AECC – ENVIRONMENTAL STUDIES SYLLABUS

Number of Theory Credits	Number of lecture hours	Number of field work hours
2	45	5

Unit	Content	45 hours
Unit 1	**Introduction to Environmental Studies** Multidisciplinary nature of environmental studies Scope and importance; Concept of sustainability andsustainable development.	2
Unit 2	**Ecosystems** Definition, concept, Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans,estuaries).	6
Unit 3	**Natural Resources: Renewable and Non-Renewable Resources** Land resources, types and distribution and land-use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Resource types, distribution and status. Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water sharing, types of water sharing (international & inter-state). Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.	8
Unit 4	**Biodiversity and Conservation** Levels of biological diversity: Genetic, species and ecosystem diversity; Biogeographic zones of India;	8

	Biodiversity patterns and global biodiversity hot spots. Biodiversity hotspots of India. India as a mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical and aesthetic value.	
Unit 5	**Environmental Pollution** Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution. Climate change, global warming, ozone layer depletion, acidrain and impacts on human communities and agriculture. Nuclear hazards and human health risks. Solid waste management, Control measures of urban and industrial waste Pollution case studies.	**8**
Unit 6	**Environmental Policies and Practices** Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act, Solid Waste Management Rules. International Conventions on Environment: Ramsar convention, Montreal protocol, Paris agreement, Basel convention and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context	**7**
Unit 7	**Human Communities and the Environment** Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods, earthquake, cyclones and landslides. Environmental movements: Chipko, Silent valley, Apikko, Salumarada Thimmakka. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation Environmental communication and public awareness, case studies (Solar energy park of Karnataka).	**6**
Unit 8	**Field work**	**5**

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SYLLABUS – Theory and Practicals

B.Sc. (Basic/Hons.) Semester 1

Title of the Course: **ES 1T1 - DIVISIONS OF THE ENVIRONMENT**

Number of Theory Credits	Number of lecturehours/ semester	Number of Practical Credits	Number of practical hours/ semester
4	**52**	**2**	**52**

Programme specific objectives	
PSO 1	To develop competency in understanding the interrelatedness of thedivisions of the Environment.
PSO 2	To instill an introductory knowledge of the divisions of Environment and develop necessary analytical skills to characterize their variations.
PSO 3	To motivate and inspire to acquire contemporary understanding andskills leading to issue identification.
PSO 4	To inculcate creativity and innovative spirit in the domain of human-environment interface leading to vocation/entrepreneurial opportunities.

Programme outcomes	
PO 1	Demonstrate an entry level competence in understanding theenvironmental divisions and associated processes.
PO 2	Demonstrate the ability to carry out water quality analysis in thelaboratory and interpret the results.
PO 3	Ability to understand and appreciate the role of environmentalparameters in specific day-to-day activities.
PO 4	Be able to understand the demands and function in work environmentdealing with environmental systems

Title of the Course: **ES 1T1 - DIVISIONS OF THE ENVIRONMENT**

Content of Theory Course 1	**52Hrs**
Unit - 1	
Environmental Science: Definition, concept & Scope. Approaches of studying Environmental Science. Division of the Environment: Definitions of Atmosphere, Hydrosphere, Lithosphere and Biosphere - their complex interactions and significance.	**08**
Unit - 2	
Atmosphere & Climatology: Evolution of the atmosphere, Structure of the atmosphere on the basis of temperature and chemical composition. Formation and significance of ozone layer. Depletion of ozone layer, effects and control measures. Weather and climate: Earth's Albedo and Heat budget of the earth. Tropical monsoon climate – Tropical cyclones and their impacts. Weather forecasting and modification. El-Nino and La-Nina effect. Global warming, effects and control measures; Global dimming - Definition, causes and implications; Urban Heat Islands.	**16**
Unit - 3	
Hydrosphere: Classification - surface water, sub-surface water, ground water. Hydrological cycle – Definition and process involved – Evaporation, Transpiration, Condensation, Precipitation, infiltration and runoff. Types of lifting and precipitation - Bergeron process and Collision and coalescence theory. Types of clouds, forms of precipitation. Artificial rainfall – Cloud seeding. Limnology: Definition and concept. Lotic – Springs, Stream, Rivers, Potomon and Rhithron. Lentic environment - Ponds, lakes & their classification. Stratification of lake – thermal and photic. Ground water Zonation: Aquifer, Aquitard, Aquiclude; Types of wells. Status of Groundwater in Karnataka. Marine Environment: Zonation, Salinity status of marine environment, biotic communities, ocean acidification and coral bleaching; ocean currents and tides – significance; Polymetallic nodules, Brackish water of estuaries and deltas.	**14**
Unit - 4	
Lithosphere: Definition. Internal Structure of the earth – crust, mantle, core. Endogenic processes: Plate Tectonics, folds, faults – Earthquake and Volcanism – Causes, Effects, and Management. Exogenic processes: River, Sand dunes, Glaciation, Avalanches and Landslides. Land forms – Mountains, plateau, plains. Mineralogy: Definition. Outline classification of minerals. Petrology: Definition. Rock Cycle. Classification - Igneous, Sedimentary and Metamorphic rocks – their formation – types – applications. Pedology: Soil – definition – formation – soil profile – physical and chemical characteristics. Types of soils – Alluvial; Black; Red and Laterite; Arid and Desert; Saline and Alkaline; Peaty and Marshy; Grassland, Forest and Mountain Soils. Soil biota. Soil weathering and erosion – Types, effects and management.	**14**

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Content of Practical Course 1: List of experiments to be conducted

