ST JOSEPH'S UNIVERSITY
BENGALURU . INDIA

Curricular Structure for the Undergraduate Programme

in

ENVIRONMENTAL SCIENCE

(Three major subjects up to IV Semester and specialisation in one subject in V and VI semesters)

As per (1)b. of

STATE EDUCATION POLICY – 2024

(SEP-2024)

(As per Case 2: Deep Specialisation in 5th & 6th Semester)

DEPARTMENT OF ENVIRONMENTAL SCIENCE

ST JOSEPH'S UNIVERSITY

 # 36, LALBAGH ROAD, BENGALURU – 560 027

DEPARTMENT OF ENVIRONMENTAL SCIENCE

ST JOSEPH'S UNIVERSITY

BENGALURU – 560 027

Curricular Structure for the Undergraduate Programme in ENVIRONMENTAL SCIENCE (Three major subjects up to IV Semester and specialisation in One subject in V and VI semesters) as per (1)b. of STATE EDUCATION POLICY – 2024 (SEP-2024) ***(As per Case 2: Deep Specialisation in 5th & 6th Semester)***

Semester	No. of Theory papers (3 credits)	No. of teaching hours / week / batch	No. of practical papers (2 credits)	Total credits (Theory + Practical)	No. of batches expected	Teaching workload (hours)	
						Theory	Practicals (2 teachers each)
I	1	3	1	3 + 2 = 05	2	3	12
II	1	3	1	3 + 2 = 05	2	3	12
III	1	3	1	3 + 2 = 05	2	3	12
IV	1	3	1	3 + 2 = 05	2	3	12
V	3	9	3	(3 + 2 = 5) X 3 papers =15	1	6	06
VI	3	9	3	(3 + 2 = 5) X 3 papers =15	1	6	06
Total	**10**	**30**	**10**	**50**	**10**	**30**	**60**

Undergraduate teaching workload of the Department of Environmental Science = 30 (theory) + 60 (Practical) **= 90 hours (Total)**

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(As per Case 2: Deep Specialisation in 5th & 6th Semester)

Sem-ester	Paper code	Tentative Paper Title
I	ES 124	Components of the Environment
	ES 1P1	Water quality analysis
II	ES 224	Ecosystem Dynamics, Biodiversity and Wildlife
	ES 2P1	Ecological analysis and Biodiversity Assessment
III	ES 324	Natural Resource Management and Environmental Pollution
	ES 3P1	Natural Resource Management and Environmental Pollution
IV	ES 424	Climate Sciences and Disaster Management
	ES 4P1	Meteorology and Climate Change Assessment
V	ES 5124	Air Pollution, Noise and Radiation Pollution Management
	ES 5P1	Air Quality and Noise Monitoring
	ES 5224	Water Pollution and Land Pollution Management
	ES 5P2	Wastewater and Soil/Refuse analysis
	ES 5324	Waste Management and Environmental Health and Safety
	ES 5P3	Dissertation
VI	ES 6124	Environmental Biotechnology and Environmental Forensics
	ES 6P1	Environmental Biotechnology and Environmental Forensics
	ES 6224	Environmental Impact Assessment, Environmental Audit and Geospatial Applications
	ES 6P2	Environmental Impact Assessment, Environmental Audit and Geospatial Applications
	ES 6324	Environmental Economics, Sustainability and Entrepreneurship
	ES 6P3	Dissertation

B.Sc. Semester – I

ES 124: COMPONENTS OF THE ENVIRONMENT

Number of Lecture hours per semester	Number of credits
45	**3**

Course Specific Objectives	
CSO 1	To develop competency in understanding the interrelatedness of the divisions of the Environment.
CSO 2	To instill an introductory knowledge of the divisions of Environment and develop necessary analytical skills to characterise their variations.
CSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
CSO 4	To inculcate creativity and innovative spirit in the domain of human-environment interface.

