An Environmental Approach 3Rd Edition</i> by Emilio Chuvieco. Publisher: Taylor and Francis 4. <i>Image Processing and GIS for Remote Sensing 2nd Edition</i> by JG Liu. Publisher: John Wiley 5. <i>Introductory Digital Image Processing: A Remote Sensing Perspective</i> by John R Jensen. Publisher: Prentice Hall. 6. <i>Lidar Remote Sensing and Applications</i> by Pinliang Dong. Publisher: Taylor & Francis 7. <i>Principles of Geographic Information System</i> by PA Burrough. Publisher: Oxford University Press. 8. <i>Remote Sensing and GIS 3Rd Edition</i> by Basudeb Bhatta. Publisher: Oxford University Press 9. <i>Remote Sensing and Image Interpretation</i> by Lillisand, Thomas, Ralph W. Kiefer and Jonathan Chipman. Publisher: Wiley India. 10. <i>Remote Sensing of the Environment: An Earth Resource Perspective</i> by JR Jensen. Publisher: Dorling Kindersley. 	

III SEMESTER

COURSE XII: Environmental Statistics & Computer Applications [Credits: 4+2]

Unit 1	An overview of environmental systems, General concept and terminology, definitions and applications, Generation of environmental data; Types and objectives of environmental studies; Sampling method, Random processes, Stochastic processes in the environment; Significance / relevance of data analysis in environmental management.
Unit II	Measures of Central Tendency & Dispersion: Various measures of Central tendency (Mean, Median & Mode) and their Merits & Demerits. Properties of good measures of dispersions, types of measures of dispersions and its merits and demerits.
Unit III	Probability: definition, addition and multiplication laws, concept of random variable, probability distribution (Normal, binomial and poisson). Co-relation analysis: Correlation and regression (positive and negative correlation) and calculation of karl pearsons co-efficient of correlation; Linear regression, ANOVA (one and two way).
Unit IV	Tests of Hypotheses: Null and Alternative Hypothesis; Type I and Type II Errors; Level of significance; Tests of significance (Z-test, T-test F-test for comparison of variance; Goodness-of-fit test; Chi-Square test; Non-parametric tests – Sign test, Wilcoxon Signed Rank test, Kruskal-Wallis test.
Unit V	Basics of Computer: Organization and working of a computer; Computer architecture fundamentals; Hardware, types of memory (primary and secondary); Software (windows an operating system); Information types, quality, needs, data processing and computer as a tool; Important features of MS word, MS excel and MS power point.

Recommended Books

1. *Statistical Methods for Environmental Pollution Monitoring* by RO Gilbert. Publisher: New York, Van Nostrand Reinhold.
2. *Health, Safety and Environmental Data Analysis* by AJ Joseph. Publisher: Lewis, New York.
3. *Principles of Environmental Sampling* ACS Professional References, American Chemical Society by Keith, L.H. (Ed.)
4. *Statistics for environmental Science and Management* by Manly. Publisher: Chapman and Hall/CRC.
5. McBeen, E.A. (1999). *Statistical Procedures for Analysis of Environmental Monitoring Data*.
6. Pentecost, A. (1999). *Analysing Environmental Data*. Longman: London.
7. *Textbook of Computer applications and biostatistics* by SB Bhise, J Dias Remeth, Kailas K Mali & PH Ghanwat. Publisher: Trinity Publishing House
8. *Environmental Statistics and Data Analysis* by RO Wayne. Publisher: CRC Press.

