GOVERNMENT OF KARNATAKA

NATIONAL EDUCATION POLICY- 2020
(NEP-2020)

Report on

Proposed Curricular Framework for Four Years Graduate Programme in Universities of Karnataka State under NEP-2020

in

ENVIRONMENTAL SCIENCE

Submitted to

Karnataka State Higher Education Council
Government of Karnataka
Bengaluru

7th June 2022

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Submitted by

Dr. N. Nandini **Chairperson, Subject Expert Committee - Environmental Science, NEP-2020** Professor, Dept. of Environmental Science, Bangalore University, Bengaluru	**Dr. Jayappa, M.** **Member Convenor, Subject Expert Committee - Environmental Science, NEP-2020** Special Officer, Karnataka State Higher Education Council Bengaluru and Coordinator, Environmental Science Committee, NEP 2020

and

Members of Subject Expert Committee - Environmental Science

1. **Dr. N. S. Raju**, Professor, Department of Studies in Environmental Science, University of Mysore, Mysuru.
2. **Dr. S. V. Krishna Murthy**, Professor, Department of PG Studies and Research in Environmental Science, Kuvempu University, Shankaraghatta.
3. **Dr. S. Suresha**, Professor and Head, Department of Environmental Science, Yuvaraja's College (Autonomous), University of Mysore, Mysuru.
4. **Dr. B. S. Prabhakar**, Associate Professor and Head, Department of Environmental Science, St. Joseph's College (Autonomous), Bengaluru.

7th June 2022

PREFACE

Education empowers life and life systems. A holistic education paradigm will effectively focus on developing knowledge, employable skill sets, appropriate attitudes and an overall personality. A graduate is the one who acquires the following attributes and employs them to benefit societies.

- Skills of identifying a problem and factors responsible for the problem
- Acquires and appreciates problem solving skills
- Logically employs problem solving tools, spatially and temporally
- Identifies timely needs of the community and contributes to them
- Takes the community together creating an equitable ecosystem
- Works towards creating employment opportunities and work domains for different skill sets and knowledge disciplines
- Blends with various social and economic situations making life happier for the self and of the communities
- Envisages and employs various attitudes and skill sets for the betterment of the Nation, blending local and regional variations

Environmental Science is a domain which seamlessly connects the sciences with day-to-day societal demands. Proposing and developing a curriculum for the subject of Environmental Science is unique in many ways. Mankind is facing serious environmental issues like climate change, desertification, deforestation, pollution, solid waste generation, natural and man-made disasters.

Improving the quality of life is a process of development which includes teaching, training and instruction. A competent subject expert committee was constituted by Karnataka State Higher Education Council, Government of Karnataka to achieve these objectives. The assigned task of this committee was to design curriculum structure for both

- ✓ Under-Graduate and Post-Graduate programmes of Environmental Science
- ✓ Environmental Studies – AECC for all Under-Graduate courses

The proposed curricular framework designed by this committee was headed by me with Eminent Educationalists in the field of Environmental Science.

NEP 2020 - SUBJECT EXPERT COMMITTEE – ENVIRONMENTAL SCIENCE		
Name	**Designation and address**	**Position**
Dr. N. Nandini	Professor Department of Environmental Science, Bangalore University Bengaluru	Chairperson
Dr. N. S. Raju	Professor Department of Studies in Environmental Science, University of Mysore, Mysuru	Member
Dr. S. V. Krishnamurthy	Professor Department of PG Studies and Research in Environmental Science, Kuvempu University Shankaraghatta	Member
Dr. S. Suresha	Professor and Head Department of Environmental Science, Yuvaraja's College (Autonomous) University of Mysore, Mysuru	Member
Dr. B. S. Prabhakar	Associate Professor and Head Department of Environmental Science, St. Joseph's College (Autonomous), Bengaluru	Member
Dr. Jayappa, M.	Special Officer Karnataka State Higher Education Council, Government of Karnataka	Member Convenor

Our Nation's vision for higher education through National Education Policy – 2020 is to transform it into a sustainable system. The Government of Karnataka is first State to launch the National Education Policy – 2020. The programme was launched virtually by Union Education Minister Shri. Dharmendra Pradhan. The Honorable Chief Minister of Karnataka, Shri. Basavaraj Bommai launched the policy of digitization, research and development that could help implement the new NEP-2020, which aims at bringing

fundamental changes in the education system. With this vision, Minister for Higher Education and also Chairman for Higher Education Council, Government of Karnataka, initiated to implement the NEP-2020 effectively as a First State in the country by constituting various committees comprising of Education Experts. Prof. B. Thimme Gowda, Vice-Chairman, Karnataka State Higher Education Council, Government of Karnataka conducted several meetings with the committees constituted by Government.

The Chairpersons of Board of Studies, Board of Examiners (Environmental Science) and Subject experts teaching under-graduate and post-graduate courses of various Universities in the State of Karnataka, who participated actively in this process are - **Dr. N. S. Raju**, Professor, Department of Studies in Environmental Science, University of Mysore, Mysuru; **Dr. B. S. Prabhakar**, Associate Professor and Head, St. Joseph's College (Autonomous), Bengaluru; **Dr. J. Narayana**, Professor, Department of Environmental Science, Kuvempu University, Shankaraghatta; **Dr. K. L. Prakash**, Professor, Department of Environmental Science, Bengaluru University, Bengaluru; **Dr. G. V. Venkataramana**, Professor and Chairman, Department of Studies in Environmental Sciences, University of Mysore, Mysuru; **Dr. S. Srikanta Swamy**, Professor, Department of Environmental Science, University of Mysore, Mysuru; **Dr. Yogendra, K.,** Associate Professor, Department of Environmental Science, Kuvempu University, Shankaraghatta; **Dr. Prakash Kariajjanavar**, Assistant Professor, Department of Environmental Science, Gulbarga University, Kalaburagi; **Dr. B. C. Nagaraja**, Professor and Chairman, Department of Environmental Science, Bengaluru University, Bengaluru; **Dr. J. S. Chandrashekar**, Assistant Professor and Chairman, Department of Environmental Science, Karnataka State Open University, Mysuru; **Dr. T. S. Harsha**, Assistant Professor, Department of Environmental Science, Karnataka State Open University, Mysuru; **Dr. Basavarajappa, S. H.,** Assistant Professor, Department of Environmental Science, Kuvempu University, Shankaraghatta; **Dr. M. R. Ebenezer Wilson**, Associate Professor, St. Joseph's College (Autonomous), Bengaluru; **Dr. Helen**

Roselene, Associate Professor and Head, Department of Environmental Science, Mount Carmel College (Autonomous), Bengaluru; and **Dr. K. Harish Kumar**, Assistant Professor, Department of Environmental Science, Government First Grade College, Hosakote; **Dr. Kumar, M**., Faculty, Department of Environmental Science, Bangalore University, Bengaluru; **Dr. Alaknanda J. Adur**, Associate Professor and Head, Department of Environmental Science, Surana College, Peenya, Bengaluru; **Sri. Sachin A. Rosario**, Assistant Professor, St. Joseph's College (Autonomous), Bengaluru; **Dr. M. Raghavendra**, **Sri. Vivek Amuthan**, **Sri. S. Niranjankumar** and **Sri. Vishnu, H. S.,** from Department of Environmental Science, Bangalore University, Bengaluru. This work progressed under the guidance of **Sri. L. S. Ramesh**, Special Officer, Karnataka State Higher Education Council, Government of Karnataka, initially and later steered by **Dr. Jayappa, M**., Special Officer, Karnataka State Higher Education Council, Government of Karnataka.