Course Outcomes	
CO 1	Demonstrate an entry-level competence in understanding the environmental divisions and associated processes.
CO 2	Demonstrate the ability to carry out water quality analysis in the laboratory and interpret the results.
CO 3	Ability to understand and appreciate the role of environmental parameters in specific day-to-day activities.
CO 4	Be able to understand the demands and function in work environment dealing with environmental systems

ES 124 – COMPONENTS OF THE ENVIRONMENT	45 Hours
Unit – 1	**8**
Environmental Education: Definition, Aim, Objectives and Scope. Environmental Science: Definition, Aim of Study and Scope. Differences between Ecology and Environmental Science; Various approaches to study Environmental Science. **Solar system:** Formation and evolution. **Evolution of Earth:** Theories of origin. Earth: Position in the solar system, distance from the Sun, rotation, revolution, tilt, axis and their influences.	

Geological time scale: Geochronologic units - Eon, Era, Period, Epoch, Sub-epoch and Age. Period and Etymology of eras – Cenozoic, Mesozoic, Paleozoic, Neoproterozoic, Mesoproterozoic, Paleoproterozoic, Neoarchean, Mesoarchean, Paleoarchean and Eoarchean. **Anthropocene:** Definition and significance. **Earth as a system** - Spheres of Earth - Atmosphere, Hydrosphere, Lithosphere and Biosphere - their complex interactions and significance.	
Unit – 2	**10**
Atmosphere: Definition, Evolution of the atmosphere – Principal components – permanent and variable gases. Chemical composition - Homosphere and Heterosphere. Thermal structure of the atmosphere. **Insolation:** Definition, Factors affecting the distribution. Solar (short-wave) and terrestrial (long-wave) radiations. Thermodynamics and Atmospheric circulation. Earth's Albedo and Heat Budget of the Earth. **Weather:** Definition, parameters - Temperature, Pressure, Humidity, Precipitation, Wind Speed & Direction. Differences between weather and climate. **Greenhouse effect:** Factors and significance. **Ozone chemistry:** Significance of stratospheric ozone layer, causes, mechanism and effects of ozone layer depletion. Control measures - Vienna Convention and Montreal Protocol. Recovery of stratospheric ozone. Ozone layer monitoring.	
Unit – 3	**12**
Hydrosphere: Hydrologic cycle - process of heat energy transfer - Radiation, Conduction and Convection. Types of lifting and precipitation - Bergeron process – The Collision and Coalescence process. Cloud formation and classification. Forms of condensation; Forms of precipitation; Cloud burst and flash floods. Artificial rainfall - Cloud seeding. **Limnology:** Definition – Lotic and Lentic environment. Differences	

between Lotic and Lentic systems. Lotic environment: Springs, Stream profile: Potomon and Rhithron. Lentic environment: Ponds, Lakes and Estuaries – their types. Photic and thermal stratification of Lentic systems. Marine environment: Zonation, Salinity status of marine environment, biotic communities of oceanic zones, acidification of sea water; Coral bleaching; ocean currents and tides, coastal upwelling and Red tide – significance. **Groundwater:** Definition. Zonation; Types of wells. Salinization of groundwater in coastal regions.	
Unit – 4	**15**
Lithosphere: Definition. Internal structure of the Earth. Endogenic processes: Plate Tectonics – Earthquake and Volcanism – Causes, Effects, and Management. Exogenic processes: River, Sand dunes, Glaciation, Avalanches and Landslides. **Mineralogy:** Definition. Outline classification of minerals. **Petrology:** Definition. Classification - Igneous, Sedimentary and Metamorphic rocks – their formation – types – uses. **Pedology:** Soil – definition – formation – soil profile. Soil types – Alluvial; Black; Red and Laterite; Arid and Desert; Saline and Alkaline; Peaty and Marshy; Grassland, Forest and Mountain Soils. **Soil biota:** Definition, characteristics, flora & fauna and their significance. **Weathering:** Definitions, factors and types. **Soil erosion:** Definitions, types, effects and management.	

