Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Autonomous College)

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highlighting component
of Research Project/Internship

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the Environmental Science and Disaster Management

Program Code: RJSPGESDM

(CBCS onwards 2020)

Syllabus for the Environmental Science and Disaster Management

Program Code: RJSPGESDM (101-104)

SEMESTER 1

(CBCS onwards 2020)

Environmental Science and Disaster Management semester 1

Course Code	**Unit**	**Title: Environment**	**Credit 4**
RJSPGESDM101	1	Introduction to the Environment	1
	2	Introduction to Natural Resource Management and Sustainable Development	1
	3	Introduction to the Energy and Environment	1
	4	Introduction to the Environmental education	1

Course Code	**Unit**	**Title: Fundamentals of Environmental Chemistry**	**Credit 4**
RJSPGESDM102	1	Element and Composition of air	1
	2	Water and air quality	1
	3	Environmental issues and conservation related to water	1
	4	Principles of analytical methods	1

Course Code	**Unit**	**Title: Environmental Pollution and Control**	**Credit 4**
RJSPGESDM103	1	Air Pollution	1
	2	Control devices for particulate matter	1
	3	Effect of Air Quality on Health and and environmental disasters	1
	4	Noise Pollution	1

Course Code	**Unit**	**Title: Water and soil pollution and its current issues**	**Credit 4**
RJSPGESDM104	1	Water Pollution and Effect of water pollutant	1
	2	Groundwater study and Wastewater Treatment	1
	3	Soil Pollution	1
	4	Eutrophication, soil erosion and climate change	1

Semester 1 Practical		**Credit**
RJSPGESDMP101	Environment	2
RJSPGESDMP102	Fundamentals of Environmental Chemistry	2
RJSPGESDMP103	Environmental Pollution and Control	2
RJSPGESDMP104	Water and soil pollution with current environmental issues	2

Semester 1	**Paper 1**
Course Code: RJSPGESDM101	**Environment**

Unit I: Introduction to the Environment

1. Definition, Principles and Scope of Environmental Science.
2. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.
3. Laws of thermodynamics, heat transfer processes, mass and energy transfer across various interfaces, material balance.

Unit II: Introduction to Natural Resource Management and Sustainable Development

1. Meteorological parameters – pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, radiation and wind velocity, adiabatic lapse rate, environmental lapse rate. Wind roses.
2. Interaction between Earth, Man and Environment. Biogeographic provinces of the world and agro-climatic zones of India. Concept of sustainable development.

Unit: III Introduction to the Energy and Environment

1. Sun as source of energy; solar radiation and its spectral characteristics. Fossil fuels: classification, composition, Physico-chemical characteristics and energy content of coal, petroleum and natural gas. Shale oil, Coal bed Methane, Gas hydrates. Gross-calorific value and net t-calorific value.
2. Principles of generation of hydropower, tidal energy, ocean thermal energy conversion, wind power, geothermal energy, solar energy (solar collectors, photovoltaic modules, solar ponds).
3. Nuclear energy – fission and fusion, Nuclear fuels, Nuclear reactor – principles and types.

Unit: IV Introduction to the Environmental education

1. Natural resources and their assessment; Environmental education and awareness; Environmental ethics; waste management and climate change
2. Remote Sensing and GIS: Principles of remote sensing and GIS. Digital image processing and ground truthing. Application of remote sensing and GIS in land cover/land use planning and management (urban sprawling, vegetation study, forestry, natural resource),

M.Sc. (EVDM)	Semester I Theory
RJSPGESDM101 Paper 1 Environment	Course Outcome 1.1 1. A broad perspective of Environment 2. Natural resources and sustainable development 3. Introduction to solar energy and alternative sources of energy 4. Tools for environment education Learning Outcomes ➢ Understanding the various aspects of environment, natural resources, energy renewable, non-renewable. ➢ Dissemination of information related to environment and need for achieving SDG's ➢ Knowledge of remote sensing and GIS ➢ Understanding the importance of environmental ethics and its application.

Semester 1	**Paper 2**
Course Code: RJSPGESDM102	**Fundamentals of Environmental Chemistry**

Unit I: Element and Composition of air

1. Classification of elements, Stoichiometry, Gibbs' energy, chemical potential, chemical kinetics, chemical equilibrium, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes.
2. Composition of air. Particles, ions and radicals in the atmosphere. Chemical speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog.

Unit II: Water and air quality

1. Hydrological cycle. Water as a universal solvent. Concept of DO, BOD and COD. Sedimentation, coagulation, flocculation, filtration, pH and Redox potential (Eh).
2. Inorganic and organic components of soils. Biogeochemical cycles – nitrogen, carbon, phosphorus and sulphur.
3. Toxic chemicals: Pesticides and their classification and effects. Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O3, PAN, VOC and POP. Carcinogens in the air.

Unit: III Environmental issues and conservation related to water

1. Environmental issues related to water resource projects – Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States.
2. Water conservation-development of watersheds, Rainwater harvesting and ground water recharge.
3. National river conservation plan – Namami Gange and Yamuna Action Plan

Unit: IV Principles of analytical methods

1. Principles of analytical methods: Titrimetric, Gravimetry, Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flame photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS), Electrophoresis, XRF, XRD, NMR, FTIR, GC-MS, SEM, TEM.

M.Sc. (EVDM)	Semester I Theory
RJSPGESDM102 Paper 2 Fundamentals of Environmental Chemistry	Course Outcome 1.2 1. Detailed study of elements and its chemical potential and kinetics. 2. Study of Particles, ions and radicals in the atmosphere and sources of harmful components in air. 3. Detailed study of hydrological and biogeochemical cycle. 4. Study of heavy metals classification and side effects. 5. Detailed study of Principles of analytical methods. 6. Detailed study of Environmental issues related to water resource projects and Water conservation. Learning Outcomes: ➢ Understanding the various aspects of elements, particles, ions and radicals in the atmosphere ➢ Knowledge about Carcinogens in the air. ➢ Understanding the effect of depletion of ozone, smog and heavy metals. ➢ Learning the application of analytical methods. ➢ Understanding the human surrounding and the role of human being in shaping the surrounding water related issues.

Semester 1	**Paper 3**
Course Code: RJSPGESDM103	**Environmental Pollution and Control**

Unit I: Air Pollution

1. Sources and types of Pollutants – Natural and anthropogenic sources, primary and secondary pollutants. Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates); period, frequency and duration of sampling.
2. Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards.
3. Impact of air pollutants on human health, plants and materials. Acid rain. Dispersion of air pollutants. Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model.

Unit II: Control devices for particulate matter

1. Principle and working of settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator.
2. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality.
3. Vehicular emission norms in India.

Unit: III Effect of Air Quality on Health and and environmental disasters

1. Respiratory diseases, Cardiovascular damage, Fatigue, headaches and anxiety Irritation of the eyes, nose and throat damage to reproductive organs, Harm to the liver, spleen and blood Nervous system damage.
2. Air pollution Public health matters, Air pollution source apportionment, regulation, and mitigation.
3. Environmental Disasters: Minamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukushima Daiichi nuclear disaster, 2011.