The valuable support from subject experts **Dr. B. S. Prabhakar**, Associate Professor and Head, St. Joseph's College (Autonomous), Bengaluru and **Dr. Kumar, M**., Faculty, Department of Environmental Science, Bangalore University, Bengaluru, in compiling the report and overall editing is appreciated.

I take this opportunity to express my gratitude to the authorities of Karnataka State Higher Education Council, Government of Karnataka for giving us an opportunity to be a part of curriculum framework design and implementation of NEP-2020.

- **Prof. N. Nandini**
Chairperson
Subject Expert Committee – Environmental Science
Karnataka State Higher Education Council
Government of Karnataka

CONTENTS

PREAMBLE

The course curriculum for undergraduate studies under choice based credit system (CBCS) for B.Sc. in Environmental Science (Basic/Hons.) is framed in this document. This exercise was undertaken as part of the nationwide curriculum restructuring initiative by the National Education Policy-2020. Many formal and informal meetings were held with a number of colleagues from the universities and colleges, who helped with crucial inputs as to the content of the course. This curriculum is a fresh exercise, but also represents a continuous effort of deliberations with the University and College teachers.

As enshrined in the National Education Policy-2020 vision of introducing course curriculum for undergraduate studies under Choice Based Credit System (CBCS), the main objective of framing this curriculum of B.Sc. (Basic/Hons.) in Environmental Science is to impart the students a holistic understanding of the subject giving substantial weightage to the core contents, skill, value-based and ability enhancement. The syllabus has given due importance on the main streams of the body of knowledge on 'Environment' with due recognition of its wide spectrum. The ultimate goal of the syllabus is to enable the students to have an in-depth knowledge on the subject and enhance their scope of employment at every level of exit. Adequate emphasis has been given on the new and emerging techniques and understanding of the subject under the changing regime and global context.

There is need to strengthen the students to understand essential aspects of environmental science in diverse subject areas such as ecology, environmental chemistry, environmental pollution, environmental geoscience, atmospheric sciences, biodiversity, natural resources management, global warming, climate change and waste management. The curriculum lays focus on creating new knowledge, acquiring new skills and capabilities in Environmental Science producing an intelligent human resource serving the Environment and society, focusing on problem solving critical thinking, team work and collaboration. There

is also an additional emphasis in providing opportunities to understand the integration of modern disciplines such as environmental modelling, geographical information systems and remote sensing, environmental sustainability, corporate governance and their applications to environmental sciences. Students would be encouraged to go beyond the classroom and conduct active action-research, research projects, technology based learning and internships in industry/ private/government/manufacturing and service sectors based on suitability. Lectures and classroom sessions are accompanied with on-field visits, industrial visits, seminars, laboratory experiments and in-plant training. Educational visits are an integral part of teaching Environmental Science. These interventions are compulsory and essential aspects of the curriculum. There are optional subject that can be chosen by the students as per their desire and their professional choices.

It is hoped that a student with a four years B.Sc. Environmental Science (Hons.) degree, after having the rigor of the courses outlined here, will feel adequately equipped to meet the challenges of career development. At the same time, there is sufficient content for those who wish to continue academic life at the University beyond the under-graduate level. Due care has been taken to maintain necessary academic wholesomeness and depth in the course content so that the learning outcomes from these courses will lead to intellectual growth of a student. The need for a Basic/Hons. course in Environmental Sciences is necessitated by our country's requirement and also the acceptability of the subject by young students from the view point of career opportunity. There is a demand for the subject in our country and as Educationists we have a societal obligation to meet such aspirations of the youths. It is equally expected that Environmental Science graduates will significantly contribute to the vision of 'Zero Defect, Zero Effect' policy initiative of Government of India.

The course curriculum presented in the following table confirms to the general Guidelines of NEP-2020 scheme, semester schedule, evaluation criteria

and course credit structure of B.Sc. Environmental Science (Basic/Hons.) Programme, like all other undergraduate courses shall comprise of 184 credits spread over Thirty Seven (37) papers to be completed in four years/eight semesters.

Sem	Theory	Practicals	Open Electives	Vocational Course	Internships	Discipline Specific Electives	Research Methodology	Project	Total Papers
I	1 (4)	1 (2)	1 (3)	-	-	-	-	-	**3**
II	1 (4)	1 (2)	1 (3)	-	-	-	-	-	**3**
III	1 (4)	1 (2)	1 (3)	-	-	-	-	-	**3**
IV	1 (4)	1 (2)	1 (3)	-	-	-	-	-	**3**
V	2 (6)	2 (4)	-	1 (3)	-	-	-	-	**5**
VI	2 (6)	2 (4)	-	1 (3)	1 (2)	-	-	-	**6**
VII	3 (9)	2 (4)	-	-	-	2 (6)	1 (3)	-	**8**
VIII	3 (9)	1 (2)	-	-	-	1 (3)	-	1 (6)	**6**
Total Papers	**14**	**11**	**4**	**3**	**1**	**3**	**1**	**1**	**37**

#Numbers in parenthesis indicate credits - amounting to a total of 107 credits

In addition to the subject of Environmental Science (details provided in the above table), another core paper with a similar credit pattern is to be chosen by the student.

Irrespective of the two core paper chosen, every under-graduate student needs to take up 2 Ability Enhancement Compulsory Courses (AECC), 2 languages, 4 Skill based courses and 8 Valued based courses.

A candidate with a minimum qualification of M**.Sc. in Environmental Science subject only** is qualified to teach B.Sc. (Basic/Hons.) Environmental Science at under-graduate level in all the Universities, Deemed Universities, Autonomous Institutions, Government, Aided and Private Colleges in the State of

Karnataka. Preference may be given to candidates with UGC-NET/K-SET/Ph.D in Environmental Science following the government directives.

Further, the existing number of UGC-NET Fellowships in the field of Environmental Sciences is highly inadequate; it is advisable to increase the number of Fellowships in this area.

An Environmental Science programme at the under-graduate level will be successful only when independent Departments of Environmental Sciences are established at under-graduate colleges. It is important to avoid existing problems of co-ordination in teaching carried out through participatory approach. NEP-2020 Environmental Science Subject Expert Committee urges Universities/ Colleges to take necessary steps in this direction.

EXIT OPTIONS AND CREDIT REQUIREMENTS

Progressive Certificate in Science, Diploma in Science, Bachelor of Science Degree or Bachelor of Science Degree with Honours in Environmental Science is awarded at the completion of every progressive year.

Exit with	Credit requirements
CERTIFICATE IN SCIENCE at the successful completion of First year (Two Semesters) of the Four Years Multidisciplinary Undergraduate Degree Programme.	50 credits
DIPLOMA IN SCIENCE at the successful completion of Second year (Four Semesters) of the Four Years Multidisciplinary Undergraduate Degree Programme.	100 credits
BACHELOR OF SCIENCE DEGREE at the successful completion of Three year (Six Semesters) of the Four Years Multidisciplinary Undergraduate Degree Programme.	142 credits
BACHELOR OF SCIENCE DEGREE WITH HONOURS IN ENVIRONMENTAL SCIENCE at the successful completion of Four year (Eight Semesters) of the Four Years Multidisciplinary Undergraduate Degree Programme.	184 credits

A student will be allowed to enter/re-enter only at the ODD semester and can only exit after EVEN semester. Re-entry at various as lateral entrants in academic programmes based on the above mentioned earned credits and proficiency test records.

The validity of the earned credit will be for a maximum period of seven years or as specified by the Academic Bank of Credits (ABC).

Emphasis is given on Continuous Internal Assessment (CIA) with Higher order thinking skills (40%:60% - 40% CIA and 60% End Semester Examination) for theory course and 50%:50% - End Semester Examination and CIA for Laboratory work, Field works, Project, Internship and Educational visits.