ES 1P1: WATER QUALITY ANALYSIS

(Total Teaching Hours = 52; Total Credits = 2)

1. Sampling technique of water.
2. Determination of pH and Electrical Conductance (pH metric method and Conductivity meter method).
3. Estimation of Turbidity (Nephelometric method) and TS, TSS & TDS (Gravimetric and Filtration method).
4. Estimation of Acidity – Alkalimetric method / CO_2 – NaOH titration method.
5. Estimation of Alkalinity – Acidimetric method.
6. Estimation of Hardness – EDTA Complexometric method.
7. Estimation of Chlorides – Argentometric method.
8. Estimation of Dissolved Oxygen – Modified Winkler's method.
9. Estimation of Nitrates – Phenol disulphonic Acid method.
10. Estimation of Fluorides – Fluoride meter method/SPADNS Reagent method.
11. Estimation of Sulphates – Barium chloride method.

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B.Sc. (Basic/Hons.) Semester 2

Title of the Course: ES 1T2 - ECOLOGY – THEORY AND PRACTICE

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/ semester
4	**52**	**2**	**52**

Programme specific objectives	
PSO 1	To develop competency in understanding the ecological principlesgoverning the biosphere.
PSO 2	To instill a knowledge of the Ecology and develop necessary analyticalskills to understand the ecological systems.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
PSO 4	To inculcate creativity and innovative spirit in the domain of human-environment interface leading to vocation/entrepreneurial opportunities.

Programme outcomes	
PO 1	Demonstrate an entry level competence in understanding the ecological dynamics and their influence on humans and anthropogenic endeavours.
PO 2	Demonstrate the ability to carry out ecological analysis in field conditions/laboratories and make appropriate judgements.
PO 3	Ability to understand and appreciate the role of ecology and systemdynamics in specific habitats/agroecosystems.
PO 4	Be able to understand the demands and function in work environmentdealing with environmental systems.

Title of the Course: ES 1T2 - ECOLOGY – THEORY AND PRACTICE

Content of Theory Course 2	52 Hrs
Unit – 1	
Ecology: Definition, Concept, sub-division, Levels of organization, approaches in studying Ecology. Ecosystems – Definitions. Classification of ecosystem – Terrestrial and Aquatic with their divisions. Structure and function of ecosystem - food chain – food web – bio-magnification. Ecological pyramids – Types. Biogeochemical cycles: Classification. Gaseous and Sedimentary cycles – anthropogenic influences on these cycles. Energy flow in an ecosystem – productivity - trophic levels; Study of pondand crop land ecosystems; Homeostasis and feedback mechanisms.	**13**
Unit – 2	
Community Ecology: Definition, Characteristics of a Community – Species diversity, growth form and structure, dominance, relative abundance, trophic structure. 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.	**13**
Unit - 3	
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. Ecological Niche: Concept and Types of niches: Spatial, Trophic and Multidimensional – Niche parameters: Form, Position and Width – Niche Partitioning - Realized and Fundamental Niche. Biomes: Definition and concept. Classification of biomes.	**13**
Unit - 4	
Biotic factors and Abiotic factors: Influence Temperature, Wind and Water, Edaphic, Topographic on flora and fauna, Ecological interactions – Intra and Interspecific interactions Concept of Limiting Factors: Liebig's Law of Minimum; Shelford's Law of Tolerance and the combined concept. Evolution: Definition – Darwin's postulates - Natural selection – Types – Industrial Melanism - Pesticide resistance. Co-evolution; Mimicry – Batesian and Mullerian mimicry, warning colouration, camouflage	**13**

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Content of Practical Course 2: List of Experiments to be conducted

ES 2P1: ECOLOGICAL ANALYSIS

(Total Teaching Hours = 52; Total Credits = 2)

1. Sampling technique for phytoplanktons and zooplanktons.
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. Estimation of primary productivity of grasses – Harvest method.
8. Study of plant community – Individual count method/Quadrat method.
9. Study of animal community – Line transect method.
10. Identification of ecological indicators – Hydrophytes, xerophytes, lichens.

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SYLLABUS – Theory and Practical's

B.Sc. (Basic/Hons.) Semester 3

Title of the Course: **ES 3T1 – NATURAL RESOURCES AND MANAGEMENT**

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semesters
4	**52**	**2**	**52**

Programme Specific Objectives	
PSO 1	To develop the understanding of role of natural resources in economic and ecological development.
PSO 2	To instill a knowledge of quantifying and evaluating contribution of natural resources management in human development.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and management of natural resources.
PSO 4	To inculcate creativity and innovative spirit in the domain of human-development and natural resource utilization efficiency.

Programme Outcomes	
PO 1	Demonstrate competence in understanding the significance of natural resources in economic/ecological development.
PO 2	Demonstrate the ability to carry out the process of identification of, data procurement and interpretation with reference to natural resources.
PO 3	Ability to understand and appreciate the role of quantification of resource use pattern in contemporary/sustainable development paradigms.
PO 4	Be able to understand the demands of data analysis and reporting in natural resource management domain.