Unit: IV Noise Pollution

1. Sources, weighting networks, measurement of noise indices (Leq, L10, L90, L50, LDN, TNI).
2. Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods.
3. Vibrations and their measurements. Impact of noise and vibrations on human health.

M.Sc. (EVDM)	Semester I Theory
RJSPGESDM103 Paper 3 Environmental Pollution and Control	Course Outcome 1.3 1. Detailed study of sources and types of air pollutant and its impact on human health 2. Study of principle and working of various control devices for particulate matter. 3. Detailed study of respiratory and cardiovascular diseases. 4. Detailed study of sources and types of noise pollution and its impact. 5. Measures to abate noise pollution. Learning Outcomes ➢ To understand the various air pollutants and measures to be taken to reduce the same. ➢ To able to discriminate between sound and noise. Measures to be taken to reduce noise pollution. ➢ To be able to educate public to reduce noise pollution

Semester 1	**Paper 4**
Course Code: RJSPGESDM104	**Water and soil pollution**

Unit I: Water Pollution and Effect of water pollutant

1. Types and sources of water pollution. Impact on humans, plants, and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN.
2. Indian standards for drinking water (IS:10500, 2012). Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater
3. Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant.
4. Problems of pesticides and chemical fertilizers, Geogenic Contamination – problems of As and F- in ground water and human health, Case of As and F-

Unit II: Groundwater study and Wastewater Treatment

1. Groundwater Contamination by Hazardous Wastes leaching.
2. Industrial and Mining Operations and water pollution, Sewage and wastewater, Pharmaceuticals in Wastewater, Sanitation and Drinking Water, waterborne diseases,
3. Wastewater Treatment and Water Reuse, Implications on health – appreciation of Minamata disease, *itaiitai* disease, blue baby syndrome.

Unit: III Soil Pollution

1. Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Analysis of soil quality.
2. Soil Pollution control. Industrial effluents and their interactions with soil components. Soil microorganisms and their functions – degradation of pesticides and synthetic fertilizers.

Unit: IV: Eutrophication, soil erosion and climate change

1. Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India.
2. Soil erosion, reclamation of degraded land, desertification, and its control.
3. Climate change – adaptability, energy security, food security and sustainability.

M.Sc. (EVDM)	Semester I Theory
RJSPGESDM104 Paper 4 Water and soil pollution	Course Outcomes 1.4: ➢ Detailed study of sources and types of water pollution and its impact on human health. ➢ Detailed study the effect of water pollutant and problems due to pesticides and chemical fertilizers. ➢ Detailed study of groundwater study and wastewater treatment. ➢ Detailed study of sources and types of soil pollution and its impact on human health. ➢ Detailed study of Eutrophication and restoration of lakes, Soil erosion and Climate change. Learning Outcomes ➢ To understand the various water pollutants and measures to be taken to protect potable water. ➢ Understanding the application and need for treatment of effluent and microbiological analysis of polluted water bodies. ➢ Understanding application and need for wastewater treatment and water reuse. ➢ Understanding the effect of Industrial effluents and their interactions with soil components. ➢ Ability to understand the need to address current environmental issues for Eutrophication, Soil erosion and climate change.

Semester 1	**Practical Paper 1**
Course Code: RJSPGESDMP101	**Energy and Environment**
1. Measuring plant canopy by height and girth 2. GPS sensing of tree. 3. Comment - Responses of plant to environment adaptation study- light and nutrient. 4. Waste management and natural resource study: Mini project based for reduce, recycle, and reuse. 5. Field visit: with the help of GPS and canopy make a report on park, green place visit	

Semester 1	**Practical Paper 2**
Course Code: RJSPGESDMP102	**Fundamentals of Environmental Chemistry**

1. Comment on type of unit used in measurement of particulate matter in air by grab sampling and gravimetric method.
2. Comment on type of unit used in Air monitoring at Workplace, Ambient Indoor Air Quality Monitoring,
3. Visit to industry for measuring air-pollution control measures and reporting, Metrological Studies.
4. Analysis of organic matter in given soil sample.
5. Estimation of inorganic composition in given soil sample
6. Understanding the study of mobile metals and semi volatile organic as per toxicity (TCLP EPA 1311)

Semester 1	**Practical Paper 3**
Course Code: RJSPGESDMP103	**Environmental Pollution and Control**

1. Use Noise Monitoring unit to understand and compare noise levels of selected localities.
2. Illumination Studies by lux meter
3. Understanding levels of SOx and NOx in ambient air - Comment
4. Analysis of nitrate-nitrite content in given sample.
5. Estimation of sulphates in given sample
6. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural, sampling, analysis and reporting.

Semester 1	**Practical Paper 4**
Course Code: RJSPGESDMP104	**Water and soil pollution**

1. Measurement of acidity and alkalinity in samples.
2. Estimation of dissolved oxygen (DO), BOD and chemical oxygen demand of water samples.
3. Estimation of Turbidity Test; pH and Conductivity Test
4. Analysis of residual chlorine in water samples.
5. Field visit: sampling of wastewater/soil/sediment and its characterization.
6. Field visit: Identification of water bloom forming micro-organisms.
7. Field visit: Identification of keystones species responsible for eutrophication of water body.

Syllabus for the Environmental Science and Disaster Management

Program Code: RJSPGESDM (201-204)

SEMESTER 2

(CBCS onwards 2020)

Environmental Science and Disaster Management semester 2

Course Code	**Unit**	**Title: Thermal, Marine Pollution and Radioactive**	**Credit 4**
RJSPGESDM201	1	Thermal and Radioactive Pollution	1
	2	Solid Waste	1
	3	Solid waste processing and recovery	1
	4	Hazardous waste and E-waste	1

Course Code	**Unit**	**Title: Environmental Biology**	**Credit 4**
RJSPGESDM202	1	Ecology, Ecosystem and Biogeochemical cycles	1
	2	Biomes, Population ecology, Community and industrial ecology	1
	3	Forest and wildlife Conservation	1
	4	Environmental and population models	1

Course Code	**Unit**	**Title: Environmental Geosciences**	**Credit 4**
RJSPGESDM203	1	Origin of earth and Concept of minerals and rocks	1
	2	Concept of steady state and Climates of India	1
	3	Toxicology, Microbiology, and current epidemiological Issues	1
	4	Environmental Biotechnology	1

Course Code	**Unit**	**Title: Soil weathering, hydrogeology, and Environmental implications of energy use**	**Credit 4**
RJSPGESDM204	1	Soil weathering and geochemical classification of elements	**1**
	2	Distribution of water in earth and pollution of groundwater resource	**1**
	3	Natural resource exploration and exploitation and natural hazards	**1**
	4	Bioenergy and environmental implications of energy use	**1**

Semester 2 practical		**Credit**
RJSPGESDMP201	Thermal, Marine Pollution and Radioactive	2
RJSPGESDMP202	Environmental Biology	2
RJSPGESDMP203	Environmental Geosciences	2
RJSPGESDMP204	Soil weathering, hydrogeology, and Environmental implications of energy use	2

Semester 2	**Paper 1**
Course Code: RJSPGESDM201	**Thermal, Marine Pollution and Radioactive**

Unit I: Thermal and Radioactive Pollution

1. Sources of Thermal Pollution, Heat Islands, causes and consequences.
2. Sources and impact of Marine Pollution. Methods of Abatement of Marine Pollution. Coastal management.
3. Radioactive pollution – sources, biological effects of ionizing radiations, radiation exposure and radiation standards, radiation protection.

