



Bangalore University
Department of Environmental Science
Jnana Bharathi Campus
Bengaluru – 560 056

Syllabus for
III & IV Semester Environmental Science Papers
Under-Graduate (UG) Program
Framed according to the National Education Policy
(NEP - 2020)

August - 2022



BANAGALORE UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL SCIENCE
BANGALORE - 560056

Proceedings of the Board of Studies (UG) meeting held on 26th of August 2022 in the Department of Environmental Science, Bangalore University, Bengaluru - 560056

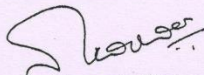
A meeting of BOS (UG) was convened on 26th of August 2022 in the Department of Environmental Science, Jnana Bharathi Campus, Bangalore University, Bengaluru - 560056.

The Chairman welcomed all the members of the BOS(UG) in the beginning and then the members were invited to discuss on the following agenda in the meeting;

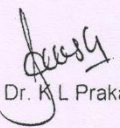
1. Approval of Under Graduate second year syllabus (III & IV Semester) for implementation from the academic year 2022-23 as per the New National Education Policy (NEP - 2020).
2. Course pattern and Scheme of Examination, 2022-23
3. Approval of Panel of Examiners for the academic year 2022-23

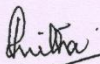
Members gone through the scheme and syllabus submitted by Expert Committee constituted by Government of Karnataka. The committee members have discussed and approved the scheme and syllabus for third and fourth semester UG course for implementation from the academic year 2022-23. The meeting ended with vote of thanks by the chairman.

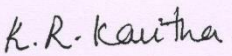
Members Presents

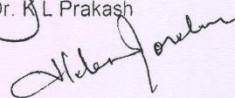

1. Dr. Nagaraja Parisara


2. Dr. Alannanda J Adur


3. Dr. K L Prakash

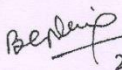

4. Dr. Anitha P


5. Dr. Kavitha K R


6. Dr. Helene Roseline

Members Absents

1. Dr. Abdul Khayum
2. Dr. Rinku Verma


26/08/2022
(Dr. B. C. Nagaraja)
Dr. B. C. NAGARAJA Ph.D.
CHAIRMAN
Dept. of Environmental Science
Bangalore University
Bangaluru - 560 056.
M26/6

PROPOSED CURRICULUM STRUCTURE FOR UNDERGRADUATE ENVIRONMENTAL SCIENCE DEGREE PROGRAMME

II A. Model Programme structure for Bachelor of Science (Basic/Hons.) with practicals with one major and one minor

Semester	Discipline Core (DSC) (Credits) (L+T+P)	Discipline Specific Elective (DSE) /Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Compulsory Course (AECC) (L+T+P)		Skill Enhancement Course (SEC)			TOTAL CREDITS
					SKILL BASED (Credits) (L+T+P)	VALUE BASED (credits) (L+T+P)		
I	ES A1 (4+2) Other subject B1 (4+2)	OE-1 (3)	L1-1(3), L2-1(3), (4hrs. each)	-	SEC-1 Digital Fluency (2) (1+0+2)	Physical Education for fitness (1) (0+0+2)	Health & Wellness (1) (0+0+2)	2 5
II	ES-A2 (4+2) Other subject B2 (4+2)	OE-2 (3)	L1-2(3), L2-2(3), (4hrs. each)	Environmental Studies (2)	-	Physical Education – Yoga (1) (0+0+2)	NCC/NSS/R &R(S&G)/Cu ltural (1) (0+0+1)	2 5
Exit option with Certificate in Science (50 credits)								
III	ES A3 (4+2) Other subject B3 (4+2)	OE-3 (3)	L1-3 (2) L2-3 (2) (4hrs. each)	--	SEC-2: Artificial Intelligence (2) (1+0+2)	Physical Education – Sports (1) (0+0+2)	NCC/NSS/R &R(S&G)/Cu ltural (1) (0+0+1)	2 5
IV	ES-A4 (4+2) Other subject B4 (4+2)	OE-4 (3)	L1-4(3) L2-4(3) (4hrs. each)	Constitution of India (2)	-	Physical Education – Games (1) (0+0+2)	NCC/NSS/R &R(S&G) Cu ltural (1) (0+0+1)	2 5
Exit option with Diploma in Science (100 credits) OR choose any one of the core subjects as Major and other as Minor								