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ES 1P24: WATER QUALITY ANALYSIS

Number of practical hours per semester	Number of credits
45	**2**

1. Sampling techniques of water
2. 2a. Determination of Colour - *Visual/Colorimetric method*
   2b. Determination of Temperature - Thermometer method
3. Determination of Turbidity - Nephelometric method
4. Determination of pH – Electrochemical method
5. Determination of Electrical Conductance - Conductivity meter method
6. 6a. Estimation of Total Solids - Evaporation and Gravimetric method
   6b. Estimation of Total Settleable Solids - Volumetric method
7. 7a. Estimation of Total Dissolved Solids - Filtration and Gravimetric method
   7b. Estimation of Total Suspended Solids - Filtration and Gravimetric method
8. Determination of Alkalinity - Acidimetric method
9. Determination of Total Hardness - EDTA complexometric method
10. Estimation of Dissolved Oxygen – Modified Winkler's method
11. Estimation of Dissolved Carbon dioxide - Titrimetric method
12. Determination of Chlorides - Argentometric method

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B.Sc. Semester – II

ES 224: ECOSYSTEM DYNAMICS, BIODIVERSITY AND WILDLIFE

Number of Lecture hours per semester	Number of credits
45	3

Course Specific Objectives	
CSO 1	To develop competency in understanding the ecological principles governing the biosphere, biodiversity and wildlife.
CSO 2	To develop necessary analytical skills to assess and understand the ecological systems, local biodiversity and regional wildlife.
CSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and conservation.
CSO 4	To inculcate creativity and innovative spirit in identifying appropriate conservation tools and their timely implementation.

Course Outcomes	
CO 1	Demonstrate an entry-level competence in understanding the ecological dynamics and the influence of biodiversity/wildlife on social and legal dimensions.
CO 2	Demonstrate the ability to carry-out data collection procedures and analysis in field conditions/laboratories leading to appropriate interpretations.
CO 3	Ability to understand and appreciate the role of ecosystem dynamics in conservation of specific habitats/ agroecosystems.
CO 4	Be able to develop competence and academic skills in contributing towards biodiversity and wildlife conservation.

ES 224 – ECOSYSTEM DYNAMICS, BIODIVERSITY AND WILDLIFE	45 Hours
Unit – 1	**13**
Ecology: Levels of organization, Ecology: Divisions of Ecology - approaches in studying Ecology. **Ecosystems**: Definitions. Classification of ecosystem – Terrestrial and Aquatic with their divisions. Structure of the ecosystem - Function of ecosystem - food chain – food web – bio-magnification. Ecological pyramids – Types. **Ecological Niche:** Concept and Types of niches: Spatial, Trophic and Multidimensional – Niche parameters: Form, Position and Width –	

Niche Partitioning - Realized and Fundamental Niche. **Biotic and Abiotic factors:** Influence of Temperature, Wind and Water, Edaphic, Topographic on flora and fauna. **Concept of Limiting Factors:** Liebig's Law of Minimum; Shelford's Law of Tolerance and the combined concept. **Biogeochemical cycles:** Classification. Carbon and Phosphorus cycles – anthropogenic influences on these cycles. **Energy flow in an ecosystem**: Productivity - trophic levels; Study of pond and crop land ecosystems; homeostasis and feedback mechanisms.	
Unit – 2	**12**
Population Ecology: Definition, Characteristics of Population: Density – Natality – Mortality – Age distribution – Growth form – Population Equilibrium – Biotic potential – Carrying capacity – Dispersal – Dispersion – Population fluctuations – Population regulation. **Community Ecology:** Definition, Characteristics of a Community – Species diversity, growth form and structure, dominance, relative abundance, trophic structure. **Ecological succession**: Primary and Secondary succession – Natural and man-influenced succession, – Hydrarch and Xerarch - Climax vegetation and their theories; Ecotone and Edge effect; Ecological equivalents; Ecotypes and Ecophenes; Ecological indicators. **Biomes:** Definition and concept. Classification of biomes. **Evolution:** Definition – Darwin's postulates - Natural selection – Types – Industrial Melanism – Pesticide resistance. Co-evolution; Mimicry – Batesian and Mullerian mimicry, warning colouration.	
Unit – 3	**10**
Biodiversity: Definition: Levels of Biodiversity - genetic diversity, species diversity and ecosystem diversity. Values of Biodiversity: *Consumptive use value, productive use value; Non-consumptive values*	