Unit II: Solid Waste

1. Solid Waste – types and sources. Solid waste characteristics, generation rates, solid waste components, proximate and ultimate analyses of solid wastes.
2. Solid waste collection and transportation: container systems – hauled and stationary, layout of collection routes, transfer stations and transportation.
3. Waste Management – Swachh Bharat Abhiyan.

Unit: III Solid waste processing and recovery

1. Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products.
2. Electrical energy generation from solid waste (Fuel pellets, refuse derived fuels), composting and vermicomposting, bio methanation of solid waste.
3. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste.

Unit: IV Hazardous waste and E-waste

1. Hazardous waste – Types, characteristics, and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration, and final disposal.
2. E-waste: classification, methods of handling and disposal. Fly ash: sources, composition, and utilisation. Plastic waste: sources, consequences, and management.

M.Sc. (EVDM)	Semester II Theory
RJSPGESDM201 Paper 1 Thermal, Marine Pollution and Radioactive	Course Outcomes 2.1: 1. Detailed study of thermal, marine and radioactive pollution. 2. Detailed study of solid waste management and processing. 3. Study of disaster caused hazardous waste. 4. Detailed study of electronic waste management and processing. Learning outcomes: ➢ Learning the causes and consequences of thermal, marine, and radioactive pollution. ➢ Learning the application for reduce, reuse, and recycle. ➢ Learning about methods for waste handling and its disposal.

Semester 2	**Paper 2**
Course Code: RJSPGESDM202	**Environmental Biology and Modelling in Environmental Sciences**

Unit I: Ecology, Ecosystem and Biogeochemical cycles

1. Ecology as an interdisciplinary science and origin of life and speciation, Human Ecology and Settlement.
2. Basis of Ecosystem classification. Types of Ecosystem: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic.
3. Ecosystem Structure and functions: Structures – Biotic and Abiotic components. Functions – Energy flow in ecosystems, energy flow models, food chains and food webs.
4. Biogeochemical cycles, Ecological succession. Species diversity, Concept of ecotone, edge effects, ecological habitats and niche. Ecosystem stability and factors affecting stability. Ecosystem services.

Unit II: Biomes, Population ecology, Community, and industrial ecology

1. Biomes: Concept, classification, and distribution. Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chaparral, Savanna, Tropical Rainforest.
2. Population ecology: Characteristics of population, concept of carrying capacity, population growth and regulations. Population fluctuations, dispersion and metapopulation. Concept of 'r' and 'k' species. Keystone species.
3. Community ecology: Definition, community concept, types, and interaction – predation, herbivory, parasitism, and allelopathy. Biological invasions. Concept of Industrial Ecology.

Unit: III Forest and wildlife Conservation

1. Forest Conservation – Chipko movement, Appiko movement, Silent Valley movement and Gandhamardan movement. People Biodiversity register.
2. Wildlife conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision.
3. Sustainable Habitat: Green Building, GRIHA Rating Norms.
4. Carbon sequestration and carbon credits.

Unit: IV Environmental and population models

1. Approaches to development of environmental models; linear, simple, and multiple regression models, validation and forecasting.
2. Models of population growth and interactions: Lotka-Volterra model, Leslie's matrix model.

M.Sc. (EVDM)	Semester II Theory
RJSPGESDM202 Paper 2 Environmental Biology	Course Outcomes 2.2: 1. Detailed study of ecology, origin of life and human ecology. 2. Detailed study of ecosystem as per the structure and functions, biogeochemical cycles, and ecological succession. 3. Detailed study of Biomes, population ecology and community ecology. 4. Detailed study of Models of population growth and interactions and it's to development of environmental models. Learning outcomes: ➢ Knowledge of ecology, speciation, and human ecological behaviour. ➢ Learning about energy flow, ecosystem stability and different types of forest. ➢ Learning the application of 'r' and 'k' species concept. ➢ Knowledge about drastic effect of biological invasions. ➢ Ability to draw conclusions for Forest and wildlife Conservation. ➢ Understanding different environmental systems, their components, processes, and their interconnections. ➢ Understanding the importance and implications of quantifying uncertainty in environmental assessment, modelling.

Semester 2	**Paper 3**
Course Code: RJSPGESDM203	**Environmental Geosciences**

Unit I: Origin of earth and Concept of minerals and rocks

1. Origin of earth. Primary geochemical differentiation and formation of core, mantle, crust, atmosphere, and hydrosphere.
2. Concept of minerals and rocks. Formation of igneous and metamorphic rocks. Controls on formation of landforms – tectonic including plate tectonic and climatic.

Unit II: Concept of steady state and Climates of India

1. Concept of steady state and equilibrium, Energy budget of the earth. Earth's thermal environment and seasons.
2. Coriolis force, pressure gradient force, frictional force, geostrophic wind field, gradient wind.
3. Climates of India, western disturbances, Indian monsoon, droughts, El Nino, La Nina.
4. Concept of residence time and rates of natural cycles. Geophysical fields.

Unit: III Toxicology, Microbiology, and current epidemiological Issues

1. Toxicology and Microbiology: Absorption, distribution and excretion of toxic agents, acute and chronic toxicity, concept of bioassay, threshold limit value, margin of safety, therapeutic index, and biotransformation.
2. Major water borne diseases and air borne microbes.
3. Epidemiological Issues: Fluorosis, Arsenicosis, Goitre, Dengue.

Unit: IV Environmental Biotechnology

1. Bioremediation – definition, types and role of plants and microbes for in situ and ex situ remediation.
2. Bioindicators, Biofertilizers, Biofuels and Biosensors.

M.Sc. (EVDM)	Semester II Theory
RJSPGESDM203 Paper 3 Environmental Geosciences	Course Outcomes 2.3: 1. Detailed study of origin of earth, minerals, and rocks formation. 2. Detailed study of climates in India and geophysical fields. 3. Study of toxicology and microbiology and major air and water borne diseases. 4. Detailed study of bioremediation, bioindicators, biofertilizers, biofuels and biosensors. 5. Detailed Study of epidemiological issues Learning outcomes: ➢ Learning about geochemical differentiation and formation of core and mantle of earth for understand importance of tectonic plates. ➢ Learning the concept of residence time and rates of natural cycles. ➢ Understanding the safety protocol and risk assessment during epidemic diseases. ➢ Knowledge about plants and microbe's interaction and its application in nature. ➢ Case studies from epidemiological issues.