MODEL CURRICULUM

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

Discipline Core: **Environmental Science**

Total Credits for the Programme: **184**

Starting year of implementation: **2021-22**

Programme Outcomes:

By the End of the Programme the students will be able to develop:

1. Disciplinary knowledge in fields related to Environmental Science
2. Systemic and critical thinking with reference to environment-people-economic-development attributes
3. Problem identification skills and sustainable solution provisioning
4. Analytical reasoning and appropriate interpretation skills
5. Self-directed learning efficiencies leading to a productive lifelong learning process
6. Research-related skills such as review of literature, design of experiments, statistical competence, report writing and prepare target specific communication packages
7. Cooperation/Team work
8. Reflective thinking
9. Multidisciplinary competence catering to environmental sustainability

Assessment:
Weightage for assessments (in percentage)

Type of Course	Formative Assessment/IA	Summative Assessment
Theory	**40**	**60**
Practical	**25**	**25**
Project/Experiential Learning (Internship etc.)	**Report = 50** - Relevance of the topic = 05 - Robustness of literature review = 10 - Appropriateness of Methodology = 10 - Results, Discussion and Interpretation = 20 - Referencing and citation = 05	**Viva-voce = 50** - Presentation skills = 25 - Question answer = 25

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	Env. Science A1 (4+2) Other Core B1 (4+2)	Open Elective - 1 (3)	L1-1 (3) L2-1 (3) (4 hours each)	Environmental Studies (2)	SEC-1 Digital Fluency (2) (1+0+2)	Physical Education for fitness (1) (0+0+2)	Health & Wellness (1) (0+0+2)	25
II	Env. Science A2 (4+2) Other Core B2 (4+2)	Open Elective - 2 (3)	L1-2 (3), L2-2 (3), (4 hours each)			Physical Education – Yoga (1) (0+0+2)	NCC/NSS/R&R (S&G)/Cultural (1) (0+0+1)	25
Exit option with Certificate in Science (50 credits)								
III	Env. Science A3 (4+2) Other Core B3 (4+2)	Open Elective - 3 (3)	L1-3 (3) L2-3 (3) (4 hours each)	-	SEC-2: Artificial Intelligence (2) (1+0+2)	Physical Education – Sports (1) (0+0+2)	NCC/NSS/R&R (S&G)/Cultural (1) (0+0+1)	25
IV	Env. Science A4 (4+2) Other Core B4 (4+2)	Open Elective - 4 (3)	L1-4 (3) L2-4 (3) (4 hours each)	Constitution of India (2)	-	Physical Education – Games (1) (0+0+2)	NCC/NSS/R&R (S&G)/Cultural (1) (0+0+1)	25
Exit option with Diploma in Science (100 credits) OR Choose any one of the core subjects as Major and other as Minor								

V	Env. Science A5 (3+2) Env. Science A6 (3+2) Other Core B5 (3+2)	Vocational course - 1 (3)	-	-	SEC - 3: SEC such as Cyber Security (2) (1+0+2)	-	-	**20**
VI	Env. Science A7 (3+2) Env. Science A8 (3+2) Other Core B6 (3+2)	Vocational course - 2 (3) Internship (2)	-	-	SEC-4: Professional communication (2)	-	-	**22**
Exit option with Bachelor of Science, B.Sc. Degree in Environmental Science (142 credits) OR continue studies with Major in the fourth year								
VII	Env. Science A9 (3+2) Env. Science A10 (3+2) Env. Science A11 (3)	Env. Science Elective - 1 (3) Env. Science Elective - 2 (3) Research Methodology (3)	-	-	-	-	-	**22**
VIII	Env. Science A12 (3+2) Env. Science A13 (3) Env. Science A14 (3)	Env. Science Elective - 3 (3) Research project (6)*	-	-	-	-	**-**	**20**
Award of Bachelor of Science Honors Degree, B.Sc. (Hons.) Degree in Environmental Science (184 credits)								

Note: *L+T+P= Lecturing in Theory + Tutorial + Practicals.

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

Numbers in the parenthesis refer to credits.

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
1	**ES 1T1 – DIVISIONS OF ENVIRONMENT (4)**	Have developed knowledge and understanding of the Divisions of the Environment and able to appreciate the holistic relationship between them.	PUC or equivalent in Science subjects	Theory and course projects	Continuous Internal Assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	ES 1P1 – WATER QUALITY ANALYSIS (2)	Be able to analyze the vital physicochemical parameters of water, interpret and suggest suitable treatment methods.		Hands-on-training	
	ES 1OE1 – ENVIRONMENTAL CONSERVATION MOVEMENTS (3) OR ES 1OE1 – ENVIRONMENTAL POLLUTION (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	

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course (s)	Pedagogy	Assessment
2	**ES 2T1 – ECOLOGY – THEORY AND PRACTICE (4)**	Have developed sound knowledge of Basic and Applied Ecology.	-	Theory, case studies and course projects	Continuous Internal Assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	ES 2P1 – ECOLOGICAL ANALYSIS (2)	Be able to Identify and Enumerate Planktons, Estimate the Primary Productivity of an Aquatic Ecosystem, study the characteristics of a Biotic Community; Be able to Compute Carbon Sequestration of trees.		Hands-on-training	
	ES 2OE2 – CLIMATE CHANGE AND ITS IMPLICATIONS (3) OR ES 2OE2 – ENVIRONMENT AND PUBLIC HEALTH IN CONTEMPORARY SOCIETY (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 Certificate in Science (50 credits)

Job opportunities for the Exit option with Certificate

- Sampling Assistant in wastewater treatment plants
- Analytical Assistant/Intern analyst in water testing laboratories
- Laboratory instructor in in educational institutions
- Field Technician in mobile environmental laboratories
- Field Technician in Research institutions/NGOs involved in environmental monitoring/carbon credit establishment/productivity studies.
- Sampling and execution assistant in environmental auditing
- Garden/nursery Supervisor/Entrepreneurship
- NGOs/Consultancy firms
- Self-employment

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	

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 analyse the behaviour of local weather patterns by monitoring meteorological parameters. Develop wind and pollution roses; analyse 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

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course (s)	Pedagogy	Assessment
5	**ES 5T1 – ENVIRONMENTAL MICROBIOLOGY, ENVIRONMENTAL BIOTECHNOLOGY, ENVIRONMENTAL STATISTICS (3)**	Have developed knowledge and understanding of Environmental Microbiology, Environmental Biotechnology and Environmental Statistics.	Diploma in Science with Environmental Science as a subject and a total credit score of 100	Theory and statistical practices	Continuous internal assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	ES 5P1 – ENVIRONMENTAL MICROBIOLOGY, ENVIRONMENTAL BIOTECHNOLOGY, ENVIRONMENTAL STATISTICS (2)	Be able to culture and identify Bacteria and Fungi; be able to detect the fecal contamination drinking water; have knowledge and understanding of the Plant-Microbial Symbiosis and able to apply Statistical methods.		Hands-on-training and statistical practices	
	ES 5T2 – AIR POLLUTION, WATER POLLUTION AND ENVIRONMENTAL ENGINEERING (3)	Have developed knowledge and understanding of Air, Water and Land Pollution and Application of Control Measures.		Theory, Self-study and Case studies	