- social value, ethical value, aesthetic value, option values and ecosystem service value. **Biodiversity Hotspots:** Global and Indian centres. Biogeography of India. Concept of Eco-Sensitive Areas (ESA). Biodiversity profile of India: Forests and Grasslands; Wetlands and Riverine ecosystems; Marine and coastal diversity; Agrobiodiversity; Urban Biodiversity; Invasive Alien species. **Wildlife:** Definition. Wildlife of India. Values of wildlife. Importance of wildlife: Ecological, economic, socio-cultural, investigatory, medicinal, conservation of biological diversities, importance in agriculture. Endangered species: Definition, characteristics and reasons for endangering. Endangered species of India. Endemic species – Concept, types, characteristics, theories of endemism. Endemic Wildlife Species of India. Wildlife (Protection) Act, 1972, Concept of Eco-Sensitive Zones (ESZ). Threats to biodiversity and wildlife: *Over exploitation, Habitat destruction, fragmentation, urbanisation, agriculture extension, Illegal trapping and poaching, diseases, deforestation, invasive species, pollution, acidification of soil and water, desertification, tourism and climate change.*	
Unit – 4	**10**
Conservation (Biodiversity and Wildlife): Definition, need and significance. Conservation goals - *Habitat conservation, Prevention of deforestation, Preventing species from extinction, Sustainable harvest of biological resources and climate change mitigation.* Terminologies of conservation significance: *Keystone species, Foundation species, Umbrella Species and Flagship species, Edge species, Critical link species, Indicator species, Priority species and Rare species.* **IUCN Red Listed species:** *Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct.* **In-situ conservation:** Protected areas – Sanctuaries - National Parks	

– Biosphere Reserves – Sacred groves. Case studies Project Tiger and Project Elephant, Project Crocodile; Vulture (Ramadevarabetta Vulture Sanctuary), Black Buck, Snow Leopard, Amur falcon, Sarus Crane, Great Indian Bustard, King Cobra and Mahseer Fish; Translocation of Cheetah in Kuno National Park, M.P. ***(One Case study to be taught in the class; Others are to be given as assignments)*.** **Ex-situ conservation:** Captive breeding (Botanical gardens, zoological parks, seed banks). Case study of *Ailuropoda melanoleuca* (Giant panda), *Ramosmania heterophylla* and *Madhuca insignis*. Cryopreservation, pollen storage, tissue culture, genetic engineering, field gene banks. Case study of Indian rhinoceros and black rhinoceros. ***(One Case study to be taught in the class; Others are to be given as assignments)***. Traditional Knowledge and ethics in conservation of biodiversity. A locally relevant case study on biodiversity related aspects. People's Biodiversity Register. Bio-piracy. **Communication on Wildlife:** Journalism and Wildlife Photography. **Overview of International and National conservation efforts -** *Convention on Biological Diversity and Agenda 21. Ramsar Convention, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on the Conservation of Migratory Species of Wild Animals (CMS), Trade Records Analysis of Flora and Fauna in Commerce (TRAFFIC). Reducing Emissions from Deforestation and Forest Degradation (REDD) and REDD+. National Biodiversity Action Plan (NBAP).*	

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ES 2P24: ECOLOGICAL ANALYSIS AND BIODIVERSITY ASSESSMENT

Number of practical hours/semester	Number of credits
45	**2**

1. Sampling technique of plankton
2. Quantitative estimation of phytoplankton – Sedgwick-Rafter method
3. Quantitative estimation of zooplankton – Sedgwick-Rafter method
4. Determination of organic pollution – Palmer's Algal Pollution index
5. Estimation of primary productivity of a pond – Light and Dark bottle method
6. Estimation of primary productivity of terrestrial vegetation – Chlorophyll method
7. Identification of ecological indicators and Identification of endangered flora and fauna of India
8. Documentation and assessment of vegetation diversity – Census method/quadrat method
9. Documentation and assessment of faunal diversity – Line transect method
10. Documentation and assessment of winged insect fauna (Entomology) – Light trap/Sticky trap method / Visual encounter /Photographic survey
11. Documentation and assessment of soil fauna – Pitfall trap method
12. Determination of species diversity indices – Simpson's Index and Shannon-Weiner Index