Semester 2	**Paper 4**
Course Code: RJSPGESDM204	**Soil weathering, hydrogeology and Environmental implications of energy use**

Unit I: Soil weathering and geochemical classification of elements

1. Weathering including weathering reactions, erosion, transportation, and deposition of sediments. Soil forming minerals and process of soil formation, Identification and characterization of clay minerals, Soil physical and chemical properties, soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls.
2. Geochemical classification of elements, abundance of elements in bulk earth, crust, hydrosphere, and biosphere. Partitioning of elements during surficial geologic processes, Geochemical recycling of elements. Paleoclimate

Unit II: Distribution of water in earth and pollution of groundwater resource

1. Distribution of water in earth, hydrology and hydrogeology, major basins and groundwater provinces of India, Darcy's law and its validity, groundwater fluctuations, hydraulic conductivity, groundwater tracers, land subsidence, effects of excessive use of groundwater, groundwater quality.
2. Pollution of groundwater resources, Ghyben-Herzberg relation between fresh-saline water.

Unit: III Natural resource exploration and exploitation and natural hazards

1. Natural resource exploration and exploitation and related environmental concerns. Historical perspective and conservation of non-renewable resources.
2. Natural Hazards: Catastrophic geological hazards – floods, landslides, earthquakes, volcanism, avalanche, tsunami and cloud bursts. Prediction of hazards and mitigation of their impacts.

Unit: IV Bioenergy and environmental implications of energy use

1. Bioenergy: methods to produce energy from biomass.
2. Environmental implications of energy use; energy use pattern in India and the world, emissions of CO2 in developed and developing countries including India, radiative forcing, and global warming. Impacts of large-scale exploitation of solar, wind, hydro, and nuclear energy sources.

M.Sc. (EVDM)	Semester II Theory
RJSPGESDM204 Paper 4 Soil weathering, hydrogeology, and Environmental implications of energy use	Course Outcomes 2.4: 1. Detailed study of soil weathering and geochemical elements. 2. Detailed study of distribution of water and pollution found in groundwater resource. 3. Detailed study of exploration of natural resource and natural hazards. 4. Detailed study of bioenergy. Learning outcomes: ➢ Learning about soil type and its physical and chemical properties for its application. ➢ Learning the management and its execution for solving ground water pollution problem. ➢ Learning the concept for prediction of hazards and mitigation of catastrophic geological hazards impacts ➢ Understanding the environmental implications of energy use.

Semester 2	**Practical Paper 1**
Course Code: RJSPGESDMP201	**Thermal, Marine Pollution and Radioactive**
1. Enlisted Solid waste in selected locality. 2. Types of solid waste management by different method. 3. Different methods for Recycling of waste. 4. Finding out the presence of hazardous waste in selected area and suggest its treatment. 5. Case study of natural disaster caused by thermal pollution in India. 6. Case study of natural disaster caused by radioactive pollution in India.	

Semester 2	**Practical Paper 2**
Course Code: RJSPGESDMP202	**Environmental Biology Statistical Approaches and Modelling in Environmental Sciences**

1. Assessment of biotic components in an ecosystem primarily pattern of organisms and habitat exposure
2. Assessment of biodiversity in each geographical area – floristic diversity (citing categories of different life forms based on morphological features only)
3. Quadrat study for plants (1m× 1m), involving random sampling to random sampling to measure the abundance, density, and frequency of various species in an ecosystem.
4. Field visit and reporting – Recording bio-complexity at field level (Relationships within plants, animals and between plants and animals in the ecosystem.
5. R software Introduction, software Module download, Data entry into R Workstation, Matrix operation.
6. Statistical Plots generation and Simple statistical analysis in R
7. Field - Forest/desert/aquatic ecosystem – record biotic and abiotic components and interactions

Semester 2	**Practical Paper 3**
Course Code: RJSPGESDMP203	**Environmental Geosciences, microbiology, and toxicology**

1. Analysis of water by MPN method.
2. Microbial assessment of air and water by open plate method.
3. Gravimetric analysis of TS, TDS and TSS.
4. Comment - identification and handling of Rhizobium and Mycorrhiza.
5. A visit to industry to study industrial fermenter/wine industry.
6. Case studies of environmental disasters and epidemiological issues.

Semester 2	**Practical Paper 4**
Course Code: RJSPGESDMP204	**Soil weathering, hydrogeology, and Environmental implications of energy use**

1. Estimation of fluorides from ground water samples
2. Estimation of Hardness of water
3. Identification of rocks and soil for learning soil formation and soil erosion.
4. Measuring the percentage of silt, clay and sand of collected sample.
5. Case study of natural disaster caused by landslides, Tsunami and cloud burst in India, mitigation.

Syllabus for the Environmental Science and Disaster Management

Program Code: RJSPGESDM (301-304)

SEMESTER 3

(CBCS onwards 2020)

Environmental Science and Disaster Management semester 3

Semester 3 Course Code	**Unit**	**Title: Natural Hazards, disaster management Statistical concepts**	**Credit 4**
RJSPGESDM301	1	Earth atmospheric process, Earthquake and Disaster management	1
	2	Drought and Floods, Cyclones and Landslides	1
	4	Data, central tendency, sampling Probability and parameters	1
	4	Attributes and Variables, distributions and biostatistical test application	1

Course Code	**Unit**	**Title: Environmental Instrumentation**	**Credit 4**
RJSPGESDM302	1	Analytical instruments	1
	2	Chromatography	1
	4	Absorption spectrum studies and Spectroscopy	1
	4	Gas Chromatography and HPLC	1

Course Code	**Unit**	**Title: Environmental Assessment, Management and Legislation**	**Credit 4**
RJSPGESDM303	1	Environmental Impact Assessment (EIA)	1
	2	Hazardous and Waste Management Rules	1
	4	Environmental Laws in India and National Forest Policy	1
	4	Environmental Conventions and Agreements	1

Course Code	**Unit**	**Title: Environmental Economics and Contemporary Environmental Issues**	**Credit 4**
RJSPGESDM304	1	Environmental economics	1
	2	Environmental economics Issues	1
	4	Environmental Risk analysis	1
	4	Contemporary Environmental Issues	1

Semester 3 practical		**Credit**
RJSPGESDMP301	Natural Hazards, disaster management Statistical concepts	2
RJSPGESDMP302	Environmental Instrumentation	2
RJSPGESDMP303	Environmental Assessment, Management and Legislation	2
RJSPGESDMP304	Environmental Economics and Contemporary Environmental Issues	2

Semester 3	**Paper 1**
Course Code: RJSPGESDM301	**Natural Hazards, disaster management Statistical concepts**

Unit I: Earth atmospheric process, Earthquake and Disaster management

1. Earth and atmospheric process: basics of plate-tectonic, hydro-geomorphic and atmospheric (energy atmospheric circulation) processes.
2. Definitions and associated concepts: natural hazards, risk, vulnerability; Hazards and risk assessment.
3. Earthquake: origin of earthquakes; seismic waves; world's seismicity with emphasis on Indo-Burma region; hazards associated with earthquakes; response to earthquake hazards.
4. Disaster management: causes, immediate effects, delayed effects, management and case studies.