V	ES A 5 (3+2)	Vocational - 1 (3)	-	-	SEC - 3: SEC such as Cyber Security (2) (1+0+2)	-	-	2
	ES A 6 (3+2)							0
VI	ES A 7 (3+2)	Vocational - 2 (3) Internship (2)	-	-	SEC-4: Professional communication (2)	-	-	2
	ES A 8 (3+2)							2
Exit option with Bachelor of Science, B.Sc. Degree in Environmental Science (142 credits) OR continue studies with Major in the fourth year								
VII	ES A 9 (3+2)	ES E1 (3) ES E2 (3)	-	-	-	-	-	2
	ES A 10 (3+2)							2
VIII	ES A 11 (3)	Research Methodology (3)	-	-	-	-	-	2
	ES A 12 (3+2)	ES E3 (3) Research project (6) *	-	-	-	-	-	2
	ES A 13 (3+2) ES A 14 (3)							0
Award of Bachelor of Science Honors Degree, B.Sc. (Hons.) Degree in Environmental Science (184 credits)								

*L+T+P= Lecturing in Theory + Tutorial + Practical's. Numbers in the parenthesis refer to credits.

*In lieu of the research project, two additional elective papers/ Internship may be offered

CURRICULUM STRUCTURE FOR THE UNDERGRADUATE DEGREE PROGRAMME - B.Sc. (BASIC/HONS.)

Total Credits for the Programme: **184**

Starting year of implementation: **2021-2022**

Name of the Degree Programme: **B.Sc. (Basic/Hons.)**

Discipline/Subject: **Environmental Science**

Programme Articulation Matrix

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course (s)	Pedagogy	Assessment
3	ES 3T1 – NATURAL RESOURCES AND MANAGEMENT (4)	Have developed a sound knowledge and understanding of Natural Resources and Application of various management practices.	Certificate in Science with Environmental Science as a subject and a total credit score of 50	Theory, case studies and problem-solving methods	Continuous Internal Assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	ES 3P1 – MINERALOGY, PETROLOGY, ENERGY RESOURCES AND MEDICINAL PLANTS (2)	Be able to Identify Major Rock forming Minerals and Rocks. Learn basic skills of mapping and cartography.		Hands-on-training and field studies	
	ES 3OE3 – WOMEN AND ENVIRONMENT (3) OR ES 3OE3 – ENVIRONMENTAL DISASTERS AND MANAGEMENT (3)	Be able to get an introductory account of the chosen open elective paper and use the acquired knowledge in decision making and hence add to quality of life.		Theory, Case studies and Self-study	

IV. Model Programme structure for Bachelor of Science (Basic/Hons.) with practical with one major and one minor

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course (s)	Pedagogy	Assessment
4	ES 4T1 – BIODIVERSITY, WILDLIFE AND CONSERVATION (4)	Have developed an understanding of the biodiversity resources, status of wildlife, the pressures faced by wildlife areas and cultivate an insight into the conservation practices.	Theory, case studies and field studies	Continuous Internal Assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	ES 4P1 – BIODIVERSITY ASSESSMENT AND ECOSYSTEM SERVICES (2)	Be able to analyze the behavior of local weather patterns by monitoring meteorological parameters. Develop wind and pollution roses; analyze climate maps and make interpretations. Be able to execute sampling and data collection skills with reference to biodiversity and wildlife. Will have an exposure to wildlife monitoring techniques such as quadrats, line transects and mark-release-recapture methods.		Data handling and Hands-on-training	
	ES 4OE4 – ENVIRONMENT AND SUSTAINABLE AGRICULTURE (3) OR ES 4OE4 – INITIATIVES FOR ENVIRONMENTAL MANAGEMENT (3)	Be able to get an introductory account of the chosen open elective paper and use the acquired knowledge in decision making and hence add to quality of life.		Theory, Case studies and Self-study	
Exit option with Diploma in Science (100 credits) OR choose any one of the core subjects as Major and other as Minor					