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B. Sc. Semester – III

ES 325: NATURAL RESOURCE MANAGEMENT AND ENVIRONMENTAL POLLUTION

Number of Lecture hours per semester	Number of credits
45	3

Course Specific Objectives	
CSO 1	To equip students with a thorough understanding of natural resource distribution, management, and sustainability challenges in India, focusing on water, land and marine resources.
CSO 2	To provide students with an understanding of forest, energy, and mineral resources, their classification, impacts, and sustainable management strategies, emphasizing conservation, alternative energy, and eco-friendly practices.
CSO 3	To provide students with an in-depth understanding of air, water, and noise pollution, their sources, effects, and control measures, emphasizing pollution indicators, treatment methods, and environmental standards.
CSO 4	To equip students with knowledge of solid waste, hazardous waste, e-waste, biomedical waste, plastic waste, and construction waste management, focusing on their characteristics, environmental impacts, and sustainable disposal and recycling methods.

Course Outcomes	
CO 1	Students will be able to analyse the distribution, utilization, and sustainability challenges of natural resources in India, and propose effective management strategies for water, land, and marine resources.
CO 2	Students will be able to assess the impacts of resource extraction and utilization, identify sustainable management practices for forests, energy, and minerals, and propose solutions for balancing development with environmental conservation.
CO 3	Students will be able to identify the sources and effects of air, water, and noise pollution, assess their impact on human health and the environment, and apply appropriate control measures and treatment methods to mitigate pollution.
CO 4	Students will be able to identify different types of waste, assess their environmental impacts, and apply sustainable management practices for solid, hazardous, e-waste, biomedical, plastic, and construction waste.

ES 325: NATURAL RESOURCE MANAGEMENT AND ENVIRONMENTAL POLLUTION	45 Hours
Unit – 1	**7**
Natural resource: Definition, Characteristics and Classification of natural resources based on utility potential. Availability and distribution of natural resources in India. **Surface water resources:** Water budget of India – Watershed Management; Dams: Impact on environment – alternatives. Conflicts over	

water. **Groundwater resources:** Impacts of urbanization, industrialisation and agriculture on groundwater. Rainwater harvesting. **Marine water resources**: Ocean as a resource – Marine ranching: fisheries, aquaculture; Transportation – Shipping (people, goods and oil) and its impacts. Desalination of marine water. **Water resource management:** Judicious use, Conjunctive use, reuse, recharge and recycle. **Land resources:** Land-use patterns in India. Ownership patterns and conflicts. Desertification: causes, impacts and control measures.	
Unit – 2	**12**
Forest resources: Importance of forestry – Types of forests of India and Karnataka – Pressures on forest areas – NTFPs. Forest diversions for infrastructure development. Impacts of deforestation; Forest fires and their control; Forest conservation: Sacred groves; Chipko and Appiko Movements; Forest based industries (Plywood, Pulp and Paper and Cottage industries) and Energy plantations. **Energy resources:** Definition - Classification of energy resources; Conventional sources and their impacts (fossil fuels and electricity), non-conventional sources and their impacts (Fuelwood, Agriculture residue, Cow dung, Geothermal, Solar - Thermal and Photovoltaic, Wind, Tidal, Briquettes, Wood gas, Energy from waste - Pyrolysis and Biogas, Agrofuels, Bioenergy and Hydrogen fuels) and emerging energy resources. **Mineral resources:** Mining and Quarrying and their impacts; Deep-sea mining – Polymetallic nodules. Reclamation of mines. Ecological conflicts of mineral extraction **Sustainable Resource Management Strategies:** Integrated resource management, community-based management and green technologies.	
Unit – 3	**16**
Air pollution: Definition. Sources of air pollution (Point and non-point). Classification of air pollutants – Particulates ($PM_{<10\mu m}$, $PM_{<2.5\mu m}$, $PM_{<1\mu m}$), gaseous (CO, CO_2, SO_2, NO_X) and aerosols (PAN and Ground level Ozone). **Air pollution episodes:** Acid rain, Los Angeles Smog, London Smog and Delhi Smog. - *Effect on Humans:* Respiratory and cardiovascular diseases, neuropsychiatric complications, the eyes irritation, skin diseases and long-term chronic diseases. Pneumoconiosis. - *Effect on plants:* Necrosis, Chlorosis and Senescence. - *Effect on materials:* Corrosion, discolouration and structural failure. **Indoor air pollution:** Causes- Radon, VOCs – Control measures. **Indicators of air pollution:** Physical, chemical and biological. **Control of air pollution:** - *Gaseous pollutants* – Absorption, Adsorption and Condensation. - *Particulate matter* – Gravity settling chambers, Cyclonic separators, Filters (Baghouse), Electrostatic precipitators and Scrubbers. National Ambient Air Quality Standards (NAAQS), 2009. Air Quality Indices. Bharat Stage Standards.	