Unit II: Drought and Floods, Cyclones and Landslides

1. Drought: Cause and impact; types of draughts (meteorological, hydrological, agricultural and socio-economic) response to hazards- mitigation and adaptation; droughts in India
2. Floods: floods as physical process (river systems, runoff, river activities); causes and factors of flooding, effects of /hazards associated with flooding; response to flood hazards; global and India scenario.
3. Cyclones: Genesis; tropical cyclones- formation, frequency and trajectory; impact of cyclones, mitigation and adaptation
4. Landslides: Genesis (slope failure mechanism); causes of landslides, prevention and correction methods; Global and Indian scenario

Unit III: Data, central tendency, sampling Probability and parameters

1. Introduction, Data presentation, Frequency, Histogram, Basic Statistics (Mean Median, Mode, Standard Deviation, Skewness, Kurtosis), Quartiles, Box, Whisker Plots
2. Concept of population, sample, Sample design, Sample size for data analysis, data quality, Quality control.
3. Probability, Probability distribution, cumulative distribution function, parametric distributions, and non-parametric distributions.
4. Estimating distribution parameters, Ordinary least square technique, Maximum likelihood estimates,

Unit: IV Attributes and Variables, distributions and biostatistical test application

1. Attributes and Variables: types of variables, scales of measurement, measurement of Central tendency and Dispersion, Standard error.
2. Moments – measure of Skewness and Kurtosis, Basic concept of probability theory, Sampling theory, Distributions – Normal, log-normal, Binomial, Poisson, t, X2 and F-distribution.
3. Correlation, Regression, tests of hypothesis (t-test, X2 -test ANOVA: one-way and two-way); significance and confidence limits.

M.Sc. (EVDM)	Semester IV Theory
RJSPGESDM301 Paper 1 Natural Hazards and disaster management	Course Outcomes 3.1: 1. Detailed study of earth and atmospheric process, natural hazards and risk assessment during earthquakes. 2. Detailed study of drought and floods cause and impact. 3. Detailed study of cyclones and landslides cause and impact. 4. Study of disaster management during natural hazards impact with the help of case studies. 5. Detailed study of basic statistical parameter, data, central tendency and sampling 6. Detailed study of Probability, Attributes and Variables, Correlation, Regression, tests of hypothesis. Learning outcomes 3.1: ➢ Learning the disaster extremities and risk assessment during earthquakes, drought, floods, cyclones and landslides. ➢ Learning and knowing the cause and effect of natural hazards till recent date. ➢ Understanding mathematical and statistical concepts required for model development. ➢ Perform data exploration and visualization. ➢ Test model performance in terms of statistical error estimation.

Semester 3	**Paper 2**
Course Code: RJSPGESDM302	**Environmental Instrumentation**

Unit I: Analytical instruments

1. Basics principles of analytical instruments - spectroscope, diffraction, chromatography, electronic transition, fundamentals of optics and photometry, principles of microscopy.
2. Principle of diffraction and X-ray diffraction: X- ray spectra, Bragg's law and intensity of X- rays, Mosley's law, XRD techniques

Unit II: Chromatography

1. Introduction to Chromatography: Classification – Theory – distribution coefficient, rate of travel, retention time, retention volume, adjusted retention volume, specific retention volume, column capacity, separation number, peak capacity, shapes of chromatic peak, column efficiency, resolution.

Unit: III Absorption spectrum studies and Spectroscopy

1. Absorption spectrum, Emission spectra, Wavelength and Wave number, Electromagnetic radiation, Quantization of energy, Electronic, vibrational and rotational spectroscopy.
2. Spectroscopy: Introduction, basic principles, Electromagnetic radiations and interactions with matters: Define Spectroscopy, Types of spectroscopy.
3. Franck–Condon principle, Jablonski diagram, radiative, non-radiative pathways, fluorescence and phosphorescence.
4. Absorption of radiation, Beer-Lambert's law, deviation of Beer-Lambert's equation and its limitations. UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, Flame Photometry, Atomic Absorption Spectroscopy, NMR Spectroscopy and Mass spectroscopy.

Unit: IV Gas Chromatography and HPLC

1. Gas Chromatography: Principle, carrier gas, stationary phase, instrumentation, sample injection, column detectors (TCD, FID, ECD), effect of temperature on retention, qualitative and quantitative analysis.
2. High Performance Liquid Chromatography: Principle, instrumentation, column, sample injection, detectors (absorbance, refractive index, electrochemical), mobile phase selection, ion pair chromatography. Introduction to sampling techniques and analytical methods to measure environmental contamination in air, water, soils, and food. Safe Laboratory Practices, Quality assurance and Quality.

M.Sc. (EVDM)	**Semester III Theory**
RJSPGESDM302 Paper 3 Environmental Instrumentation	**Course Outcomes 3.2:** 1. Detailed study of Basics principles of analytical instruments. 2. Detailed study of spectroscopy, chromatography and X-ray diffraction. 3. Detailed study of absorption and emission spectra, absorption of radiation and Beer-Lambert's law 4. Study of safe Laboratory Practices, Quality assurance and Quality. **Learning outcomes 3.2:** ➢ Learning the principal and fundamentals of analytical instruments. ➢ Learn and disseminate issues related to occupational health and hazards. ➢ Protocol development for an industry on disaster prevention, health issues, safety measures and environment management.

Semester 3	**Paper 3**
Course Code: RJSPGESDM303	**Environmental Assessment, Management and Legislation**

Unit I: Environmental Impact Assessment (EIA)

1. Aims and objectives of Environmental Impact Assessment (EIA). Environmental Impact Statement (EIS) and Environmental Management Plan (EMP). EIA Guidelines. Impact Assessment Methodologies. Procedure for reviewing EIA of developmental projects. Life-cycle analysis, cost benefit analysis.
2. Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit. Environmental Management System Standards (ISO 14000 series). EIA Notification, 2006 and amendments from time to time. Eco-labelling schemes.
3. Risk Assessment – Hazard identification, Hazard accounting, Scenarios of exposure, Risk characterization and Risk management.

Unit II: Hazardous and Waste Management Rules

1. The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016.
2. The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Batteries (Management and Handling) Rules, 2010 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991, Noise Pollution (Regulation and Control) Rules, 2000, Coastal Regulation Zones (CRZ) 1991 amended from time to time.

Unit: IIIEnvironmental Laws in India and National Forest Policy

1. Overview of Environmental Laws in India: Constitutional provisions in India (Article 48A and 51A). Wildlife Protection Act, 1972 amendments 1991, Forest Conservation Act, 1980, Indian Forest Act, Revised 1982, Biological Diversity Act, 2002, Water (Prevention and Control of Pollution) Act, 1974 amended 1988 and Rules 1975, Air (Prevention and Control of Pollution) Act, 1981 amended 1987 and Rules 1982, Environmental (Protection) Act, 1986 and Rules 1986, Motor Vehicle Act, 1988,
2. National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

Unit: IV Environmental Conventions and Agreements

1. Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM),
2. Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.