Job opportunities for the Exit option with Diploma in Science

- Procurement, processing, value addition and Marketing of NTFPs - Executive/Entrepreneurship
- Procurement of Medicinal Plants – Marketing/Entrepreneurship
- Lab assistant in educational institutions
- Wildlife and Ecotourism guides
- Public Health/Waste Management Assistants in Municipalities
- Incinerator operators in small establishments
- NGOs/Consultancy firms
- Self-employment
- Lab assistant in educational institutions
- Wildlife and Ecotourism guides
- Public Health/Waste Management Assistants in Municipalities
- Incinerator operators in small establishments

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
<p>Natural Resources: Definition; Functional theory of resource and dynamic theory of resource. Natural resources and wealth.</p> <p>Classification of natural resources based on utility potential - Organic and inorganic resources; exhaustible and inexhaustible resources;</p> <p>Factors influencing resource availability, distribution and utilization patterns - Nature, Culture and Man. International, National and Individual resources; Ubiquitous and localized resources. Phantom pile concept.</p> <p>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.</p>	
Unit – 2	14
<p>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.</p> <p>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.</p>	
Unit - 3	14
<p>Forest Resources: Importance of Forestry – Types of Forests of India and Karnataka – Pressures on forest areas – <i>encroachments, forest fires, land use change - allocation for agriculture, industry and housing</i> and over utilization of forest resources - harvesting of NTFPs, overgrazing, other anthropogenic pressures.</p> <p>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</p> <p>Forest and wildlife conservation - Protected areas – Sanctuaries - National Parks – Biosphere Reserves.</p>	

Unit – 4	14
<p>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.</p> <p>Mineral resources: Mining and Quarrying and their impacts; Ecological conflicts of mineral extraction; Deep Sea mining and off shore oil exploration. Case studies on Coal and stone quarries.</p> <p>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 - <i>Biodiesel, Gasohal</i>; Hydrogen fuels. Cogeneration.</p>	

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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 local agricultural 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)

ES 3OE3: WOMEN AND ENVIRONMENT

Number of Theory Credits	Number of lecture hours/semester
3	42

Content of OPEN ELECTIVE Theory Course 3	42Hrs
Unit - 1	14
<p>Ecology and Environment: Definitions, meaning and significance. Ecosystem: Structure and function. Natural resources – definition, their local availability, harvest and utility.</p> <p>Gender ideology, Gender inequality and gender justice in India. Women studies: Concept, Objectives of women studies. Nature and Feminine principle - basic human needs from rural and urban environment. Interaction of women with the local ecosystems for household water collection, fuelwood, fodder, medicinal plants, livestock management, food security and non-timber forest produce.</p> <p>Rural women: Role in agriculture sector – Soil-water conservation, chemical free food and food storage. Role in social forestry - Achieving the 5F objectives – Food, Fodder, Firewood, Fiber and Fertilizer; Conservation of indigenous species.</p> <p>Urban women: Role in urban climate management, lifestyle choices and resource conservation – water, electricity, food, fuel resources and development of conservation culture among young generation.</p> <p>Sustainable Development Goals: Goal No. 5 - Gender equality.</p>	
Unit - 2	14
<p>Eco-feminism: Meaning and concept, Emergence and branches of Eco- feminism, Eco-feminism in the global economy, Eco-feminist power, politics and resistance to war and violence.</p> <p>Women and resource scarcity: Impacts of Natural resource depletion, Climate change and environmental degradation on women.</p> <p>Impacts of commonly used chemicals on Women and Environment: Endocrine-disrupting chemicals (EDCs), household chemicals, pesticides, cosmetics, food additives, food preservatives, organic pollutants, Volatile Organic Compounds (VOC's) and indoor air pollution from cooking activities.</p> <p>Climate change and women's health: Vector borne diseases, poor air quality and extreme variance in climatic temperatures -<i>Anaemia, malnutrition and foodinsecurity - reduced cognitive skills, poor attention span, reduced working memory and poor education outcomes. Respiratory distress, cardiovascular disease, negative birth outcomes and reduced mental health in children.</i></p>	