Title of the Course: **ES 3T1 – NATURAL RESOURCES AND MANAGEMENT**

Number of Theory Credits	Number of lecture hours/semester
4	**52**

Content of Theory Course 3	52 Hours
Unit - 1	**14**
Natural Resources: Definition; Functional theory of resource and dynamic theory of resource. Natural resources and wealth. Classification of natural resources based on utility potential - Organic and inorganic resources; exhaustible and inexhaustible resources; Factors influencing resource availability, distribution and utilization patterns - Nature, Culture and Man. International, National and Individual resources; Ubiquitous and localized resources. Phantom pile concept. Resources scarcity: Definition; types - Demand-induced, supply-induced, and structural. Natural resource conservation methods following 5R principle and zero-waste concepts, Case studies on energy and paper conservation.	
Unit – 2	**14**
Water Resources: Types - Fresh water, Marine water and Ground Water. Water budget of India, Impact of Dams on environment, Causes and Control Strategies of floods, Watershed Management; Rain Water Harvesting and ground water recharge; River linking – pros and cons; impacts of groundwater extraction; Ocean as a resource - fisheries, aquaculture, transportation, desalination, coastal erosion & reclamation, CRZ. Water and agriculture: Irrigated and rain-fed cultivation; Types of irrigation. Irrigation, drainage and nutrient delivery. Environmental implications of Conventional Agriculture - soil degradation, water pollution, loss of natural biodiversity, water logging and soil salinity. Hydroponics as a Soil-water conservation practices in agriculture.	
Unit - 3	**14**
Forest Resources: Importance of Forestry – Types of Forests of India and Karnataka – Pressures on forest areas – *encroachments, forest fires, land use change - allocation for agriculture, industry and housing* and over utilization of forest resources - harvesting of NTFPs, overgrazing, other anthropogenic pressures. Impacts of Deforestation: Forest Fires and their Control; Forest conservation: Sacred Groves – Chipko and Appiko Movements; Joint Forest Management; Afforestation and Reforestation - Social forestry, Agro-forestry, Urban forestry; Major and Minor Forest Products; Forest based industries = Plywood, Pulp and Paper and Cottage industries. Ecotourism and its impacts. Captive plantations and Energy plantations Forest and wildlife conservation - Protected areas – Sanctuaries - National Parks – Biosphere Reserves.	

Unit – 4	**14**
Land resources: Land-use patterns in India. Agro-climatic zones of India and Karnataka. Types of agriculture and cropping patterns. Implications of agriculture on soil - Soil erosion – causes, types, impacts, control measures. Desertification: causes, impacts and control measures. Mineral resources: Mining and Quarrying and their impacts; Ecological conflicts of mineral extraction; Deep Sea mining and off shore oilexploration. Case studies on Coal and stone quarries. Energy Resources: Definition. Conventional, non-conventional and alternative energy resources. Energy sources and their impacts: Biomass burning - Fuelwood, Agriculture residue, Cow dung; Fossil fuels, Hydel, Geothermal, Nuclear energy; Solar - Thermal and Photovoltaic; Wind, Tidal, Microhydel. Briquettes, Wood gas; Energy from waste - Pyrolysis and Biogas; Agri-based fuels - *Biodiesel, Gasohal;* Hydrogen fuels. Cogeneration.	

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Formative Assessment – Continuous Internal Assessment = 40% (40 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	60% (60 Marks)
Total	100% (100 Marks)

Content of Practical Course 3: List of Experiments to be conducted

ES 3P1 – MINERALOGY, PETROLOGY, ENERGY RESOURCES AND MEDICINAL PLANTS

(Total Teaching Hours = 52; Total Credits = 2)

1. Mineralogy: Identification properties of Minerals
2. Description of Minerals
3. Petrology: Identification properties of Rocks
4. Description of Rocks – Igneous, Sedimentary and Metamorphic
5. Introduction to Mapping - Direction, scale and conventional signs and symbols
6. Properties of Maps – Latitude & Longitude; Grid references
7. Representation of Relief
8. Study of drainage pattern and settlement pattern
9. Geolocation of resources - Mineral, ore, petroleum and energy resources
10. Characteristics and delineation of watershed using topo-sheets
11. Identification of medicinal plants of Karnataka
12. Identification of locally available NTFP's
13. Introduction to Agro-climatic zones of Karnataka and mapping of localagricultural diversity (District level)

References

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Formative Assessment – Practical Internal Assessment = 50% (25 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	50% (25 Marks)
Total	100% (50 Marks)

B.Sc. (Basic/Hons.) Semester 4

Title of the Course: **ES 4T1 – BIODIVERSITY, WILDLIFE AND CONSERVATION**

Number of Theory	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/ semesters
4	**52**	**2**	**52**

Programme Specific Objectives	
PSO 1	To develop competency in understanding biodiversity and wildlife.
PSO 2	To instill a knowledge about human interactions with uncultivated varieties and develop necessary analytical skills to appreciate these interactions.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and conservation.
PSO 4	To inculcate creativity and innovative spirit in identifying appropriate conservation tools and their timely implementation.

Programme Outcomes	
PO 1	Demonstrate competence in understanding the ecological, social and legal dimensions of biodiversity and wildlife.
PO 2	Demonstrate the ability to carry out data collection procedures and analysis in field conditions/laboratories and make appropriate interpretations.
PO 3	Ability to understand and appreciate the role of biodiversity in specific natural habitats and agroecosystems.
PO 4	Be able to develop competence and academic skills in contributing towards biodiversity and wildlife conservation.