IV SEMESTER	
COURSE XIII: Research Methodology & Research Ethics [Credits: 6]	
Unit 1	Research: Definition, Conceptualization and Formulation of Research Problem, Identifying Variables, Constructing Hypotheses, Significance of Research, Application of Computer in Research
Unit II	Types of Research: Descriptive vs Analytical, Applied vs Fundamental, Research Proposals: Preamble, Objectives, Hypothesis to be tested; Identifying gap areas from literature review, Research Report Writing and Publication: Out line; Objective, Introduction, Design or rationale of work, Experimental Methods, Result, Discussion, Conclusion, Reference, Impact Factor
Unit III	Data: Sample Collection, Classification, Presentation of Data
Unit IV	Statistical Analysis: Correlation Analysis, Types of Correlation, Regression Analysis, Test of Significance: Level of Significance, 't'-Test, 'Z'-Test, 'Chi-square'-Test, Analysis of Variance
Unit V	Emergence of Environmental Ethics Ethical Conduct: Honesty, Objectivity, Integrity, Carefulness, Openness, Respect for Intellectual Property, Confidentiality, Responsible Publication, Social Responsibility; Ethical issues in Environmental Research: Sustainability, Ecosystem Health, Responsiveness, Accountability, Location specificity, Capacity building
Recommended Books	
<ol style="list-style-type: none"> 1. <i>Research Methodology: Methods and Techniques</i> by C. R. Kothari. ISBN:81-224-1522-9 2. <i>Research Methods for Environmental Studies: A Social Science Approach</i> by Mark Kanazawa. ISBN 9781138680173 3. <i>Handbook of Research Methods and Applications in Environmental Studies</i> by Matthias Ruth. ISBN:978178347 4639 4. <i>Statistical Methods for Environmental Pollution Monitoring</i> by RO Gilbert. ISBN 0-442-23050-8 5. <i>Health, Safety and Environmental Data Analysis</i> by AJ Joseph. ISBN-13 : 978-0367400804 6. <i>Environmental Data Analysis: Methods and Applications</i> by Zhihua Zhang. ISBN: 9783110424904 7. <i>Environmental Ethics</i> by Marion Hourdequin. ISBN 9781472507617 8. <i>Environmental Ethics: A Very Short Introduction</i> by Robin Attfield. ISBN-13: 9780198797166 9. <i>Ethics and the Environment: An Introduction</i> by Dale Jamieson. ISBN 9780511806186 10. <i>Ecological Ethics: An Introduction</i> by Patrick Curry. ISBN: 978-0-745-65125-5 	

Open Elective

II SEMESTER	
Climate Change Mitigation and Adaptation (Open Elective)	
[Credits:6]	
Unit 1	Basic concepts and mechanisms: Science of climate change, global warming and greenhouse effect, radiative balance, earth's carbon reservoirs and carbon cycle, El-Nino and La Nino, greenhouse gases in the atmosphere – sources, levels and mechanisms of action. Effects: Rise in earth's temperature; effects on forests; effects on agro ecosystems; desertification; effects on freshwater ecosystems; effects on oceans; sea level rise; melting of polar ice and glaciers; effects on rainfall patterns; extreme events, socio-economic and public health consequences..
Unit II	Climate Change Policy-Mitigation: Carbon storage and sequestration, carbon management through a biotic sequestration; oceanic and geologic injection, scrubbing and mineral carbonation; carbon management through biotic sequestration; forest ecosystems, wetlands; soil carbon sequestration; bio fuels, carbon farming and carbon trading
Unit III	Climate Change Policy Adaptation: Climate change impact assessment – applications for agriculture, sea level rise and health; vulnerability assessment; economics of adaptation, measurement of adaptation cost; issues in financing adaptation; case studies
Unit IV	International response: Intergovernmental panel for climate change (IPCC) and its role; United Nations framework convention on climate change (UNFCCC), CDM and Kyoto Protocol; the bali road map; The Copenhagen Accord; future actions; ethics of climate change.
Unit V	The Indian Scenario: Projected impact of climate change on India; temperature, rainfall, forests, agriculture, water resources; India's response to climate change; National Action Plan on climate change; India's position and actions vis-a-vis international programmes (UNFCCC, CDM and Kyoto Protocol, REDD+, Copenhagen Accord, etc.).
<p>Recommended Books</p> <ol style="list-style-type: none"> 1. <i>Climate Change: Causes, effects and solutions</i> by JT Hardy. Publisher: John Wiley and Sons 2. <i>Environmental Science- Physical Principles and Applications</i> by Egbert Boeker & Rienk van Grondelle. Publisher: John Wiley & Sons, Ltd., New York 3. <i>Trace Gas Emission and Plants</i> by S. Singh. Publisher: Kluwer Academic Publishers. 4. <i>The economics of climate change – The Stern Review</i> by N Stern. Publisher: Cambridge University Press 5. <i>Managing the Global Commons: The Economics of Climate Change</i> by WD Nordhaus. Publisher: MIT Press 6. <i>India and Global Climate Change: Perspectives on Economics and Policy from a Developing Country</i> by MA Toman, U. Chakravorty & S Gupta. Publisher: RFF Press 7. <i>Adaptation and mitigation strategies for climate change</i> by Akimasa Suni, F Kensuke & AI Hiramatsu. Publisher: Springer. 8. <i>Ecosystem diversity and carbon sequestration: climate change challenge and a way out for ushering in a sustainable future</i> by PL Gautam, V Singh & U Melkania (Eds.). Publisher: Daya Publishing House, Delhi. 9. <i>Climate Change and Developing Countries</i> by NH Ravindranath, N Ravindranath & JA Sathaye. Publisher: Kluwer Academic Publishers. 10. <i>Emissions trading and carbon Management</i> by AN Sarkar. Publisher: Pentagon earth. 11. <i>Climate Change: A Multidisciplinary Approach (2nd edition.)</i> by WJ Burroughs). Cambridge University Press. 12. <i>Climate Change: An Indian perspective</i> by Sushil Kumar. Publisher: Cambridge University Press India Pvt. Ltd. New Delhi. 	