Post-disaster impacts on women: Higher risk of physical, sexual, and domestic violence in the aftermath of disasters. Increased stress due to forced migration, mood disorders and poor economic recovery.	
Unit - 3	14
<p>Women response to environmental degradation: Case studies of collective empowerment – The Chippko Movement - Gaura Devi - Mahila Mangal Dal; Silent Valley Conservation Movement -Sugathakumari; Neem Patent Victory - World’s First Case Against Biopiracy; Narmada Bachao Andolan (NBA).</p> <p>Women and Environmental Conservation: Joint Forest Management (JFM), Social Forestry, Agroforestry, Agriculture, Community nurseries and seed banks, Household Solid Waste Management, Home gardens/rooftop gardening, United Nations Clean Development Mechanism (CDM).</p> <p>Women empowerment through Ecotourism, Cottage industries - NTFP and forest produce processing and value addition; Eco-entrepreneurship - Handicrafts, Case studies of Desi-Charaka and Hasiru Dala.</p> <p>Prominent women environmentalists: Rachel Carson, Wangari Maathai, Gro Harlem Brundtland, Elinor Ostrom, Amritha Devi Bishnoi, Medha Patkar, Sunita Narain, Tulsi Gowda and Saalumarada Thimmakka.</p>	

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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)

ES 3OE3: ENVIRONMENTAL DISASTERS AND MANAGEMENT

Number of Theory Credits	Number of lecture hours/semester
3	42

Content of OPEN ELECTIVE Theory Course 3	42Hrs
Unit - 1	14
<p>Disasters: Definition, History of disasters; Components of disasters.</p> <p>Types of disasters: Natural disasters: Definitions; 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; Introduction to Gas leaks, Toxic and Hazardous wastes, Nuclear and radiation accidents, Oil spills, Forest fires, Pandemics, Weather Extremes & Climate Change and Wars.</p> <p>Weather parameters: Concept, Definition, Role of meteorological parameters in disasters prediction.</p> <p>Mitigation and Management techniques of Disaster: Definitions of Risk, Hazard, Exposure, Vulnerability, Response, Mitigation, Preparedness and Prevention. Basic principles of disaster management, Disaster Management cycle, Disaster management policy.</p> <p>Disaster Management Authority at National, State and District levels; Roles and responsibilities of Govt. Authorities including Local Self Govt. at various levels.</p>	
Unit - 2	14
<p>Natural Disasters – Introduction to natural disaster episodes, causative agent, environmental effects and recovery, damage assessment, management, compensation</p> <p>Earthquakes - types and causes, magnitude and intensity, seismic zones of India and Karnataka. Earthquake measurements- Richter Scale and predications. Earthquake preparedness and management.</p> <p>Tropical Cyclones - Types and causes. Cyclone naming. Cyclone prediction, warning, Preparedness and Management.</p> <p>Floods - Types and causes, Flash floods. Cloud bursts, Floods warning, Preparedness and Management.</p> <p>Land subsidence - Types and causes, Landslides and Mudslides and Avalanches. Land subsidence preparedness and management.</p> <p>Tsunami - types and causes. Tsunami prediction, warning, preparedness and management.</p> <p>Heat waves and Cold waves – Causes and effects, Warning, preparedness and management.</p> <p>Locust attacks – Causes and effects Preparedness and management.</p>	

Unit – 3	14
<p>Man-made disasters – Introduction to man-made disaster episodes, causative agent, environmental effects and recovery, damage assessment, management, compensation</p> <p>Nuclear disaster: Chernobyl and Fukushima; Exxon Valdez oil spill; Indonesia's land and forest fires; Bhopal Gas Tragedy; Visakhapatnam gas leak; Endosulfan disaster in Karnataka and Kerala - Ennore oil spill, Uttarakhand and Kerala floods, Kodagu Landslides/Recent/Local episodes, Bandipura Forest fires/Recent/Local episodes, Bengaluru Urban floods/Recent/Local episodes, Epidemics, Pandemics and Zoonoses.</p>	