Title of the Course: **ES 4T1 – BIODIVERSITY, WILDLIFE AND CONSERVATION**

Number of Theory Credits	Number of lecture hours/semester
4	**52**

Content of Theory Course 4	**52 Hours**
Unit - 1	**14**
Biodiversity: Definition: Levels of Biodiversity - genetic diversity, species diversity and ecosystem diversity. Riverine ecosystems; Marine and coastal diversity; Agrobiodiversity; Urban Biodiversity; Invasive Alien species. Biodiversity Hotspots: Global and Indian centers. Biogeography of India. Biodiversity profile of India: Forests and Grasslands; Wetlands Threats to biodiversity: Over exploitation, Habitat destruction,fragmentation, urbanization, agriculture extension, river valley projects, industrialization, deforestation, invasive species, pollution, acidification of soil and water, mining activities, desertification and climate change. Traditional Knowledge and ethics in conservation of biodiversity. A locally relevant case study on biodiversity related aspects. People's Biodiversity Register and Bio-piracy. The Biological Diversity Bill, 2000 and The Biological Diversity (Amendment) Bill, 2021. Convention on Biological Diversity and Agenda 21. National Biodiversity Action Plan (NBAP).	
Unit - 2	**14**
Ecosystem Services: Concept and Definition. Types of ecosystem services - Regulating services - carbon sequestration, climate regulation, waste decomposition and detoxification, prey regulation; Provisioning services - Food, Fodder, Firewood, Fiber and Fertilizer, minerals, medicine, genetic diversity; Cultural services -aesthetics, spiritual, science and education, ecotourism/ recreational, ecotherapy / therapeutic, ornamental; Supporting services - Nutrient cycling, Soil formation, productivity and Habitatprovision; Values of Biodiversity – direct use / consumptive value andindirect value / non-consumptive values - social value, ethical value, aesthetic value, option values and ecosystem service value etc.	
Unit – 3	**14**
Wildlife: Definition. Wildlife of India. Values of wildlife (ecological, economic, socio-cultural, investigatory, medicinal, conservation of biological diversities, importance in agriculture) of wildlife. Endemic species – Concept, types, characteristics, theories of endemism. Endemic Wildlife Species of India. Endangered species – Definition, characteristics and reasons for engendering; Specialized habitat and niche conditions - creation of protected areas, captive breeding and reintroduction, conservation legislation, and increased public awareness. 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.	

Unit - 4	**14**
Threats to wildlife: Over exploitation, habitat loss, encroachment and fragmentation, disease, pollution, invasive and exotic species, Illegal trapping and poaching, *wildlife diseases to man and competition effect*, agricultural/unrestricted/ over grazing, urbanization and climate change. Human- animal conflict Conservation (Biodiversity and Wildlife): Definition, need and significance. Conservation vs. Preservation. Conservation goals - Habitat conservation, Prevention of deforestation, Preventing species from extinction, Sustainable harvest of biological resources and climate change mitigation. In-situ conservation: Protected areas - Sanctuaries - National Parks – Biosphere Reserves; Project Tiger and Project Elephant; Ramadevarabetta Vulture Sanctuary. Community Conserved Areas – case studies on Black Buck, Snow leopard, Amur falcon and Sarus Crane. 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. International conservation efforts - 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+. Wildlife (Protection) Act, 1972 and US Endangered Species Act (ESA, 1973)	

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Formative Assessment – Continuous Internal Assessment = 40% (40 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	60% (60 Marks)
Total	100% (100 Marks)

Content of Practical Course 4: List of Experiments to be conducted ES 4P1 –

BIODIVERSITY ASSESSMENT AND ECOSYSTEM SERVICES

(Total Teaching Hours = 52; Total Credits = 2)

1. Documentation and assessment of tree diversity – Census method/Point- centered quarter method
2. Documentation and assessment of avian faunal diversity – Line transect method
3. Documentation and assessment of winged insect fauna – Light trap/Sticky trap method
4. Documentation and assessment of Butterflies – Visual encounter /Photographic survey
5. Documentation and assessment of soil fauna – Pitfall trap method
6. Documentation and assessment of crop diversity – Sampling method
7. Identification and documentation of aquatic macroflora – Visual encounter survey
8. Estimation of animal population size – Mark, Release and Recapture method
9. Assessment of regulatory services of terrestrial ecosystems (Green spaces) – Comparison method (air temperature, relative humidity and solar influx).
10. Assessment of provisional services of wetland ecosystems – Questionnaire survey method.
11. Introduction to global biodiversity databases – Global Biodiversity Information Facility (GBIF), Integrated Biodiversity Assessment Tool (IBAT-alliance)

12. Hands-on experience with biodiversity assessment software - Paleontological Statistics Software Package for Education and Data Analysis (PAST). *Note: Data from experiment No 1 to 8 can be used for analysis.*

13. Mapping of International, National and State-wise biodiversity and wildlife conservation sites – Hotspots, Ramsar convention sites, Biosphere reserves, National parks, Sanctuaries, Protected areas and Ecologically significant zones.

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Formative Assessment – Practical Internal Assessment = 50% (25 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	50% (25 Marks)
Total	100% (50 Marks)

SYLLABUS – Theory and Practicals for Bachelor of Science degree in Environmental Science

B.Sc. (Basic/Hons.) Semester 5

Title of the Course: **DSC ENV C9-T-AIR POLLUTION, WATER POLLUTION AND ENVIRONMENTAL ENGINEERING**

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/ semester
4	**60**	**2**	**60**

Programme Specific Objectives	
PSO 1	To develop competency in understanding the concepts of pollution and pollutants.
PSO 2	To instil an introductory knowledge of engineering concepts for controlling the pollution.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
PSO 4	To develop knowledge on act and rules related to pollution.

Programme Outcomes	
PO 1	Demonstrate an entry level competence in understanding the environmental pollutants and their impacts.
PO 2	Demonstrate the ability to carry out air and water quality analysis in the laboratory and interpret the results.
PO 3	Ability to understand the harmful impact of pollutants on environment and human health.
PO 4	Be able to understand the existing treatment technologies and scope of developing these methods.

Content of Theory Course	**60 Hours**
Unit - 1	**15**
Meteorology: Definition. Significance of meteorology.	