M.Sc. (EVDM)	Semester III Theory
RJSPGESDM303 Paper 3 Environmental Assessment, Management and Legislation	Course Outcomes 3.3: 1. Detailed study of aims and objectives of environmental impact assessment (EIA). 2. Detailed study of rules about hazardous waste, construction and demolition waste management. 3. Detailed study of Overview of Environmental Laws in India. 4. Detailed Study of Environmental Conventions and Agreements Learning outcomes 3.3: ➢ Understand the human surrounding and the role of human being in shaping the surrounding environmental management system standards. ➢ Ability to understand the need to address current environmental issues. ➢ Ability to draw conclusions form environmental movements, environmental legislations rules. ➢ Knowledge on forest and environment, agriculture and environment and conducting institutional initiatives in the field of environment.

Semester 3	**Paper 4**
Course Code: RJSPGESDM304	**Environmental Economics and Contemporary Environmental Issues**

Unit I: Environmental economics

1. Introduction: History and fundamental concept of environmental economics; introduction to economic theories and economic approach to real world environmental problems.
2. Depletion of natural resources, climate change impacts, degradation of environmental quality, solid and toxic wastes, best management practice and sustainable development, national and international agreement.

Unit II: Environmental economics Issues

1. Environmental goods, public goods, private goods, common property resources, economic valuation, concept of market, market failure, social costs, private costs, externalities.
2. Economic Solution, policy instruments and environmental markets, environmental market-based instruments: pollution charge, subsidy, deposit refund system and pollution permit trading system; scenario of environmental market worldwide.
3. Economic analysis vis-à-vis benefit-cost analysis in environmental decision making – present value, future value, inflation correction; comparing environmental benefits and costs.

Unit: III Environmental Risk analysis

1. Risk analysis: risk assessment and risk management.
2. Case studies: air quality regulation, water quality regulation, solid and toxic waste regulation.
3. Economic issues of ABS (Access Benefit Sharing) as per Biodiversity Act 2002.
4. Concepts related to Life Cycle Assessment of products and economic concerns.
5. Methods of assessing Natural Capital in economic terms.

Unit: IV- Contemporary Environmental Issues

1. Global Environmental Issues – Biodiversity loss, Climate change, Ozone layer depletion. Sea level rise. International efforts for environmental protection.
2. National Action Plan on Climate Change (Eight National missions – National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a 'Green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change).

M.Sc. (EVDM)	Semester IV Theory
RJSPGESDM304 Paper 4 Environmental Economics and Contemporary Environmental Issues	Course Outcomes 3.4: 1. Detailed study of history and fundamental concept environmental economics and its issues. 2. Detailed study of contemporary environmental issues, risk assessment and risk management. 3. Detailed study of global environmental issues and national action plan on climate change. 4. Detailed study about concepts related to Life Cycle Assessment of products and economic concerns. Learning outcomes 3.4: ➢ Know the concepts of market and the economics of the environment. ➢ Identify economic solutions to environmental problems and the role of environmental market-based instruments. ➢ Apply of economic theories to analyze environmental problems and solutions. ➢ Appreciate risk analysis in providing economic solutions to environmental Problems. ➢ Apply economic analysis in environmental decision-making process.

Semester 3	**Practical Paper 1**
Course Code: RJSPGESDMP301	**Natural Hazards, disaster management Statistical concepts**

1. Morphological and anatomical variations in plants under stress.
2. Stress induced organic solute proline as a physiological marker of salt stress.
3. Case study of natural disaster caused by earthquake, drought, and cyclone in India.
4. Understanding the application of parametric and non-parametric biostatical analysis based on data.
5. Test of Hypothesis, Case studies from Different domain of Environment such as air, water, soil, and Biodiversity etc. and statistical Modelling with Regression Model / Multivariate.

Semester 3	**Practical Paper 2**
Course Code: RJSPGESDMP302	**Environmental Instrumentation**

1. Separation of organic mixture with the help of layer separation.
2. Separation of compounds by chromatography – paper and thin layer.
3. Understanding the Profiling of various chemical and pharmaceutical products for impurities by HPLC / HPTLC.
4. Understanding the mechanical Testing for Packaging Materials - plastic containers IS 15410 and polyethylene flexible pouches & films IS 15609.
5. Understanding the analysis of concrete samples.

Semester 3	**Practical Paper 3**
Course Code: RJSPGESDMP303	**Environmental Assessment, Management and Legislation**

1. Understanding the preparation of a matrix of every environmental resource existing in your college/ resident/ selected area.
2. Prepare a case report of environmental impact of a selected area under development.
3. Case study for procedures in India for EIA .
4. Understanding the analysis of toys as per BIS guidelines
5. Understanding the analysis of Electronic Items as per RoHS guidelines

Semester 3	**Practical Paper 4**
Course Code: RJSPGESDMP304	**Environmental Economics and Contemporary Environmental Issues**

1. Evaluation of contingent value of the scenic beauty by travel cost, time and biodiversity data.
2. Measurement of trees using different methods – total height, bole height, DBH, volume and age.
3. Measurement of wood volume, wood density, specific gravity and non-woody products
4. Evaluation of biomass.
5. Carbon sequestration of selected species tree / area.

Syllabus for the Environmental Science and Disaster Management

Program Code: RJSPGESDM (401-404)

SEMESTER 4

(CBCS onwards 2020)

Environmental Science and Disaster Management semester 4

Course Code: - RJSPGESDM401; RJSPGESDM402;RJSPGESDM403; RJSPGESDM404, RJSPGESDMP401; RJSPGESDMP402; RJSPGESDMP403; RJSPGESDMP404.	Internship, Project Report and Presentation	Credit 24

PRE-WORK

A. Resume making and selection of area of internship.
B. Identification of organization
C. Rubrics for assessment

STEPS OF RUBRICS

- Step 1: - Goals and Policy
- Step 2: - Plan for internship
- Step 3: - Identify the appropriate agency/ organization/ industry/ NGO.
- Step 4: - Monitoring progress of intern
- Step 5: - Assessment

PARTICIPANTS

1. Student
2. Organization/ agency/ industry/ NGO mentor/ co-supervisor
3. College mentor

REPORTS

- ❖ Fortnight report submission to Organization/ agency/ industry/ NGO mentor/ co-supervisor
- ❖ Monthly report submission to College mentor

Credits	24
Hours / credits	Minimum 360 hours
Duration	May – October

ORGANIZATION RESPONSIBILITY

1) Monitoring the attendance record of intern
2) Discipline
3) Fortnight report
4) Mentor grade for 300 marks

O	A+	A	B+	B	C+	C

5) Mentor marks form 200 marks divided as follows:

Completion of work	100
Presentation and submission of report	100

COLLEGE RESPONSIBILITY

Final evaluation at the institution (400 marks)	
Monthly Report	100
Dissertation	100
Presentation	100
Viva	100