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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)

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
<p>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</p> <p>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.</p> <p>Traditional Knowledge and ethics in conservation of biodiversity. A locally relevant case study on biodiversity related aspects. People's Biodiversity Register and Bio-piracy.</p> <p>The Biological Diversity Bill, 2000 and The Biological Diversity (Amendment) Bill, 2021. Convention on Biological Diversity and Agenda 21. National Biodiversity Action Plan (NBAP).</p>	
Unit - 2	14
<p>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 and indirect value / non-consumptive values - social value, ethical value, aesthetic value, option values and ecosystem service value etc.</p>	
Unit – 3	14
<p>Wildlife: Definition. Wildlife of India. Values of wildlife (ecological, economic, socio-cultural, investigatory, medicinal, conservation of biological diversities, importance in agriculture) of wildlife.</p> <p>Endemic species – Concept, types, characteristics, theories of endemism. Endemic Wildlife Species of India.</p> <p>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.</p> <p>Keystone species, Foundation species, Umbrella Species and Flagship species, Edge species, Critical link species, Indicator species, Priority species and Rare species.</p> <p>IUCN Red Listed species - Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct.</p>	

Unit - 4	14
<p>Threats to wildlife: Over exploitation, habitat loss, encroachment and fragmentation, disease, pollution, invasive and exotic species, Illegal trapping and poaching, <i>wildlife diseases to man and competition effect</i>, agricultural/unrestricted/ over grazing, urbanization and climate change. Human- animal conflict</p> <p>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.</p> <p>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.</p> <p>Ex-situ conservation: Captive breeding (Botanical gardens, zoological parks, seed banks). Case study of <i>Ailuropoda melanoleuca</i> (Giant panda), <i>Ramosmania heterophylla</i> and <i>Madhuca insignis</i>. Cryopreservation, pollen storage, tissue culture, genetic engineering, field gene banks. Case study of Indian rhinoceros and black rhinoceros.</p> <p>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+.</p> <p>Wildlife (Protection) Act, 1972 and US Endangered Species Act (ESA, 1973)</p>	

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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.

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)

ES 4OE4: ENVIRONMENT AND SUSTAINABLE AGRICULTURE

Number of Theory Credits	Number of lecture hours/semester
3	42

Content of OPEN ELECTIVE Theory Course 4	42 Hours
Unit - 1	14
<p>Environment – Definition, scope and significance.</p> <p>Agriculture – Definition, scope and significance. Environmental basis for agriculture and food. Agricultural patterns in India. Socio-economic pressures on agriculture. Food security and food scarcity.</p> <p>Types of agriculture – rain-fed cultivation and irrigation – water intensive agriculture – Reservoirs and ground water exploitation. Conventional and mechanized agriculture.</p> <p>Natural and chemical agriculture. Subsistence and commercial agriculture. Environmental effects of land use and landscape changes.</p>	
Unit - 2	14
<p>Environmental determinants of agriculture – role of rainfall, humidity, wind, topography and edaphic factors in crop selection.</p> <p>Animal husbandry – Dairy and poultry – role of transboundary species of cattle in Indian scenario.</p> <p>Pisciculture – Environmental effects of intensive Pisciculture.</p> <p>Agricultural biodiversity: Crop diversity – Definition and significance. Poly culture and mono culture. Influences of green revolution on modern agricultural practices of India – Loss of agrobiodiversity – Influence of transboundary crops. Agricultural biotechnology – Genetically Modified Crops – Influence on environment. Pollination crisis. Integrated pest management.</p>	
Unit - 3	14
<p>Environmental impacts of agriculture – Loss of biodiversity – soil salinity – fertilizer and pesticide pollution, Climate change and global warming. Erosion and problems of deposition in irrigation systems. Desertification. Biomagnification – Case studies.</p> <p>Contemporary issues and management – Farmer distress – market mechanisms – natural farming methods/organic farming. Urban agriculture and hydroponics.</p> <p>Ecological principles of farming – Sustainable agriculture – Significance of indigenous crops and cattle varieties. Watershed management. Agricultural policies of India.</p>	