Meteorological parameters: Solar radiation, Temperature, Humidity (Absolute, Specific & Relative), Wind speed & direction, Pressure and Precipitation. **Air pollution**: Definition. Sources of air pollution (Point and non-point). Classification of air pollutants – Particulates, gaseous and aerosols. Meteorology of air pollution: Airshed – Concept and Scope. Atmospheric stability, Temperature inversions. Plume Behaviour. Effects of air pollution on humans, plants and materials (CO, CO_2, SOx, NOx, PAN, Ground level Ozone, $PM_{<10\mu m}$, $PM_{<2.5\mu m}$, $PM_{<1\mu m}$, Acid rain, Thermo-chemical – CO_2, and Photochemical reactions - O_3 & Smog) in atmosphere. Respiratory and cardiovascular diseases, neuropsychiatric complications, the eyes irritation, skin diseases and long-term chronic diseases. Pneumoconiosis. Necrosis, Chlorosis and Senescence. Discoloration, Stone cancer and material loss. **Automobile pollution**: Definition. Sources – Petrol, Diesel, LPG, CNG, Biodiesel, Ethanol, Hydrogen and Fuel cells. Emerging fuels – Biobutanol, Dimethyl ether, Methanol and Renewable hydrocarbon biofuels. Electric Vehicles – issues and management. Internal Combustion Engines (Two stroke and Four stroke: Carburettor and Fuel Injection systems) – Exhaust emissions, Evaporative emissions and Crankcase blow-by. Mild hybrid, Full hybrid and Plug-in hybrid engines. Effects and control of automobile pollution.	
Unit – 2	**13**

Air Pollution Control Engineering Monitoring and Control of Air Pollution: Scope and significance. Air Sampling: Ambient, Indoor and Stack - Gaseous and particulates. National Ambient Air Quality Monitoring Programme (NAQMP) – Introduction, Guidelines for Sampling and Measurement of notified Ambient Air Quality Parameters (NAAQS), National Ambient Air Quality Standards. Bharat Stage Emission Standards (BSES) – Introduction, Timeline of Implementation of BSES in India. Current Emissions norms. Air Quality Indices. Concept of Air Pollution Tolerance Index and Industrial Greenbelts. Gaseous – Absorption, Adsorption and Condensation. Particulate – Settling Chambers, Inertial Separators, Cyclones, Filters (Baghouse), Electrostatic Precipitators and Scrubbers. Salient features of Air Pollution (Prevention and Control) Act, 1981 and latest amendments; National Clean Air Programme 2019 and latest amendments.	
Unit – 3	**12**
Water pollution: Definition, Sources (Point and non-point). Classification of Water Pollutants. Heavy metal pollution: Sources/Causes, Effects and Control Measures with reference to Lead and Mercury. Fertiliser pollution: Sources/Causes, Effects and Control Measures with reference to Nitrogen, Phosphorus and Potassium. Agriculture runoff and detergents as pollutants. Eutrophication. Pesticide pollution: Sources/Causes, Effects and Control Measures with reference to Organo-chlorine and Organo-phosphate pesticides. Thermal pollution: Sources/Causes, Effects and Control Measures. Oil pollution: Sources/Causes, Effects and Control Measures. Groundwater pollution: Sources/Causes, Effects and Control Measures with reference to Nitrate, Fluoride and Arsenic. Coliform contamination of water.	
Unit – 4	**20**
Water and Wastewater Engineering: Characteristics of potable water: Physical, Chemical and Biological.	

Treatment of water for potable purposes: Intake, screening, aeration, pre-chlorination, coagulation, flocculation, sedimentation, filtration (SSF and RSF), disinfection and distribution. Characteristics of domestic and industrial wastewater: *Physical* – Colour, Odour, Turbidity, Temperature and Solids (Dissolved, Suspended, Settleable, Volatile; MLSS & MLVSS); *Chemical* – Organic, Inorganic and Volatile Organic compounds; and *Biological* – Coliforms and other organisms. Disposal of sewage on land; disposal of sewage by dilution. Aerobic and Anaerobic methods of treatment. Preliminary and Primary treatment: Screening (fine, medium and coarse – stationary, moving and movable – disposal of screenings), pumping, grit removal (sedimentation tank and detritus tank – types; disposal of detritus) and skimming. Secondary treatment: Activated Sludge Process and Tricking filters. Sludge management. Tertiary treatment: Chlorination; Reverse Osmosis, Activated Carbon. Advanced treatment methods: Filtration, ion exchange, activated carbon adsorption, electro dialysis, nitrification, de-nitrification and Phosphorous removal. Other treatment methods: Oxidation ponds; oxidation ditches; septic tanks Anaerobic lagoons, Anaerobic filter reactors and Up-flow anaerobic digesters. Treatment of Industrial Effluents: Dairy and Electroplating industry. Monitoring of water pollutants: Scope and significance. Salient features of Water Pollution (Prevention and Control) Act, 1974; Water Quality Standards – Drinking water - IS 10500 & Surface water - IS 2296.	

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Content of Practical Course 5: List of Experiments to be conducted

DSC ENV C10-P-AIR AND WASTEWATER ANALYSIS

(Total Teaching Hours = 60; Total Credits = 2)

13 experiments can be chosen from the list below and incorporated into the syllabus delivered in different Institutions based on the availability of resources.