	ES 5P2 – AIR AND WASTEWATER ANALYSIS (2)	Be able to analyze vital parameters of Wastewater, interpret and suggest suitable treatment methods, analyze vital Air Pollutants, interpret and suggest suitable control methods.		Hands-on-training	
	ES 5V1 – ENVIRONMENTAL CHEMISTRY AND INSTRUMENTATION (3) **OR** **ES 5V1 – URBAN WASTE AND HAZARDOUS WASTE MANAGEMENT (3)**	Have developed knowledge and skills on chemistry of environmental pollution, principles of chemistry employed in treatment and mitigation mechanisms. Be able to understand the governing principles of analytical procedures like titrimetry, gravimetry, spectrophotometry, Flamephotometry and atomic absorption spectroscopy. Have developed knowledge and skills on chemistry of environmental pollution, principles of chemistry employed in treatment and mitigation mechanisms. Be able to understand the governing principles of analytical procedures like titrimetry, gravimetry, spectrophotometry, Flamephotometry and atomic absorption spectroscopy. **OR** Have developed knowledge of quantification and characteristics of urban and hazardous waste and their management. Be able to understand the handling techniques and legislations governing wastes.		Theory and seminar/term paper	

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course (s)	Pedagogy	Assessment
6	**ES 6T1 – NOISE, LAND, RADIATION POLLUTION AND SOLID WASTE MANAGEMENT (3)**	Have developed knowledge and understanding of Noise, Land, Radiation Pollution and Solid Waste Management	-	Theory, Self-study and Case studies	Continuous internal assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	ES 6P1 – SOIL ANALYSIS, NOISE MEASUREMENT AND SOLID WASTE (2)	Be able to Analyze noise levels, identify and categories land pollution and be capable of developing a solid waste management plan for urban areas.		Hands-on-training	
	ES 6T2 – ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL RISK ASSESSMENT (3)	Have developed knowledge and understanding of various process involved in Environmental Impact Assessment, be able to employ assessment techniques and analyse the reports. Have developed knowledge to enable identification of risk perception and implement assessment protocols.		Theory, Self-study and Case studies	
	ES 6P2 – METHODS OF ENVIRONMENTAL IMPACT AND RISK ASSESSMENT (2)	Be able to make appropriate choices of impact identification methodologies such as checklist and matrices. Be able to compile the collected data, suggest suitable amelioration measures and develop monitoring protocols.		Hands-on-training	
	ES 6V1 – INDUSTRIAL WASTEWATER TREATMENT (3) **OR** **ES 6V1 – DISASTER MANAGEMENT (3)**	Have developed knowledge and managerial skills of industrial wastewater treatment facilities. Be able to understand the legal stipulations of pollution control boards and develop abilities to handle regular reporting protocols. **OR** Have developed knowledge and understanding of natural and man-made disasters, reasons for their occurrence, prevention and management techniques. Be aware of emergency response protocols and be available in case of emergencies.		Theory and seminar/term paper	

Exit option with Bachelor of Science, B.Sc. Degree in Environmental Science (142 credits) or continue studies with Major in the Fourth year
Job opportunities for the Exit option with Bachelor of Science Degree
• Assistants in Central and State Pollution Control Boards • Environmental Health and Safety Assistant in industries • Occupational Health and Safety Assistant in industries/theme parks • Public Health/Waste Management Officers in Municipalities • Wastewater Treatment Plant Managers • Environmental/Production Quality Assurance Executive - Junior • Environmental Analyst (Validation) • Research Assistant/Staff • R&D Lab Assistant • Water testing labs or chemical suppliers/ Entrepreneurship • Liaison Officer • Watershed Management Assistant • Mineral/Energy Resource Exploration Assistant • Solar energy/alternate energy Executives • Micro irrigation Executives • Organic Farming Executives/Entrepreneurship • NGOs/Consultancy firms • Teachers in Schools • Self-employment

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course (s)	Pedagogy	Assessment
7	**ES 7T1 – ENVIRONMENTAL TOXICOLOGY (3)**	Have developed knowledge on the behaviour of environmental contaminants and xenobiotics. Have an understanding of bioassay test procedures/experimental designs of toxicity studies.	B.Sc. in Science with Environmental Science as major subject and a total credit score of 142	Theory, Self-study and Case studies	Continuous internal assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	ES 7P1 – BIOASSAY, ACUTE AND SUB-ACUTE TOXICITY TESTS (2)	Be able to setup simple bioassay test procedures leading to LD50, LC50 assessments.		Hands-on-training	
	ES 7T2 – APPLICATIONS OF REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEMS (3)	Have understood the techniques involved in remote data collection, their applications in land-use, resource distribution, pollution and wildlife studies. Get an introduction to select GIS software.		Theory, Self-study and Case studies	
	ES 7P2 – CARTOGRAPHY AND GEOGRAPHICAL INFORMATION SYSTEMS (2)	Have developed knowledge, understanding and skills of handling cartographic and remote sensing data. Be able to digitize basic environmental data using GIS tools.		Hands-on-training	
	ES 7T3 – OCCUPATIONAL HEALTH AND SAFETY (3)	Have developed knowledge of work environments, understand exposure risks and have an exposure to legal requirements.		Theory, Self-study and Case studies	
	ES 7E1 – LANDSCAPE ECOLOGY AND URBAN PLANNING (3)	Have developed knowledge and understanding of landscape ecology and urban planning. Be able to develop need based and dynamic urban planning protocols to reduce energy demands, waste generation and facilitate smart city initiatives.		Theory and seminar/term paper	
	ES 7E2 – ENVIRONMENTAL CONTAMINATION AND REMEDIATION TECHNOLOGIES (3)	Have developed knowledge and understanding of the types and dynamics of environmental contamination. Be able to choose and employ appropriate remediation technologies from the available physical, chemical and biological remediation technologies.		Theory and seminar/term paper	
	ES 7R1 – RESEARCH METHODOLOGY (3)	Have enhanced knowledge and understanding of various research techniques leading to applied research. Will develop skills of handling statistical and data interpretation tools.		Theory and seminar/term paper	

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course(s)	Pedagogy	Assessment
8	**ES 8T1 – CLIMATE CHANGE AND MITIGATION (3)**	Have developed knowledge and understanding of meteorology, climatology and understand dynamics of factors leading to climate change and related knowledge systems. Be able to critically analyse various climate mitigation and adaptation measures.	-	Theory, Self-study and Case studies	Continuous internal assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	ES 8P1 – CLIMATE CHANGE ANALYSIS (2)	Have developed knowledge, understanding and skills of handling global and regional climate data. Be able to collate, analyse and interpret using appropriate tools.		Hands-on-training	
	ES 8T2 – ENVIRONMENTAL ECONOMICS, SUSTAINABLE DEVELOPMENT, BUSINESS AND ENTREPRENEURSHIP (3)	Have developed knowledge and understanding of Environmental Economics, Sustainable Development and SDGs. Get an exposure to the characteristics of an entrepreneur, understand green business models and the details of Corporate Social Responsibility (CSR).		Theory, Self-study and Case studies	
	ES 8T3 – ENVIRONMENTAL POLICY, LAW AND ENVIRONMENTAL MANAGEMENT SYSTEMS (3)	Have developed knowledge and understanding legal implications of environmental protection legislations of India. Get an exposure to environmental audit and Environmental Management Systems.		Theory, Self-study and Case studies	
	ES 8E3 – QUALITY ASSURANCE AND QUALITY CONTROL IN ENVIRONMENTAL ANALYSIS (3)	Have developed knowledge of total quality management protocols and develop skills of monitoring and interpreting industrial reporting procedures.		Theory and seminar/term paper	
	ES 8R1 – RESEARCH PROJECT (6)	Have developed skills in Research Methodology, able to frame research query, develop methodology, Analyze the data, interpret the results and suggest suitable solutions and recommendations. Also will develop report writing skills, research ethics, use of reference organizing software and anti-plagiarism databases.		Hands-on training	