Books in College library

Library	Code	Book name	Author name
910.285/BUR MCD	89754	Principles of Geographical information systems	Peter , Rachael, and Christopher
372.357/ROG JAL	89755	An introduction to sustainable development	Peter Rogers, Kazi and John
333.714/ CUN CUN	89756	Principles of ENVIRONMENTAL SCIENCE	William and Mary Ann
372.357/ATK DIE	89757	Handbook of Sustainable development	Atkison and Matthew
333.714/PET	89758	Handbook of environmental impact assessment (volume 1)	Judith Petts
333.714/PET	89759	Handbook of environmental impact assessment (volume 2)	Judith Petts

No.	Textbook name	Library code
1	Dash M. C. and Dash S.P. (2009) Fundamentals of Ecology, Mcgraw Hill.	42904-1993
2	Elliott, W.H., Elliott, D.C. and Jefferson, J.R., 1997. Biochemistry and molecular biology (Vol. 2001, p. 586). Oxford: Oxford University Press	45141, 56064, 68090
3	Gaston K.J. and Spicer (2004) Biodiversity – An Introduction, Blackwell Publishing	54247
4	Kormondy E.J., 2017. Concepts of Ecology, Pearson.	85669
5	Krishnamurthy K. V. (2008) An Advanced Textbook on	66168,

	Biodiversity: principles and Practice, Oxford & IBH Pub. Co. Pvt. Ltd.	69338
6	Krishnamurthy, K.V., An Advanced Textbook on Biodiversity- Principle and Practices, Oxford & IBH Publishing., 2004.	2009
7	Lehninger, A.L., Nelson, D.L., Cox, M.M. and Cox, M.M., 2005. Lehninger principles of biochemistry. Macmillan.	
8	Odum, E.P. and Barrett, G.W., 1971. Fundamentals of ecology (Vol. 3, p. 5). Philadelphia: Saunders.	81328
9	Ricklefs, R.E. and Miller, G.L., 2000. Ecology. W. H. Freeman & Co.	61986
10	Sanghi, R. and Srivastava, M.M., 2003. Green Chemistry: Environment Friendly Alternatives. Alpha Science Int'l Ltd.	60978
11	Singh, B.D. and Singh, B.D., 2007. Biotechnology expanding horizons. Kalyani publishers.	88410
12	Smith, R.L., Smith, T.M., Hickman, G.C. and Hickman, S.M., 1998. Elements of ecology. Pearson Benjamin Cummings, San Francisco, CA.	45818, 83865
13	Spiegel M, Stephens LJ, Schaum's Outline of Statistics, McGraw Hill.	65427, 65428, 82828, 82835
14	William P. Cunningham, Mary Ann Cunningham, Barbara Woodworth Saigo, Environmental Science: A global concern, McGrawHill 2003.	50665

No.	Reference book name	Library code
1	Agarwal, Anil, and SunitaNarain, eds. *Dying Wisdom: Rise, fall and potential of India's traditional water harvesting systems*. Centre for Science and Environment, 1997.	46376
2	Basham, A.L. (2008) The Wonder That was India, Surjeet Publications.	73098
3	Biswas T.D. and Mukherjee S.K., Textbook of Soil Sciences, Publisher: McGraw-Hill Inc., US, 2nd edition, 1995.	42788
4	De A.K., Environmental Chemistry, Wiley Eastern Limited, 2000.	48787
5	Environment, Peter H Raven and Lind R Berg (John Wiley & Sons)	75641
6	Jense J. R., Remote Sensing of the Environment – An earth resource perspective. Pearson Education, 2nd Edition, 2013.	54160
7	Krebs C.J. 2016. Ecology: The experimental Analysis of Distribution and Abundance, Pearson.	85672
8	Murugesan, S., 2008. Harnessing green IT: Principles and practices. IT professional, 10(1), pp.24-33.	82260
9	Patel A.H., 2000. Industrial microbiology. Macillan India Ltd.	45263, 51682
10	Prosser C. Ladd., (ed) Comparative Animal Physiology, fourth edition, WileyLiss, New York, 1991.	34397,
11	Warren, Karen J. (2018) *Ecofeminism: Women, Culture, Nature*, Jaipur: Rawat Publications.	77215

Textbooks

1. Alexander D., Natural Disasters, ULC press Ltd, London, 1993.
2. Andersen, M.S. and Sprenger, R.U. eds., 2000. Market-based instruments for environmental management: politics and institutions. Edward Elgar Publishing
3. Barrow, C.J. 2000. Social Impact Assessment: An Introduction. Oxford University Press.
4. Bell F.G., Geological Hazards: Their Assessment, Avoidance & Mitigation, Taylor and Francis, 2003.
5. Bewick, M.W., 1980. Handbook of organic waste conversion. Van Nostrand Reinhold Co.
6. Bhatia A. L., Textbook of Environmental Biology, I K International Publishing House (March 27, 2010).
7. Burrough P.A. and McDonnell R.A., Principles of Geographical Information Systems. 2nd Edition, Oxford University Press, 2006.
8. Chow V. T., Maidment D. R., Mays L. W., "Applied hydrology", McGraw Hill Education.
9. E. Bryant, Natural Hazards, 2nd Edition, Cambridge University Press
10. Field, B.C. and Field, M.K., 1997. Environmental economics: an introduction. Sustainable Human Development Review, 105.
11. Forsyth D, Probability and Statistics for Computer Science, Springer
12. Girard J, Principles of Environmental Chemistry, Jones Bartlett Learning, 2014
13. Glasson, J., Therivel, R., Chadwick, A. 1994. Introduction to Environmental Impact Assessment. London, Research Press, UK.
14. H.S. Peavy, D.R. Rowe & G. Tchobanoglous, "Environmental Engineering". McGraw Hill International Edition.
15. Jacob D. J, Introduction to Atmospheric Chemistry, Princeton, 2004.

16. JH Seinfeld and SN Pandis, Atmospheric Chemistry and Physics. Wiley 2006.
17. Jördening, H.J. and Winter, J. eds., 2005. Environmental biotechnology: concepts and applications. John Wiley & Sons.
18. Karia GL (3013) Wastewater Treatment: Concepts and Design Approach, PHI
19. Kiang, Y.H., 1981. Waste energy utilization technology. United States
20. Krishnamurthy K. V. (2003) Textbook of Biodiversity, CRC Press.
21. Lillesand T. M., Remote Sensing and Image Interpretation. John Wiley, 7th Edition, 2015.
22. Manahan SE, Environmental Chemistry, CRC Press2010.
23. Modi P. N., "Irrigation Water Resources and Waterpower Engineering", Standard Book House.
24. Moorthy V. V. N., Land and water management, Kalyani 2006
25. Peter V. Hobbs, Introduction to Atmospheric Chemistry, CUP 2000.
26. Rai, G.D., 2013. Non-conventional sources of energy. Khanna Publishers
27. Rittmann, B.E. and McCarty, P.L., 2012. Environmental biotechnology: principles and applications. Tata McGraw-Hill Education.
28. Rogers PP, Jalal, KF, Boyd JA, An introduction to sustainable development, Earthscan
29. S. K. Garg, "Hydrology and Water Resources Engineering", Khanna Publishers
30. S.K. Garg, Water Supply Engineering (Vol-I & II), Khanna Publishers
31. Saradhi P.P., Biophysical processes in living systems, Oxford & IBH Publishing, 2008.
32. Singh, K. and Shishodia, A., 2007. Environmental economics: Theory and applications. SAGE Publications India
33. Subramanya, K., "Engineering Hydrology", McGraw Hill Education.