1. Study of meteorological parameters – Light, Temperature, Pressure and Rain fall
2. Study of meteorological parameters – Relative Humidity, Wind Speed and Direction
3. Construction of a Wind rose
4. Sampling techniques of air
5. Determination of Particulate Matter
6. Determination of Sulphur-di-oxide in ambient air
7. Determination of Nitrogen-di-oxide in ambient air
8. Determination of Carbon-di-oxide in ambient air
9. Calculate Air Quality Indices from secondary data sources
10. Sampling techniques of waste water
11. Determination of total solids in wastewater
12. Determination of Chromium in liquid effluents
13. Determination of Copper in liquid effluents
14. Determination of Iron in liquid effluents
15. Determination of BOD
16. Determination of COD

References

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B.Sc. Semester 5

Title of the Course: **DSC ENV C11-T-NOISE, LAND, RADIATION POLLUTION AND SOLID WASTE MANAGEMENT**

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/ semester
4	**60**	**2**	**60**

Programme Specific Objectives	
PSO 1	To develop competency in understanding the pollution from noise and radiation.
PSO 2	To instil a knowledge of types of waste and develop skill for waste management.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
PSO 4	To inculcate creativity and innovative spirit in the domain of human-environment interface leading to vocation/entrepreneurial opportunities.

Programme Outcomes	
PO 1	Demonstrate an entry level competence in understanding about the noise, land and radiation pollution and its control measures.
PO 2	Demonstrate the ability to carry out sampling/monitoring and analysis in field conditions/laboratories and make appropriate judgements.
PO 3	Ability to understand different types of waste and their management.
PO 4	Be able to understand the demands of the society with respect to waste management.

Content of Theory Course	**60 Hours**
Unit - 1	**15**
Noise Pollution: Definitions of sound and noise. Sources of noise – Transport, neighbourhood industrial and indoor. Noise, Vibration and Harshness. Decibel scale. Metrics of noise – pressure, intensity and frequency. Sound pressure level (SPL). Energy average equivalent level of the A-weighted sound - LAeq; Day-time level - LAeqD or Lday; Night-time level - LAeqN or Lnight; Maximum level, LAmax; Sound exposure level of A-weighted sound - SEL; Percentile-derived measurements (L10, L50, L90).	

Special noise environments: Infrasound, ultrasound, impulsive sound and sonic boom. Effects of noise on human beings: Noise Induced Hearing Loss (NIHL), Sleep apnea and others; Psychoacoustics and annoyance rating schemes. Control measures - at source; in the transmission path and protection at the receiver end. Engineering and administrative controls. Noise standards. The Noise Pollution (Regulation and Control) Rules.	
Unit – 2	**15**
Radioactive pollution: Radiation and their types. Wave and particle radiation. Sources; Radiation Dose; Effects on human beings; Preventive measures. Radioactive waste management. Atomic Energy (Radiation Protection) Rules. Soil Pollution: Soil Characteristics - Physical, Chemical and Biological characteristics; Macronutrients, Micronutrients and Organic matter; Cation exchange capacity. Sources and Classification of Soil Pollutants. Water logging and soil salinity. Reclamation of saline and alkaline soils. Synthetic Fertiliser and Pesticide Pollution - Causes, effects and control; Effects of industrial and urban wastes (solid and liquid) on soil. Methods of Soil Management: Farm Yard Manure (FYM), Biopesticides, Integrated Pest Management (IPM), Phytoremediation technology.	
Unit – 3	**15**
Solid Wastes and Management: Definition, Types, Sources and Characteristics of solid waste - *Density, Moisture content, Size of Waste constituents, Calorific Value, Field capacity, Permeability of compacted wastes and Compressibility*. Impacts of Solid Waste on Environment - *Infectious diseases, land and water pollution, obstruction of drains, loss of biodiversity and implications on climate.* Principles of Integrated Solid Waste Management. 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*. Sanitary Value Chain. Environmentally Sound Solid Waste Management (ESSWM), Factors affecting Solid Waste Management. Waste stream assessment (WSA). Solid Waste Management Rules, 2016. Urban Solid Waste Management (USWM): Definition, Classification of solid wastes (source and type based), Elements of USWM - onsite storage, processing and handling, collection, transfer and transport, resource recovery, and final disposal. Case study of USWM of Bengaluru/local town. E-wastes and management: Definition, sources and composition. Effects of E-waste on human health and Environment. E-waste disposal - *Domestic, Commercial and Industrial*. Steps in E-waste management - *Collection, Sorting, Repair, Refurbishing and Dismantling of disused Electrical and*	

Electronic products. Recovery of valuable metals. Life Cycle Assessment (LCA) of E-waste. E-Waste (Management) Rules, 2016.	
Unit – 4	**15**
Hazardous wastes and management: Definition, Sources, Classification and Characteristics of Hazardous Waste - *Ignitability, Corrosivity, Reactivity and Toxicity*. Hazardous Waste Management - Waste Minimization; Waste exchange, recycling and recovery. Treatment Technologies: Chemical treatment – *Stabilization, solidification,* neutralization, precipitation, ion exchange, reduction or oxidation. Thermal treatment – Incineration. Biological treatment – *Land farming, Bioreactors and Anaerobic decomposition*; and Physical treatment – S*olidification, flotation, sedimentation, evaporation or filtration*. Disposal of Hazardous Waste - *Sanitary landfill* and *Underground disposal*. Treatment, Storage and Disposal Facilities (TSDF). Hazardous Waste Management Rules, 2016. **Biomedical Waste Management:** Definition, Sources, Generation, Classification, Storage, Transportation and Disposal. Impacts of biomedical wastes. Biomedical Waste Treatment: *Disinfection, Irradiation and Incineration*. Biomedical Waste Management Rules, 2016. **Plastic (Polymer) Waste Management:** Definition, Sources and Types of plastics (Recyclability). Impact of Plastics on terrestrial and aquatic biota. Plastic wastes: Generation, Classification, Storage, Transportation and Disposal. Microplastics. Bioplastics. Alternatives to plastics. Plastic Waste Management Rules, 2022. **Battery Waste Management:** Definition, Sources and Types of battery wastes. Impact of Batteries/battery waste on Environment. Battery wastes: Generation, Collection, Segregation, Recycling, Treatment and Disposal. Battery Waste Management Rules, 2022. **Construction and Demolition (C&D) Waste Management:** Definition, Sources and Types of C&D wastes. Impact of C&D on the Environment. Recycling of C&D waste - *sorting, crushing and sieving of aggregates.* Construction and Demolition Waste Management Rules, 2016. **Methods of Waste Management Technologies -** Issues in waste disposal, disposal options and selection criteria. Sanitary landfill, Landfill gas emission, Leachate formation and landfill operation issues.	