Award of Bachelor of Science Honors Degree, B.Sc. (Hons.) Degree in Environmental Science (184 credits)
Job opportunities for the B.Sc. (Hons.) Degree in Environmental Science
• Scientific Assistant in Research institutions • Scientists in Central and State Pollution Control Boards • Environment Health and Safety Officer in industries • Environmental auditor I/Auditor II • Environmental/Production Quality Assurance Officer • Wastewater Treatment Plant Managers • Sanitary landfill and Hazardous Waste Handling Experts • Toxicology specialist • Forensic Scientist • Quality Control Executive • Regulatory Affairs/Liaison Officer • NGOs/Consultancy firms • Project and Planning and Development Departments • Watershed Management Professional • Teachers in Schools • Self-employment

ONE YEAR M.Sc. DEGREE FOR STUDENTS WITH B.Sc. (Hons.) DEGREE

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course(s)	Pedagogy	Assessment
9	**MES 1T1** – Ecology and Ecosystem services	Provides a holistic knowledge of ecology and sustainability for a student who has a Science degree. Emphasise their interrelatedness and significance.	1. B.Sc. (Hons.) with total credit score of 184 2. B.Sc. in Agriculture/ Forestry/ Horticulture/Life Science 3. B.E/B.Tech in Environmental/ Civil Engineering 4. B.E/B.Tech in Architecture 5. B.E/B.Tech in Urban/Regional Planning	Theory, Self-study and Case studies	Continuous internal assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	MES 1P1 – Ecology and Sustainability Studies	Introduces ecological methods, ecosystem services and sustainability evaluation methods		Hands-on-training	
	MES 1T2 – Environmental Sustainability and Pollution Prevention	Introduces problems of pollution and their impacts on sustainability. Exposes to real life situations in the form of case studies.		Theory, Self-study and Case studies	
	MES 1P2 – Pollution analysis	Develops the skills of identifying specific pollution parameters and their analysis		Hands-on-training	
	MES 1T3 – Climate Change Impacts and Resilience	Emphasises the role of lifestyles towards developing a climate resilient population and economy		Theory, Self-study and Case studies	
	MES 1P3 – Climate Change Assessments	Develops the skill of identifying, prioritising and assessing climate change parameters		Hands-on-training	
	MES 1T4 – Waste Management and Sustainability	Introduces the waste scenario with reference to economic and social paradigms. Provides methods of managing the resources sustainably.		Theory, Self-study and Case studies	
	MES 1P4 – Waste management methods	Develop skills required for managing different kinds of wastes.		Hands-on-training	
	MES OE1 – Global Environmental Concerns **OR** **MES OE1** – Natural Resources Management	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	

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course (s)	Pedagogy	Assessment
10	**MES 2T1** – Smart Cities and Sustainability	Introduces the concept of smart cities, their viability and their role in establishing sustainable economies.	-	Theory, Self-study and Case studies	Continuous internal assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	MES 2P1 – Case studies	Provides the real life perspective of smart cities, resource management patterns leading to empowerment in decision making.		Situational analysis and interpretation	
	MES 2T2 – Environmental Modelling	Introduces the concept of environmental modelling involving resource utilization modelling and pollution modelling.		Theory, Self-study and Case studies	
	MES 2P2 – Computational analysis and Environmental Modelling	Develops skills of environmental modeling and provides a hands-on exposure of modeling software.		Hands-on-training	
	MES 2T3 – Corporate Environmental Sustainability and Environmental Social Governance	Provides a corporate/ industrial view of environment and sustainability. Helps in understanding the corporate pressures yet emphasizing on sustainable Development.		Theory, Self-study and Case studies	
	MES 2P2 – Case studies	Provides the real life perspective of smart cities, resource management patterns leading to empowerment in decision making.		Suitability and Feasibility analysis	
	MES 2T4 – Research Project	Have developed skills in Research Methodology, able to frame research query, develop methodology, Analyze the data, interpret the results and suggest suitable solutions and recommendations. Also will develop report writing skills, research ethics, use of reference organizing software and anti-plagiarism databases.		Hands-on training	
	MES OE2 – Environmental Pollution and Sustainable Development **OR** **MES OE2** – Wildlife Management and Eco-tourism	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	

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 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 interrelatedness of the divisions of the Environment.
PSO 2	To instill an introductory knowledge of the divisions of Environment and develop necessary analytical skills to characterise their variations.
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 environmental divisions and associated processes.
PO 2	Demonstrate the ability to carry out water quality analysis in the laboratory and interpret the results.
PO 3	Ability to understand and appreciate the role of environmental parameters in specific day-to-day activities.
PO 4	Be able to understand the demands and function in work environment dealing with environmental systems

Content of Theory Course 1	52 Hours
Unit - 1	**08**
Environmental Education: Definition, Aim, Objectives and Scope. Environmental Science: Definition, Aim of study and Scope. Differences between Ecology and Environmental Science; Various approaches of studying Environmental Science. Components of the Environment: Definitions of Atmosphere, Hydrosphere, Lithosphere and Biosphere - their complex interactions and significance.	
Unit - 2	**16**
Atmosphere: Evolution of the atmosphere – Principal components – Permanent and variable gases. Structure of the atmosphere on the basis of temperature and composition. Ozone chemistry - Depletion and recovery of stratospheric ozone – monitoring, effects and control measures. Climatology: Differences between weather and climate; Insolation - Factors affecting the distribution. Solar (short-wave) and terrestrial (long-wave) radiations. 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.	
Unit - 3	**14**
Hydrosphere: Hydrologic cycle - process of heat energy transfer - Radiation, Conduction and Convection. Types of lifting and precipitation - Bergeron process – Cloud formation and classification. Forms of condensation; Forms of precipitation. 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; ocean currents and tides –significance; Polymetallic nodules. Ground water: Definition. Zonation; Types of wells. Salinization of ground water in coastal regions.	

Unit - 4	14
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. Types – Alluvial; Black; Red and Laterite; Arid and Desert; Saline and Alkaline; Peaty and Marshy; Grassland, Forest and Mountain Soils. A brief account of Soil biota. Soil weathering and erosion – Types, effects and management.	

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Wright, R. T. (2007). *Environmental science: toward a sustainable future*. Jones & Bartlett Publishers.

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

Date Course Co-ordinator Subject Committee Chairperson

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 – pH metric method
3. Determination of Electrical Conductance – Conductivity meter method
4. Estimation of Turbidity – Nephelometric method
5. TS, TSS & TDS – Gravimetric and Filtration method
6. Estimation of Acidity – Alkalimetric method
7. Estimation of Alkalinity – Acidimetric method
8. Estimation of Hardness – EDTA Complexometric method
9. Estimation of Chlorides – Argentometric method
10. Estimation of Dissolved Oxygen – Modified Winkler's method
11. Estimation of Nitrates – Phenoldisulfonic Acid method
12. Estimation of Fluorides – Fluoride meter method/SPADNS Reagent method
13. Estimation of Sulphates – Barium chloride method

References

Nandini, N. (2009). *Handbook on water quality monitoring and Assessment*. Sapna Book House, Bengaluru.

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Standard Methods for Examination of Water and Wastewater. (2017). APHA – WEF.

Trivedi, P. K. and Goel, P. K. (1984). Che*mical and Biological Methods of Water Pollution Studies*. Environmental Publication.

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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)

Nandini .N.