Water pollution: Definition, Sources (Point and non-point). Classification of Water pollutants. **Surface water pollution:** Self-purification potential of water bodies - Oxygen sag curve and cultural eutrophication. **Heavy metal pollution:** Sources/Causes, Effects and control measures with reference to Mercury and Chromium. Sources/causes, effects and control measures with special reference to Organo-chlorine pesticides, thermal pollution, oil pollution and groundwater pollution (Nitrate, Fluoride and Arsenic). **Domestic and industrial wastewater:** Physical, chemical and biological characteristics. **Treatment of wastewater:** Primary (Intake, screening, grit removal, pre-aeration, equalisation, neutralisation, coagulation, sedimentation and filtration), secondary (Activated Sludge process and Trickling filters) and tertiary (Chlorination; Reverse Osmosis, Activated Carbon). **Water Quality Standards**: IS 10500; 2012 for drinking water and Central Pollution Control Board (CPCB) classification for surface water – Class A, Class B, Class C, Class D and Class E and Water Quality Indices. **Noise Pollution:** Definitions of sound and noise. Sources of noise – Transport, neighbourhood, industrial and indoor. Decibel scale. Effects of noise on human beings: Auditory and Non-auditory effects - Control measures. Noise standards.	
Unit – 4	**10**
Solid Waste Management: Definition, Types, Sources and Characteristics of solid waste. Impacts of Solid Waste on Environment - Methods of Solid Waste Management - S*ource reduction, Reuse, Source and plant sorting, Recycling, Composting, Recovery of energy & materials and Final disposal of residual waste*. **Hazardous Waste Management**: Definition, sources, classification and Characteristics of Hazardous Waste - *Ignitability, Corrosivity, Reactivity and Toxicity*. Hazardous Waste Treatment, Storage and Disposal Facilities (TSDF). **E-waste Management**: Definition, sources and composition. Effects of E-waste on human health and Environment. Steps in E-waste management - *Collection, Sorting, Repair, Refurbishing and Dismantling of disused Electrical and Electronic products*. **Biomedical Waste Management:** Definition, sources, generation, classification, storage, transportation and disposal. Biomedical Waste Treatment: *Disinfection, Irradiation and Incineration*. **Plastic (Polymer) Waste Management:** Definition, Sources and Types of plastics (Recyclability) and Disposal. Microplastics. Bioplastics. **Construction and Demolition (C&D) Waste Management:** Definition, Sources and Types of C&D wastes. Sanitary landfill. Recycling of C&D waste - *sorting, crushing and sieving of aggregates.*	

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ES 3P25: NATURAL RESOURCE MANAGEMENT AND ENVIRONMENTAL POLLUTION

Number of practical hours per semester	Number of credits
45	2

1. Identification properties of minerals and rocks
2. Description of major rock forming minerals
3. Description of rocks
4. Identification of NTFPs and medicinal plants of Karnataka
5. Quantification of particulate matter in ambient air
6. Quantification of oxides of nitrogen in ambient air
7. Determination of Biochemical Oxygen Demand in wastewater
8. Determination of Chemical Oxygen Demand in wastewater
9. Measurement of Noise - Noise Level Meter
10. Determination of Calcium and Magnesium in soil / solid waste / compost
11. Determination of moisture content and bulk density in solid waste / compost
12. Determination of organic matter in agricultural residue / compost