References

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Content of Practical Course 5: List of Experiments to be conducted

DSC ENV C12-P–SOIL ANALYSIS, NOISE MEASUREMENT AND SOLID WASTE ANALYSIS

(Total Teaching Hours = 60; Total Credits = 2)

13 experiments can be chosen from the list below and incorporated into the syllabus delivered in different Institutions based on the availability of resources.

1. Sampling techniques of Soil
2. Determination of Soil Moisture and Texture
3. Determination of Specific Gravity of Soil
4. Determination of Particle Density of Soil
5. Determination of Water Holding Capacity of Soil
6. Characterization of Solid Wastes
7. Determination of pH and Electrical Conductivity in Soil/Refuse matter
8. Determination of Calcium and Magnesium in Soil/Refuse matter
9. Determination of Lime Content in Soil/Refuse matter
10. Determination of Organic Carbon in Soil/Refuse matter
11. Determination of available Nitrogen in Soil/Refuse matter
12. Determination of available Phosphorus in Soil/Refuse matter
13. Determination of available Potassium in Soil/Refuse matter
14. Determination of C/N ratio in Soil/Refuse matter
15. Measurement of Noise

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B.Sc. Semester 6

Title of the Course: **DSC ENV C14-T-ENVIRONMENTAL MICROBIOLOGY**

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	**60**	**2**	**60**

Programme Specific Objectives	
PSO 1	To develop competency in understanding the microbes of Environment.
PSO 2	To instil a knowledge about roles of microbes in the Environment.
PSO 3	To motivate and inspire to acquire contemporary understanding and using the knowledge for remediation.
PSO 4	To inculcate creativity and innovative spirit in identifying appropriate measures for recycling and conservation.

Programme Outcomes	
PO 1	Demonstrate competence in understanding the microbes of Environment.
PO 2	Demonstrate competence in understanding the microbes in water and their impact on human health.
PO 3	Ability to understand and appreciate the role of microbes in enhancing the quality of life of human.
PO 4	Demonstrate the ability to carry out data collection procedures and analysis in field conditions/laboratories and make appropriate interpretations using the microbes.

Content of Theory Course	**60 Hours**
Unit - 1	**15**
Environmental Microbiology: Definition, scope and significance. History of microbiology. Structure, Characters and Classification of Microorganisms – Bacteria, Archaea, Protozoa, Algae, Fungi, Viruses and Parasites. Environmental determinants: Definition. Influence of pH, Temperature, Radiation, Pressure and Salinity on microorganisms. Extremophiles; Bioluminescent microbes. Air Microbiology: Definition. Airborne infections – Causative microbes – Control measures; Droplet infection; Sick Building Syndrome.	
Unit – 2	**15**
Aquatic Microbiology: Definition. Water related diseases - Bradley's classification - *water-borne diseases, water-washed diseases, water-based diseases and water-related diseases*. Infection, pathogens, symptoms,	

treatment and preventive measures – Disinfection of water for potable purposes. Coliforms – *Citrobacter*, *Enterobacter*, *Escherichia* and *Klebsiella*. Total and Faecal coliforms. Role of microbes in wastewater treatment: Activated Sludge Process and Trickling Filter; Septic tank and Biomethanisation.	
Unit – 3	**15**
Soil Microbiology: Definition. Rhizosphere and Rhizoplane Microflora – Biodegradation of DDT, PCBs and Plastics; Bioleaching of Heavy Metals – Copper, Iron and Uranium; Role of microbes in Biogeochemical Cycles: Nitrogen and Phosphorus. Role of microbes in soil fertility – Rhizobium and Mycorrhiza. Role of microbes in organic solid waste management: Composting – anaerobic and aerobic (Windrow method, Bangalore method, accelerated composting, Bio-mechanical composting machines). Role of inoculum in composting. Vermicomposting. Composting as a method of household solid waste management – case studies.	
Unit – 4	**15**
Food Microbiology:	

References

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Content of Practical Course 6: List of Experiments to be conducted
DSC ENV C15-P-ENVIRONMENTAL MICROBIOLOGY

(Total Teaching Hours = 60; Total Credits = 2)

1. Best practices for microbiology laboratories
2. Microscopy – Study of Simple and Compound microscopes
3. Sterilization techniques and preparation of culture media – Broth and Solid media
4. Isolation of Bacteria from Water/Wastewater – Serial dilution technique
5. Identification of Bacteria – Colony characteristics
6. Identification of Bacteria by gram staining technique
7. Isolation of Fungi from Soils – Pour plate method
8. Identification of Fungi – Lactophenol cotton blue staining
9. Study of Root Nodule Bacteria – Gram staining
10. Study of Endomycorrhiza (VAM)
11. Estimation of Coliform Group of Bacteria – MPN Technique
12. Estimation of Coliform Group of Bacteria – MF Technique
13. Estimation of Faecal Coliform in water
14. Construction of bacterial growth curves – pH – Broth culture
15. Minimum Inhibitory Concentrations (MICs) of heavy metals on bacteria

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Bhattacharyya, B. N. 1993. Experiments with Microorganisms. Emkay Publications.