Date Course Co-ordinator Subject Committee Chairperson

ES 1OE1: ENVIRONMENTAL CONSERVATION MOVEMENTS

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

Content of OPEN ELECTIVE Theory Course 1	**42 Hours**
Unit - 1	**14**
Environment: Definition, role of environment in shaping civilisations. Interrelations between civilisation and environment – ecological economic and socio-cultural. Industrial revolution and environmental pollution. Globalisation and environmental pollution. Modern agriculture and environmental degradation. Development: Definition, Growth and development. Population growth and its impact on natural resources, Modernization and population. Causes for industrialization, changing life styles, regulatory aspects of industrialization, overall impact of industrialization on quality of human life, negative impacts of industrialization and urbanization.	
Unit - 2	**14**
Development and Environment: Types of development. Sustainable development – Need, relevance in contemporary society. Principles of Sustainable Development: History and emergence of the concept of Sustainable Development, Definitions, Environmental issues and crisis, Resource degradation, greenhouse gases, desertification, invasive species, wildlife depletion and social insecurity. United Nations Sustainable Development Goals. Strategies for implementing eco-development programmes, Sustainable development through - trade, economic growth, carrying capacity and public participation.	
Unit - 3	**14**
People movements: Types – Concept of environmental movements, Definition, levels of collective action, the local grassroots movement level; the social movement level; a cycle of protest. Environmental Movements: United Nations Conference on Human Environment, 1972 – 'Limits to Growth'. The Brundtland Commission, 1987 – 'Our Common Future'. The United Nations Conference on	

Environment and Development, 1992. Environmental Movements of India: Bishnoi Movement, The Chipko Movement, Appiko Movement, Silent Valley Movement, Narmada Bachao Andolan, Jungle Bachao Andolan, Beej Bachao Andolan. Urban-based Environmental Movements – Local case studies.	

References

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Climate Change: Science and Politics. (2021). *Centre Science and Environment*, New Delhi.

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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)

Nandini .N.

Date Course Co-ordinator Subject Committee Chairperson

ES 1OE1: ENVIRONMENTAL POLLUTION

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

Content of OPEN ELECTIVE Theory Course 1	**42 Hours**
Unit - 1	**14**
Environmental pollution: Definition, Types. Environmental contaminants and environmental pollutants. Classification of pollutants – on the basis of physical properties and forms of their existence. Primary and secondary pollutants, degradable and non-degradable, point and non-point sources of pollution. Xenobiotics and persistent organic chemicals. Characteristics of pollution – Large production quantities, usage involving leakages, toxicity, persistence and accumulation. Air pollution: Definition, sources of air pollution and their effects on flora, fauna, human-beings and materials. Indoor pollution, automobile pollution, ozone depletion and recovery, global warming and climate change. London smog, Bhopal gas tragedy, Visakhapatnam gas leak and endosulphan tragedy in Karnataka. Air quality standards – NAAQS, AQI, Bharat Stage - VI Emission standards. Air pollution control measures.	
Unit - 2	**14**
Water pollution: Definition, sources of water pollution and their effects on flora, fauna, human-beings and materials. Surface water pollution – Dissolved oxygen, biochemical oxygen demand and chemical oxygen demand. Agriculture runoff and detergents as pollutants. Eutrophication. Heavy metal pollution – Minamata episode. Ground water pollution – fluoride, nitrate, Arsenic pollution and their control. Water quality criteria – specifications for drinking and inland surface waters. Water Quality Indices. Soil pollution: Definition, sources and types. Soil pollutants – metals, inorganic ions and salts; and organic substance. Effects of pollution on soil health and productivity. Effects of pesticides on soil. Soil erosion, types and control.	
Unit - 3	**14**
Noise pollution: Definition, sources and effects. Noise induced hearing loss. Decibel scale. Noise control measures.	

Solid waste pollution: Definition, origin, classification and characteristics of solid waste. Segregation, collection, transportation and disposal of solid waste. Solid waste treatment and disposal – Composting, open dumping, sanitary landfill, incineration, recycling and recovery. E-waste: Definition, sources, composition, recycling and disposal methods. Hazardous waste: Definition, sources, classification, effects and disposal methods.	

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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)

Nandini N.

Date Course Co-ordinator Subject Committee Chairperson

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

Title of the Course: **ES 2T1 - 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 principles governing the biosphere.
PSO 2	To instill a knowledge of the Ecology and develop necessary analytical skills 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 system dynamics in specific habitats/agroecosystems.
PO 4	Be able to understand the demands and function in work environment dealing with environmental systems.

Content of Theory Course 2	**52 Hours**
Unit - 1	**14**
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. 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	**14**
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.	
Unit - 3	**14**
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.	
Unit - 4	**14**
Biotic and Abiotic factors: Influence 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. Evolution: Definition – Darwin's postulates - Natural selection – Types – Industrial Melanism - Pesticide resistance. Co-evolution; Mimicry – Batesian and Mullerian mimicry, warning colouration.	

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Smith, T. M. and Smith, R. L. (2007). *Elements of Ecology*. Pearson Education.

Taylor, T. J., Green, N. P. O. and Stout, G.W. (1998). *Biological Science* Soper, R. (ed.). Cambridge University Press.

Wallace, R. A. (1990). Biology – *The World of Life*. Harper Collins Publications.

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

Nandini N.

Date Course Co-ordinator Subject Committee Chairperson

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 of phytoplankton
2. Sampling technique of zooplankton
3. Quantitative estimation of phytoplankton – Sedgwick-Rafter method
4. Quantitative estimation of zooplankton – Sedgwick-Rafter method
5. Determination of organic pollution – Palmer's Algal Pollution index
6. Estimation of primary productivity of a pond – Light and Dark bottle method
7. Estimation of primary productivity of terrestrial vegetation – Chlorophyll method
8. Estimation of primary productivity of grasses – Harvest method
9. Study of plant community – Individual count method/Quadrat method
10. Study of animal community – Line transect method
11. Determination of species diversity indices –Simpson and Shannon's Wiener Index
12. Estimation of carbon capture and storage of trees
13. Identification of ecological indicators

References

Michael, P. (1986). Ecological Methods for Field and Laboratory Investigations. Tata Mc Graw-Hill Publishing Co. Ltd.

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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)

Nandini .N.

Date Course Co-ordinator Subject Committee Chairperson

ES 2OE2: CLIMATE CHANGE AND ITS IMPLICATIONS

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

Content of OPEN ELECTIVE Theory Course 2	**42 Hours**
Unit - 1	**14**
Climate Change: Definition, scope and facts of climate change. Origin and evolution of the earth's atmosphere. Composition and thermal structure of atmosphere; Weather and climate; Meteorological parameters - temperature, pressure, precipitation, humidity, wind speed & direction. Introduction to the effects of various anthropogenic activities on earth's atmosphere. Monsoons – Definition, Indian monsoons – seasons: Cold weather season (Winter), the hot weather season (Summer), season of advancing monsoon (The rainy season) and season of retreating monsoon (The transition season). Cyclones of the Indian region; El-Niño, La Nina and their impacts.	
Unit - 2	**14**
Greenhouse effect and global warming: Definition, impacts, major greenhouse gases, sources and sinks of greenhouse gases; Urban Heat Islands; Ozone layer depletion and recovery, issues and remedies; ground level ozone and air pollution; global dimming. Carbon footprint. Impacts of global climate change: Increased surface mean temperature, insect outbreaks, vector borne/zoonotic diseases, forest fire, reduced water availability, influence on agriculture, increase in floods and drought incidences, loss of biodiversity and extinction of species, sea level rise. Climate change and food security. Vulnerable populations – The Kiribati story.	
Unit - 3	**14**
Climate change and policy frameworks – History of international climate change policies. United Nation Framework Convention on climate change (UNFCCC), The United Nations Conference on Environment and Development, Intergovernmental Panel on Climate Change (IPCC), Ministry of Environment, Forests & Climate Change (MoEF&CC), National Action Plan on Climate Change (NAPCC), Agenda 21, The Kyoto protocol, Paris agreement. Overview of Conference of Parties (CoP). Evolution of climate change negotiations. Climate change adaptation and mitigation: Definition, scope and	

objectives. Linkages between development, climate change impacts, their mitigation and adaptation. Clean Development Mechanisms; Green Climate Fund, The Adaptation Fund. United Nations Sustainable Development Goals. Role of individuals in achieving Sustainable Development Goals.	