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B.Sc. Semester – IV

ES 425: CLIMATE SCIENCES AND DISASTER MANAGEMENT

Number of Lecture hours per semester	Number of credits
45	3

Course Specific Objectives	
CSO 1	To provide students with an understanding of climate systems, meteorological parameters, climate zones, and global phenomena, focusing on their effects on weather patterns and the environment.
CSO 2	To equip students with an understanding of climate change, its causes, evidence, impacts on ecosystems, society, and economy, and key concepts related to mitigating and adapting to climate change.
CSO 3	To provide students with a comprehensive understanding of climate change mitigation and adaptation strategies across various sectors, focusing on global and local solutions, policies, and technological innovations.
CSO 4	To provide students with an understanding of various types of disasters, their impacts, and the principles and strategies for disaster mitigation, preparedness, and management across different levels of governance.

Course Outcomes	
CO 1	Students will be able to understand and analyse climate systems, classify climate zones, evaluate global climatic phenomena, and assess their impact on weather patterns and the environment.
CO 2	Students will be able to analyse the causes and evidence of climate change, assess its impacts on ecosystems, society, and the economy, and evaluate strategies for mitigation and adaptation to reduce climate change risks.
CO 3	Students will be able to evaluate and apply climate change mitigation and adaptation strategies across sectors, understand policy frameworks, and assess the role of technological innovations in addressing climate change challenges.
CO 4	Students will be able to identify different types of natural and man-made disasters, understand their impacts, and apply disaster management principles and strategies for mitigation, preparedness, and response at local, state, and national levels.

ES 425: CLIMATE SCIENCES AND DISASTER MANAGEMENT	45 Hours
Unit – 1	**10**
Climate: Definition - Meteorological parameters. **Key concepts:** Elliptical orbit, Axial tilt, Ecliptic plane, Longitude and Latitude, Equator, Tropic of Cancer, Tropic of Capricorn, Zodiac, Perihelion, Aphelion, Equinox, Solstice, Polar day, Polar night and Sunspot. Coriolis force. Weather - short-term weather patterns; Climate - long-term climate trends. Significance of studying climate. **Energy balance:** Solar Energy and Influences of Sun on Earth's climate. Incoming solar radiation vs. outgoing heat. Earths Albedo. Role of latitude	

and the Earth's tilt (seasons). Köppen-Geiger climate classification. **Climate zones of the World:** Tropical, Dry, Temperate, Continental and Polar. **Microclimates:** Definition, Influence of topography on climate (mountains, valleys). Urban heat islands and their influence on local climate. **Monsoons:** Definition, Indian monsoons – seasons; Cold weather season, the hot weather season, season of advancing monsoon and season of retreating monsoon. Cyclones of the Indian region. **Global climatic phenomena:** El Niño and La Niña and their impacts.	
Unit – 2	**13**
Climate change: Definition, scope, history and facts of climate change. **Greenhouse gases:** Definition, sources and sinks of greenhouse gases. **Greenhouse effect:** Natural and human-induced (global warming) and global warming potential of greenhouse gases. **Natural climate variability:** Volcanic activity and sunspot cycles. **Human-induced climate variability:** Heat waves, cold waves and variations in precipitation. **Evidence of climate change:** Ice cores, tree rings, temperature records, sea-level rise, glacier retreat and warmer oceans. **Impacts of global climate change:** - *Ecosystems disruptions:* Ocean acidification and coral bleach, biodiversity loss and desertification. - *Social impacts:* Social inequality, food and water security, conflict and displacement, loss of cultural heritage and displacement, climate refugees and heat-related illnesses. - *Economic impacts:* Agricultural disruption, damage to infrastructure, loss of livelihoods, increased insurance costs, impact on energy production, migration and displacement. **Sector-wise climate change impact data:** Energy; Industrial Production and Product Use; Agriculture, Forestry and Other land use; and Waste sectors. Climate change and food security. India's climate change vulnerability. **Key concepts:** Footprints and handprints, carbon budget, carbon credits, carbon tax, carbon pricing, carbon offset, carbon neutrality, net-zero emissions, carbon positive and carbon negative.	
Unit – 3	**14**
Climate change mitigation and adaptation Urgency of climate change mitigation: Addressing the climate crisis to limit future damage. **Mitigation strategies** - *Energy sector:* Energy efficiency measures, advanced energy as a mitigation option, renewable energy technologies and Carbon Capture and Storage (CCS) – *Bioenergy plantations*. - *Transportation sector:* Sustainable transport solutions, low-carbon fuels, reducing emissions in aviation and shipping, urban planning and transport. - *Land-use and agriculture sector:* Sustainable agriculture practices, methane emissions from livestock, forest conservation and reforestation, soil carbon sequestration.	