34. Wang, L.K., Ivanov, V., Tay, J.H. and Hung, Y.T. eds., 2010. Environmental biotechnology (Vol. 10). Springer Science & Business Media.

35. William Cunningham, Mary Cunningham, Principles of Environmental Science: Seventh Edition, McGrawHill 2014.

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1. A Global Report - Reducing Disaster Risk, A Challenge for Development; UNDP Publication, 2004.
2. Abele, E., Anderl, R. and Birkhofer, H., 2005. Environmentally friendly product development. Springer-Verlag London Limited.
3. Abraham, C.M. 1999. Environmental Jurisprudence in India. Kluwer Law International.
4. Allegrini I, De Santis F. (Ed), Urban Air Pollution: Monitoring and Control Strategies,
5. Anne E. Magurran and Brian J. McGill (Eds.) (2010) Biological Diversity Frontiers in Measurement and Assessment. Oxford University Press
6. Anne E. Magurran. 2003. Measuring Biological Diversity. Wiley-Blackwell, Pp-264.
7. Arakeri H.R. and Roy D.; Principles of Soil Conservation and Water Management; Oxford IBH Pub. Co. Pvt. Ltd.; 2000
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37. Elaine MA and Bugyi G.(Eds.),Impact of Water Pollution on Human Health and Environmental Sustainability, Information Science Ref.
38. Energy and Environment- A Primer for Scientists and Engineers Edward H Thorndike (Addison Wesley, Publishing)
39. Energy and Environment, Edited by J Dunderdale (Royal Society of Chemistry)
40. Energy and its Physical Impact on Environment Delbert W Devins (John Wiley & Sons)
41. Energy, Ecology and Environment, Richard Wilson and William Jones (Academic Press, Inc).

42. Environmental Applications of General Physics John I SHonsley (Addison Wesley, Publishing)
43. Environmental Biology By Mike Calver, et al (Eds), Cambridge University Press.
44. Environmental Impact Assessment Notification, 2006
45. Environmental Physics Clare Smith (Routledge)
46. Environmental Science- The Natural Environment and Human Impact R W Andrew and Julie M Jackson (Longmon)
47. Evelyn A. Howell , John A. Harrington , Stephen B. Glass (2011) Introduction to Restoration Ecology , Island Press, Washington, United States.
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Scheme of Examination

1. Continuous Evaluation : 40% Internal and 60% External
2. Internal Examination 40 marks would be in various modes, continuous evaluation in the form of assignments, quiz, presentation, case studies, mini projects etc.
3. External examination would be semester end examination with questions from each unit.
4. Fourth semester is Internship with completion of research project and evaluation as per rubrics provided.
5. One External (Semester End Examination) of 60 marks. Duration 2 ½ hours.
6. One Practical at the end of Semester consisting of Practical I 50 marks, Practical II 50 marks, Practical III 50 marks and Practical IV 50 marks separate passing in each practical
7. Minimum marks for passing Semester End Theory and Practical Exam is 40 %. Separate passing for Internal and Semester End examination.
8. For any KT examinations, there shall be ODD-ODD/EVEN-EVEN pattern followed.
9. Two short field excursions for habitat studies are compulsory. Field report submission is mandatory
10. Field work of not less than eight hours duration is equivalent to one period per week for a batch of 15 students.
11. A candidate will be allowed to appear for the practical examinations if he/she submits a certified journal of Botany or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course as per the minimum requirements.
12. In case of loss of journal, a candidate must produce a certificate from the Head of the department /Institute that the practical for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal will not be granted.
13. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

Evaluation and Assessment

Evaluation (Theory): Total marks per course - 100.

- **CIA- 40 marks**

CIA 1 and CIA 2: Written Test / Assignment / Field Trip/mini project/ & Report -40 marks

- **Semester End Examination – 60 marks**

Question paper covering all units

- **Evaluation of Practical's 200 marks (50 marks for each practical)**

Course Semester End Examination in Semester's

Question	Knowledge	Understanding	Application and analyses	Total marks- Per unit
Unit 1	06	03	03	12
Unit 2	06	03	03	12
Unit 3	06	03	03	12
Unit 4	06	03	03	12
Short notes from topics covering all the units	06	03	03	12
-TOTAL- Per objective	30	15	15	60
% WEIGHTAGE	50	25	25	100%

Evaluation of Practical's 200 marks /Semester

Continuous Evaluation of practical components which require adequate duration for completion of the task, observation and interpretation: 25% Course end Practical Evaluation of skills of students in terms of skill, analysis, interpretation and conclusion.

ASSESSMENT OF FIELD TRIP REPORT

Course Code_____Date_____Roll No _____

Name of student:_____UID No _____

Marks____/20 Place of visit _____

Assessment Grid : Place one tick in each appropriate row. Overall mark should reflect the positions of ticks in the individual rows

(20)	**Field Trip and Report**	**80-100% 17-20 Marks**	**60-80% 13-16 Marks**	**40-60% 09-12 Marks**	**20-40% 05-08 Marks**
30% (06)	**Organization of report** -	Introduction about the location, Names, Family, Local name, Description using, Handwritten or typed. 6	Few mistakes, 5	Many mistakes 4	Inadequate presentation 3
50% (10)	**Content**	Excellent reporting of all the observed in the field, ecological and morphological data, 10/9	Good reporting, species observed in the field but few of them missing in the list 8	Satisfactory, many species or relevant data missing from the report 6	Poor, inadequate and insufficient data or just a list of the species without any data. 5
10% (02)	**Conclusion** **----Marks----**	Conclusion based on self-observation. 2	Good conclusion, comments not independent 2 / 1	Satisfactory, but insufficient 1 /0.5	Poor, irrelevant conclusion 0.5
5% (01)	**References** **----Marks----** -	Proper references, in required format 1	Proper references but no format 1	Few references 0.5	Irrelevant references 0
5% (01)	**Attendance / participation** **----Marks-----**	Attended and participated actively 1	Attended and participated 1	Infrequent Participation 0.5	No participation 0

Comments: Name and Signature of Faculty

Post-graduation project

Name of student ----------

Title of Assignment: _----------

Assessment Grid : Place one tick in each appropriate row. Overall mark should reflect the positions of ticks in the individual rows. In boxes that have more than one set of marks, cancel out the marks that are not applicable and circle the correct marks.

Project work and report (Parameters)	**Marks**	**80 – 100% Excellent**	**60 -80% Good**	**40 – 60% Satisfactory**	**20 – 40% Average**
Project work done	10	10 / 9	8 / 7	6 / 5	4 /3
Report writing and conclusions	10	10 / 9	8 / 7	6 / 5	4 /3