III SEMESTER

Disaster Risk Reduction and Management (Open Elective) [Credits:6]

Unit 1	Introduction: Concepts and definitions of Hazard, disaster, vulnerability, resilience, and risks; classification of disasters; brief introduction of Geological Disasters (earthquakes, landslides, tsunami, mining), Hydro-Meteorological Disasters (floods, cyclones, lightning, thunderstorms, avalanches, droughts, cold and heat waves); Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Man-made Disasters (building collapse, rural and urban fire, road and rail accidents); Global Disaster Trends – Emerging Risks of Disasters; Climate Change and Urban Disasters
Unit II	Disaster Management Cycle, Risk Reduction and managing risks Disaster Management Cycle; Principles of risk management, hazard and vulnerability mapping and analysis (physical, social, organizational, economical, technological). Developmental projects (dams, power plants etc.) and risk management; Evacuation, Communication, Search and Rescue; Emergency Operation Centre – Incident Command System; Relief and Rehabilitation; Post-disaster Damage and Needs Assessment; Restoration of Critical Infrastructure; Early Recovery – Reconstruction and Redevelopment;
Unit III	Disaster Risk Reduction tools and capacity building Prevention and Mitigation of Disasters, Early Warning System; Preparedness, adaptive ecosystems management for disaster risk reduction; awareness during Disasters; Geoinformatics in Disaster Management (RS, GIS, GPS); Disaster Communication Systems (Early Warning and Its Dissemination); Land Use Planning and Development; Structural and Non Structural Mitigation of Disasters; Role of print and electronic media during disasters. Community based disaster risk reduction. Health issues and hospital preparedness and response; System approach in disaster management.
Unit IV	Disasters and Ecosystems: Climate change and ecosystems based management for disaster risk reduction and resilience;
Unit V	Disaster Management in India Disaster Management Act 2005; National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies; National Disaster Management Authority (NDMA); NIDM (National Institute of Disaster Management), State Disaster Management Authorities, National Disaster Response Force; Institutional arrangement during disasters; S&T Institutions for Disaster Management in India.

Recommended Books

1. *Environmental Hazards and Disasters-Contexts, Perspectives and Management* Bimal Kanti Paul. Publisher: John Wiley & Sons.
2. *The role of ecosystems in disaster risk reduction* by Fabrice G. Renaud, Karen Sudmeier-Rieux and Marisol Estrella (Ed). Publisher: United Nations University Press.
3. *Environmental Knowledge for Disaster Risk Management, National Institute of Disaster Management, New Delhi* by AK Gupta & Sreeja S Nair.
4. *Disaster Management Act 2005* Govt, of India.
5. *Publications of National Disaster Management Authority (NDMA), and National Institute of Disaster Management (NIDM).*
6. *Health Adaptation and Resilience to Climate Change and Related Disasters: A Compendium of Case Studies 2021* by National Institute of Disaster Management
7. *Compendium Of Task Force Report On Ndma Guidelines Management Of Glacial Lake Outburst Floods (GLOFs)* by National Disaster Management Authority.
8. *Disaster management and risk reduction* by Vishwambhar Prasad Sati.
9. *The Role of Ecosystems in Disaster Risk Reduction* by Fabrice G. Renaud, Karen Sudmeier-Rieux, Marisol Estrella
10. *Nature-based Solutions for Resilient Ecosystems and Societies* by Shalini Dhyani, Anil Kumar Gupta & Madhav Karki