References

- Altieri, M. A. (2018). *Agroecology: the science of sustainable agriculture*. CRC Press.
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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)

ES 4OE4: INITIATIVES FOR ENVIRONMENTAL MANAGEMENT

Number of Theory Credits	Number of lecture hours/ semester
3	42

Content of OPEN ELECTIVE Theory Course 4	42 Hours
Unit - 1	14
<p>Environment: Definition and components of the environment – Atmosphere, hydrosphere, lithosphere and biosphere – Definitions and influences on human beings. Environmental issues: Natural resource overuse and depletion, pollution, loss of biodiversity, Degradation of air, water and land.</p> <p>Water and wastewater management: Household water demand and uses. Availability of water for household uses. Centralized supply system – Rivers. Water treatment for portable purposes. Decentralized sources – Bore wells. Sustainable use of water – Reuse and recycling, rooftop rainwater harvesting. Grey water management – Septic tanks.</p> <p>Energy conservation: Sources of energy – Electricity, LPG, Other petroleum fuels and feasible alternative sources - Solar heating and photovoltaic. Measures to conserve energy – LED, energy efficient electrical appliances. Bureau of Energy Efficiency standards and labelling.</p> <p>Domestic solid waste management: Biodegradable – Kitchen waste - Issues and management. Compositing – Composters – Bin composter, three tier composters, pipe composting and mechanical composters. Human excreta - Issues and management. Bio-toilets, Dry/waterless toilets.</p> <p>Non-Biodegradable – Issues and management. Segregation – Dry, recyclables and sanitary wastes – Incinerators, pyrolysis and sanitary landfills.</p>	
Unit - 2	14
<p>Agriculture: Implications on soil water management – Fertilizer pollution – Soil salinity, Eutrophication and Bio-magnification. Pesticide pollution - DDT and Endosulphan - Integrated Pest Management (IPM), Bio- pesticides, Genetic Modified Crops (GMCs). Natural farming methods. Irrigation and drainage systems (Israel Model), Hydroponics and Aeroponics.</p> <p>Alternative cultivation methods: Negative impacts of food grown by conventional agriculture methods. Minimizing fertiliser use and preventing chemical pesticide usage. Role of rooftop gardens and kitchen gardens in regulating microclimate. Biofertilisers – <i>Rhizobium</i>, <i>Azotobactor</i>, <i>Azospirillum</i>, Blue green algae, <i>Azolla</i>, Mycorrhizae.</p> <p>Livestock management: Dung and urine management – Biogas plants, Farm Yard Manure (FYM) and Vermi-composting.</p> <p>Human dwellings as micro climatic regimes: Variations in temperature and relative humidity in indoor and outdoor environment. Impacts of increased temperatures. Role of vegetation in micro climate regulation and Carbon capture. Green buildings and micro climate regulations.</p>	

Unit - 3	14
<p>Environmental Management: Definition, need, significance and applications. Environmental Technology vs. Technology for Environment.</p> <p>Technological solutions for environmental degradation: Concept, advantages and limitations. Remedial actions - Waste recycling; Preventive actions - pollution prevention and Management actions; Environmental Management System- ISO 14000 series.</p> <p>Factors influencing transfer of Environmental technology - developer to technology user: Information, Research and Marketing.</p> <p>Factors influencing technology development: Localization, Customization and Contextualization.</p> <p>External factors influencing technology transfer: Laws and legislation; Administrative/Management systems; Information management; Codes and Standards - <i>Eco-labelling and green ratings</i>.</p> <p>Role of individuals in Environmental management: Resource measurements and monitoring, Ecological footprint analysis, Carbon footprint analysis, Water footprint analysis, Micro-climate monitoring and Participation in eco-friendly and sustainable endeavors.</p>	

References

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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)