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B.Sc. Semester 6

Title of the Course: **DSC ENV C16–T–ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL RISK ASSESSMENT**

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/ semester
4	**60**	**2**	**60**

Programme Specific Objectives	
PSO 1	To develop competency in understanding the process of assessing the Environmental Impact.
PSO 2	To instil a knowledge on methodologies used for assessing Environmental Impact.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and conservation.
PSO 4	To inculcate creativity and innovative spirit in identifying appropriate assessment tools.

Programme Outcomes	
PO 1	Demonstrate competence in understanding the reports of Environmental Impact assessment of a project.
PO 2	Demonstrate the ability to carry out data collection procedures and analysis in field conditions/laboratories and make appropriate interpretations required for EIA.
PO 3	Ability to understand the procedure to conduct an audit.
PO 4	Demonstrate the ability to carry out risk analysis adhering to the laws.

Content of Theory Course	**60 Hours**
Unit - 1	**15**
Environmental Impact Assessment (EIA): Definition, principle, process and importance of an EIA. Salient features of EIA. Utilities of EIA. EIA Notification, 2006 and subsequent amendments. Project or Activities requiring Environmental Clearance (MoEF&CC Notification, 2017). Components of EIA – Air, Water, Nosie, Land, Biological environment, Socio-economic and Health Environment. Participants of an EIA.	

Steps in an EIA – Screening, Scoping & consideration of alternatives, Baseline data collection, Impact prediction, Assessment of alternatives, Delineation of mitigation measures, preparation of environmental impact statement, Public hearing, Environment Management Plan, Decision making and Monitoring the clearance conditions.	
Unit – 2	**15**
EIA Methodologies: Rapid and Comprehensive EIA. Characteristics of methods of Impact Identification. Criteria for the selection of EIA methodology – General, impact identification, impact measurement, impact interpretation and evaluation and impact communication. Methods of Impact Identification - Adhoc methods, Checklist methods, Matrices methods, Networks methods and Overlay methods. Environmental index using factor analysis, Cost-benefit analysis, Predictive or Simulation methods. Case Studies: Industry, Housing and Multipurpose Dams.	
Unit – 3	**15**
Environmental Audit: Concept, Aims and Objectives; Elements of Environmental audit - Internal and External audit. Types of Environmental Audit: Environmental Compliance Audits, Environmental Management Audits and Functional Environmental Audits. Water audit, Energy audit, Health & Safety audit and Waste & Waste Minimisation audit. Audit procedure: Pre-audit activities, On-site activities and Post-audit activities. Evaluation of Audit data and Preparation of audit report. Auditor profile. Environmental Audit Notifications (with latest amendments) ISO 14010 - EA- General Principles of Environmental Auditing ISO 14011 - EA- Auditing of Environmental Management Systems ISO 14012 - EA- Qualification Criteria for Environmental Auditors ISO 14013 - Management of Environmental Audit Programmes	
Unit – 4	**15**
Environmental Risk Assessment Hazard identification and risk assessment - Quantitative and Qualitative risk assessment. Quantitative - Hazard Identification and Risk Analysis (HIRA).	

Qualitative - Hazard and Operability Analysis (HAZOP), Job Safety Analysis (JSA), Fault Tree Analysis (FTA) and Event Tree Analysis (ETA). Disaster management plan - Off-site emergency plan and On-site emergency plan Occupation, Health and Safety Management Plan, PPEs, Fire Safety, Chemical and Biological Hazards. Safety Management and Laws - Factories Act; Manufacture, Storage and Import Hazardous Chemical Rules. OSHAS.	

References

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Rau, J. G. and Wooten, D. C. 1980. Environmental Impact Analysis Handbook. McGraw Hill.

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Trivedi, P. R. 2004. Environmental Impact Assessment. APH Publishing Corporation.

Content of Practical Course 6: List of Experiments to be conducted

DSC ENV C17–P–METHODS OF ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL AUDIT

(Total Teaching Hours = 60; Total Credits = 2)

1. Study of recent EIA notification and guidelines
2. Baseline data collection and analysis
3. Study of impact identification methods - Checklists
4. Study of impact identification methods - Matrices
5. Study of impact identification methods - Networks
6. Study of cost-benefit analysis of development project
7. Study of socio-economic impacts - Questionnaire method
8. Study of health impacts - Questionnaire method
9. Study of Environmental Risk Assessment – Data sheet method
10. Study of Environmental audit methods - Water audit
11. Study of Environmental audit methods - Wastewater audit
12. Study of Environmental audit methods - Energy audit – Electricity
13. Study of Environmental audit methods - Energy audit – fossil fuels
14. Study of Environmental audit methods – Solid Waste audit

References

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Barton, H., & Bruder, N. (2014). *A guide to local environmental auditing*. Routledge.

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Munier, N. (2004). *Multicriteria environmental assessment: a practical guide*. Springer Science & Business Media.

Nelson, D. D. (1998). *International environmental auditing*. Government Institutes.

Rathi, A. K. A. (2021). *Handbook of Environmental Impact Assessment: Concepts and Practice*. Cambridge Scholars Publishing.

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