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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)

Nandini.N.

Date Course Co-ordinator Subject Committee Chairperson

ES 2OE2: ENVIRONMENT AND PUBLIC HEALTH IN CONTEMPORARY SOCIETY

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

Content of OPEN ELECTIVE Theory Course 2	**42 Hours**
Unit - 1	**14**
Environment and public health: Definitions of health and disease. Perspectives on individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health. Effect of quality of air, water and soil on human health. Diseases in contemporary society: Need for good health - factors affecting health. Types of diseases - deficiency, infection, pollution diseases - allergies, respiratory, cardiovascular and cancer. Personal hygiene- food-balanced diet. Health effects of smoking, drugs and alcohol consumption.	
Unit - 2	**14**
Malnutrition: Vitamin deficiency diseases and Mineral deficiency diseases; Folic acid requirement during pregnancy; Food Safety- Adulterants and preservatives; Pesticide Toxicity: Endosulfan and DDT; Genetically Modified Food. Non-communicable diseases and Lifestyle diseases - Diabetes and Hypertension. Communicable diseases: Definition, mode of transmission – pandemic, epidemic and endemic diseases. Vector borne diseases: Plauge and Malaria; emerging diseases: Dengue, Chikungunya, Zika, Ebola, Swine Flu, Bird Flu, Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS); Zoonosis-Leptospirosis; Kyasanur Forest Disease (KFD) Toxoplasmosis and Nipah.	
Unit - 3	**14**
Occupational health: Sick Building Syndrome; Noise and Radiation; Ergonomics - Stress and Fatigue; Carpal tunnel syndrome (CTS); Methyl mercury and cerebral palsy; Synergistic effect; Irritable bowel syndrome; Crohn's disease. Environmental Sanitation and Hygiene: Safe disposal of human excreta; Solid waste disposal; Sanitation value chain. Drug safeties: Thalidomide Tragedy; Antibiotic stewardship; New Delhi Antibiotic-Resistant superbug.	

References

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Walton, M. (2017). *One Planet, One Health*. Sydney University Press.

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

Nandini N.

Date Course Co-ordinator Subject Committee Chairperson

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/semester
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 utilisation 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.

Content of Theory Course 3	**52 Hours**
Unit - 1	**14**
Resource: Definition; Resource and wealth. Functional theory of resource and dynamic theory of resource. Classification of resources - Organic and inorganic resources; exhaustible and inexhaustible resources; International, National and Individual resources; Ubiquitous and localised resources. Factors influencing resource availability, distribution and utilisation	

patterns - Nature, Culture and Man. Phantom pile concept. Resources scarcity: Definition; types of resources scarcity - Demand-induced, supply-induced, and structural. Conservation of resources: Methods of conservation - Refuse, reduce, reuse, recycle and recovery - Methods of waste reduction (Increasing the durability of products, utilising material substitution, recycling and marketability of industrial waste). Case studies on energy and paper conservation. Natural Resources: Definition, Classification of natural resources based on utility potential.	
Unit – 2	**14**
Water Resources: Fresh water - Water budget of India - Dams: Impact on environment – alternatives; Droughts and Floods: Causes and Control Strategies – Watershed Management; Rain Water Harvesting and ground water recharge; River linking – pros and cons. Marine water – Ocean as a resource - Fisheries, aquaculture – prawns and oysters - Transportation – Shipping (people, goods and oil) and its impacts - Desalinisation – Importance and impacts - Coastal erosion and reclamation - Coastal Regulation Zone (CRZ) Ground Water: Impacts of extraction: uplifting and seismic activities, land subsidence, vegetation degradation and food security implications. Water and agriculture: Irrigated and rain-fed cultivation; Types of irrigation. Irrigation and drainage. Nutrient delivery through irrigation. Environmental implications of Conventional Agriculture – Soil degradation, surface and ground water pollution, loss of natural biodiversity, water logging and soil salinity. Hydroponics – 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 utilisation 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 oil exploration. 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)

Date Course Co-ordinator Subject Committee Chairperson

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)

Date Course Co-ordinator Subject Committee Chairperson

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**
Ecology and Environment: Definitions, meaning and significance. Ecosystem: Structure and function. Natural resources – definition, their local availability, harvest and utility. 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. 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 Fertiliser). Conservation of indigenous species. 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. Sustainable Development Goals: Goal No. 5 - Gender equality.	
Unit - 2	**14**
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. Women and resource scarcity: Impacts of Natural resource depletion, Climate change and environmental degradation on women. 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. Climate change and women's health: Vector borne diseases, poor air quality and extreme variance in climatic temperatures (*Anemia, malnutrition and food insecurity - 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). 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**
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). 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). 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). Prominent women environmentalists: Rachel Carson, Wangari Maathai, Gro Harlem Brundtland, Elinor Ostrom, Amritha Devi Bishnoi, Medha Patkar, Sunita Narain, Tulsi Gowda and Saalumarada Thimmakka.	

References

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Breton, M. J. (2016). *Women pioneers for the environment*. Northeastern University 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)

Date Course Co-ordinator Subject Committee Chairperson

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**
Disasters: Definition, History of disasters; Components of disasters. Weather parameters: Concept, Definition, Units and measurements of Temperature, Pressure, Precipitation (Rain, snow, hail), Wind (Speed and direction) and Relative humidity. 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, Pandemics, Weather Extremes & Climate Change and Wars. Definitions of Risk, Hazard, Exposure, Vulnerability, Response, Mitigation, Preparedness and Prevention. Mitigation and Management techniques of Disaster: Basic principles of disaster management, Disaster Management cycle, Disaster management policy. Disaster Management Authority at National, State and District levels; Roles and responsibilities of Govt. Authorities including Local Self Govt. at various levels.	
Unit - 2	**14**
Natural Disasters Earthquakes - types and causes, magnitude and intensity, seismic zones of India and Karnataka. Earthquake measurements (Richter Scale) and predications. Earthquake preparedness and management. Tropical Cyclones - Types and causes. Cyclone naming. Cyclone prediction, warning, Preparedness and Management. Floods - Types and causes, Flash floods. Cloud bursts, Floods warning, Preparedness and Management. Land subsidence - Types and causes, Landslides and Mudslides and Avalanches. Land subsidence preparedness and management.	

Tsunami - types and causes. Tsunami prediction, warning, preparedness and management. Heat waves and Cold waves – Causes and effects, Warning, preparedness and management. Locust attacks – Causes and effects Preparedness and management.	
Unit - 3	**14**
Man-made disasters Nuclear disaster: Chernobyl and Fukushima - Episode and effects. Exxon Valdez oil spill - Episode, effects and management. Indonesia's land and forest fires – Episode, effects and management. Bhopal Gas Tragedy - Episode, causative agent, effects and recovery. Damage and compensation. Visakhapatnam gas leak - Episode, causative agent and effects. Damage and compensation. Endosulfan disaster in Karnataka and Kerala - Episode and effects. Damage and compensation. Ennore oil spill - Episode and effects. Uttarakhand and Kerala floods - Episode, effects and management. Kodagu Landslides/Recent/Local episodes, effects and management Bandipura Forest fires/Recent/Local episodes, effects and management. Bengaluru Urban floods/Recent/Local episodes, causes, effects, and management. Epidemics, Pandemics and Zoonoses.	