- *Policy and financial approaches:* International Climate Agreements - Paris agreement. National Action Plan for Climate Change (NAPCC), India's NDC. - *Social and behavioural aspects:* Public Awareness & Education and Behavioural change strategies, Role of Climate Activism and Advocacy **Case studies of successful mitigation initiatives:** Global case studies, local and community-based mitigation efforts and private sector initiatives (one each). **Climate change adaptation:** Definitions and principles of adaptation. **Urgency of adaptation**: Understanding the impacts of climate change – need for immediate and long-term adaptation efforts – Identifying vulnerable communities and ecosystems. - *Water sector:* Water efficiency and conservation. - *Agriculture and food security:* Climate-smart agriculture – crop diversification, strategies to protect rural and farming communities from climate impacts. - *Coastal zones and ecosystems:* Coastal erosion and flooding – sea walls, mangrove restoration. - *Urban infrastructure:* Designing climate-resilient cities, buildings, green spaces and sustainable transportation, integrating adaptation into development planning. - *Disaster Risk Reduction (DRR):* Integrating disaster resilience into climate adaptation. - *Climate-related health risks:* Public health - heat-related illnesses, vector-borne diseases, climate-induced malnutrition and respiratory diseases. - *Policy for climate change adaptation:* Frameworks for integrating climate change adaptation into International, National and local levels. - *Climate finance:* Adaptation fund and Green Climate Fund. **Case studies of successful climate change adaptation:** Global case studies, local and community-based adaptation and private sector initiatives (one each). **Technological innovations for mitigation and adaptation:** Artificial intelligence (AI), Internet of Things (IoT), big data and supply chain management.	
Unit – 4	**8**
Disaster management **Key concepts:** Event, Risk, Hazard, Exposure, Vulnerability, Response, Mitigation, Preparedness and Prevention. **Disasters:** Definition, History of disasters; Components of disasters. **Types of disasters:** Natural disasters and Man-made disasters. **Natural disasters:** Definitions and introduction to Earthquakes, Tropical cyclones, Cloud bursts, Floods, Drought, Land subsidence, Landslides, Mudslides, Volcanoes, Tsunami, Avalanches, Heat waves, Cold waves, Dust storms and Locust attacks. **Man-made disasters:** Definitions and introduction to Gas leaks, Toxic and Hazardous wastes, Nuclear and radiation accidents, Oil spills, Forest fires, Weather Extremes & Climate Change, Pandemics and Wars. **Mitigation and Management techniques of disaster:** Basic principles of	

disaster management, Disaster Management Cycle and Plan, Disaster Management Policy. Disaster Management Authority at National, State and District levels; Roles and responsibilities of Government authorities including Local Self-Government at various levels. **Case studies:** Uttarakhand floods (2021); Cyclone Dana (2024); Vizag gas leak (2020).	

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ES 4P24: METEOROLOGY AND CLIMATE CHANGE ASSESSMENT

Number of practical hours per semester	Number of credits
45	2

1. Measurement of minimum & maximum temperature and solar illuminance
2. Measurement of relative humidity and atmospheric pressure
3. Measurement of rainfall, wind speed and direction
4. Construction of windrose
5. Mapping Earth's climate zones – Global and India
6. Study of agroclimatic zones of India and Karnataka
7. Sector-wise climate change impact analysis – energy and agriculture sectors
8. Calculate the carbon footprint of an Individual / Institution / organisation
9. Development of hydrograph for a region
10. Carbon stock assessment of trees
11. Development of community-based disaster management plan
12. Development of community perception on climate change issues in a region using questionnaire / Focal group discussion

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