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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)

Date Course Co-ordinator Subject Committee Chairperson

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

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

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 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.

Content of Theory Course 4	**52 Hours**
Unit - 1	**14**
Biodiversity: Definition: Levels of Biodiversity - genetic diversity, species diversity and ecosystem diversity. Values of Biodiversity: Direct uses - 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 centers. Biogeography of India. Biodiversity profile of India: Forests and Grasslands; Wetlands and	

Riverine ecosystems; Marine and coastal diversity; Agrobiodiversity; Urban Biodiversity; Invasive Alien species. Threats to biodiversity: Over exploitation, Habitat destruction, fragmentation, urbanisation, agriculture extension, river valley projects, industrialisation, 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. 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**
Wildlife: Definition. Wildlife of India. Values of wildlife. Values of wildlife: - *Physical utility, economic/monetary value, recreational value, scientific value, ecological value, existence value.* - *Wildlife damage, human animal conflict, loss of economic productivity, wildlife diseases to man and competition effect*. Importance of wildlife: Ecological, economic, socio-cultural, investigatory, medicinal, conservation of biological diversities, importance in agriculture. Threats to wildlife: Over exploitation, habitat loss, encroachment and fragmentation, disease, pollution, invasive and exotic species, Illegal trapping and poaching, agricultural/unrestricted/ over grazing, urbanisation and climate change. Endangered species – Definition, characteristics and reasons for engendering. *Species with a narrow (or single) geographic range, Species with only one or few populations, Species with a small population size, Species with a declining population size, Species hunted or harvested by people, Species with low reproductive ability and/or germplasm-dispersal-ability, Species that require specialised habitat and niche conditions*. Endangered species of India. Endemic species – Concept, types, characteristics, theories of endemism. Endemic Wildlife Species of India. Wildlife (Protection) Act, 1972.	
Unit - 3	**14**
Ecosystem Services: Concept and Definition. Regulating services: *Purification of water and air; Carbon sequestration and climate regulation; Waste decomposition and detoxification; Regulation of prey*	

populations; Pollination; Biological pest and disease control; Disturbance regulation (Flood protection). Provisioning services: Food *(crops, wild foods and spices);* Raw materials *(Timber, fuelwood, organic matter, fodder, and fertiliser);* Genetic resources *(crop improvement genes, and health care);* Biogenic minerals; Medicinal resources *(Pharmaceuticals, chemical models, and bioassay organisms)*; Energy *(Hydropower, biomass fuels)*; Ornamental resources *(Fashion, handicrafts, jewelry, pets, worship, decoration, and souvenirs)*. Cultural services: Cultural *(Nature motifs in books, film, painting, folklore, national symbols, advertising); Aesthetics,* spiritual and historical *(Art, religious and heritage value);* Recreational experiences *(Ecotourism, outdoor sports and recreation);* Science and education *(Academic excursions and scientific discovery);* Therapeutic *(Ecotherapy, social forestry and animal assisted therapy).* Supporting services: Nutrient cycling, Soil formation, Primary production and Habitat provision.	
Unit - 4	**14**
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. 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 - 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^{+}.	

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)

Nandini.N.

Date Course Co-ordinator Subject Committee Chairperson

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)

Date Course Co-ordinator Subject Committee Chairperson

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**
Environment – Definition, scope and significance. 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. Types of agriculture – rain-fed cultivation and irrigation – water intensive agriculture – Reservoirs and ground water exploitation. Conventional and mechanised agriculture. Natural and chemical agriculture. Subsistence and commercial agriculture. Environmental effects of land use and landscape changes.	
Unit - 2	**14**
Environmental determinants of agriculture – role of rainfall, humidity, wind, topography and edaphic factors in crop selection. Animal husbandry – Dairy and poultry – role of transboundary species of cattle in Indian scenario. Pisiculture – Environmental effects of intensive pisiculture. 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.	
Unit - 3	**14**
Environmental impacts of agriculture – Loss of biodiversity – soil salinity – fertiliser and pesticide pollution, Climate change and global warming. Erosion and problems of deposition in irrigation systems. Desertification. Biomagnification – Case studies. Contemporary issues and management – Farmer distress – market mechanisms – natural farming methods/organic farming. Urban agriculture and hydroponics. Ecological principles of farming – Sustainable agriculture – Significance of indigenous crops and cattle varieties. Watershed management. Agricultural policies of India.	

References

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Satyanarayana, T., Johri, B. N., & Prakash, A. (Eds.). (2012). *Microorganisms in sustainable agriculture and biotechnology*. Springer Science & Business Media.

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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)

Date Course Co-ordinator Subject Committee Chairperson

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**
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. Water and wastewater management: Household water demand and uses. Availability of water for household uses. Centralised supply system – Rivers. Water treatment for portable purposes. Decentralised sources – Bore wells. Sustainable use of water – Reuse and recycling, rooftop rainwater harvesting. Grey water management – Septic tanks. 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. 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. Non- Biodegradable – Issues and management. Segregation – Dry, recyclables and sanitary wastes – Incinerators, pyrolysis and sanitary landfills.	
Unit - 2	**14**
Agriculture: Implications on soil water management – Fertiliser 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. 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 – *Rhizobium*,	

Azotobactor, *Azospirilium*, Blue green algae, *Azolla*, Mycorrhizae. Livestock management: Dung and urine management – Biogas plants, Farm Yard Manure (FYM) and Vermi-composting. 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.	
Unit - 3	**14**
Environmental Management: Definition, need, significance and applications. Environmental Technology vs. Technology for Environment. 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). Factors influencing transfer of Environmental technology - developer to technology user: Information, Research and Marketing. Factors influencing technology development: Localisation, Customisation and Contextualisation. External factors influencing technology transfer: Laws and legislation; Administrative/Management systems; Information management; and Codes and Standards (*Eco-labelling and Green ratings*). 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 ecofriendly and sustainable endeavours.	

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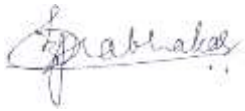
Formative Assessment – Continuous Internal Assessment = 40% (40 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	60% (60 Marks)
Total	100% (100 Marks)

Date Course Co-ordinator Subject Committee Chairperson

Subject Expert Committee Members actively participated in the preparation of proposed curriculum for four years B.Sc. (Basic/Hons.) degree in Environmental Science.

Several meetings were conducted virtually and physically with Environmental Science subject committee experts; and the proposed curriculum was approved by the Chairpersons - Board of Studies and Board of Examiners of various Universities and Colleges of Karnataka State.

NEP 2020 - SUBJECT EXPERT COMMITTEE – ENVIRONMENTAL SCIENCE			
Name	**Designation and address**	**Position**	**Signature**
Members Present			
Dr. N. Nandini	Professor, Department of Environmental Science, Bangalore University, Bengaluru	Chairperson	
Dr. N. S. Raju	Professor, Department of Studies in Environmental Science, University of Mysore, Mysuru	Member	
Dr. S. Suresha	Associate Professor and Head, Department of Environmental Science, Yuvaraja's College (Autonomous), University of Mysore, Mysuru	Member	
Dr. B. S. Prabhakar	Associate Professor and Head, Department of Environmental Science, St. Joseph's College (Autonomous), Bengaluru	Member	
Dr. Jayappa, M.	Special Officer, Karnataka State Higher Education Council, Government of Karnataka	Member Convenor	
Members Absent			
Dr. S. V. Krishnamurthy	Professor, Department of PG Studies and Research in Environmental Science, Kuvempu University, Shankaraghatta	Member	Absent