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BE BOUNDLESS

BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

(Semester Scheme with Multiple Entry and Exit Options for Under Graduate Course)

Syllabus for Environment Science
(I & II Semester)

2021-22 onwards

BENGALURU CITY UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL SCIENCE

PROCEEDINGS OF THE BOARD OF STUDIES (UG) MEETING OF B.Sc. (Basic/Hons.) in ENVIRONMENTAL SCIENCE AND ENVIRONMENTAL STUDIES (AECC) AS PER NEP - 2020

Proceedings of the Board of Studies (UG) meeting of **B.Sc. (Basic/Hons.) in Environmental Science and Environmental Studies (AECC)** as per NEP 2020 for Bengaluru City University, Bengaluru held via Zoom meeting on 22.09.2021 at 10.30 AM for approval of the below agenda.

- NEP 2020 Course pattern and scheme of examination
- NEP 2020 Syllabus of B.Sc. (Basic/Hons.) in Environmental Science
- NEP 2020 Syllabus of AECC Environmental Studies
- Panel of Examiners (UG) in Environmental Science for the academic year 2021-2022.

The BOS (UG) members approved the above agenda after discussion and clarifications. The BOS Chairperson thanked all the members for their cooperation.

Present Members

-sd-	-sd-	-sd-	-sd-
(Dr. Narayana J)	(Dr. N. S. Raju)	(Dr. Ebenezer Wilson)	(Dr. B. S. Prabhakar)
-sd-	-sd-		
(Dr. Helen Rosline)	(Smt. Hemalatha, M.)		

Nandini. N

(Prof. Nandini, N.)
BOS Chairperson (UG) BCU

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BENGALURU CENTRAL UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL SCIENCE

COURSE PATTERN AND SCHEME OF EXAMINATION
for B.Sc. (Basic/Hons.)
as per NEP (2021-22 and onwards)

SUBJECT: Environmental Science

Sl. No.	Semester	Title of the Paper	Teaching Hours	Hours / Week		Examination Pattern Max. & Min. Marks /Paper						Duration of Exam (hours)		Total Marks/paper	Credits	
						Theory			Practical							
				Theory	Practical	Max.	Min.	IA	Max.	Min.	IA	Theory	Practical		Theory	Practical
1	I	**ES 1T1:** Divisions of Environment	54	4	4	70	25	30	35	12	15	3	4	150	4	2
		ES OE 1	45	3	-	70	25	30	-	-	-	3	-	100	3	-
2	II	**ES 1T2:** Ecology - Theory and practice	54	4	4	70	25	30	35	12	15	3	4	150	4	2
		ES OE 2	45	3	-	70	25	30	-	-	-	3	-	100	3	-

Scheme of Internal Assessment Marks: Theory

Sl. No.	Particulars	IA Marks
1	Attendance	**05**
2	Internal Tests (Minimum of Two)	**15**
3	Assignments /Seminar / Case Study / Project work / Reports on - visits to Industries/Exhibitions/Science centres/active participation in Environmental Science competitions, etc.	**10**
	TOTAL Theory IA Marks	**30**

Scheme of Internal Assessment Marks: Practicals

Sl. No.	Particulars	IA Marks
1	Practical Test	**05**
2	Report on datasheet of electronic devices/Seminar on Environmental Science etc.	**05**
3	Active participation in practical classes	**05**
	TOTAL Practical IA Marks	**15**

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

6th September 2021

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-2020in

ENVIRONMENTAL SCIENCE

Submitted by

Dr. N. Nandini **Professor & Subject Chairperson** Dept. of Environmental Science, Bangalore University, Bengaluru and Chairman, Environmental Science Committee (NEP 2020)	**Shri. L. S. Ramesh** **Member Convener, Environmental Science Committee, NEP 2020** Special Officer, Karnataka State Higher Education Council, Bengaluru and Coordinator, Environmental Science Committee, NEP 2020

And

Committee Members of 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. Suresh**, Associate Professor, Yuvaraja's College (Autonomous), University of Mysore, Mysuru.
4. **Dr. B. S. Prabhakar,** Associate Professor, Department of Environmental Science, St. Joseph's College (Autonomous), Bengaluru.

6th September 2021

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 problems like global warming, desertification, deforestation, solid waste generation and 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. The assigned task of this committee was to design curriculum structure for both under Graduate and Post Graduate programmes of Environmental Science.

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 – ENVIRONEMNTAL 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. Suresh	Associate Professor Yuvaraja's College (Autonomous), University of Mysore, Mysuru	Member
Dr. B. S. Prabhakar	Associate Professor Department of Environmental Science, St. Joseph's College (Autonomous), Bengaluru	Member
Shri. L. S. Ramesh	Special Officer Karnataka State Higher Education Council, GoK	Member Convener

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, Govt. of Karnataka conducted several meetings with the committees constituted by Government.

The Environmental Science Subject Expert Committee headed by Dr. N. Nandini, Professor, Dept. of Environmental Science, Bangalore University with the support of members Prof. Dr. N. S. Raju, Professor, University of Mysore, Mysuru; Dr. S. V. Krishna Murthy Professor, Kuvempu University, Shankaraghatta; Dr. S. Suresh, Associate Professor, Yuvaraja's College, Mysuru; Dr. B. S. Prabhakar, Associate Professor, St. Joseph's College (Autonomous), Bengaluru and support from Member Convener Shri. L. S. Ramesh, Special Officer, Karnataka State Higher Education Council Bengaluru and Environmental Science Committee (NEP 2020).

With the support of all the Chairpersons – Board of Studies of various Universities Dr. J. Narayana, Professor, Dept. of Environmental Science, Kuvempu University, Shankaraghatta; Dr. S. Srikanthaswamy, Professor, Dept. of Environmental Science, University of Mysore, Mysuru; Dr. Prakash Kariajjanavar, Associate Professor, Dept. of Environmental Science, Gulbarga University, Kalburghi; Dr. B. C. Nagaraja, Associate Professor, Dept. of Environmental Science, Bengaluru University, Bengaluru; Dr. T. S. Harsha, Assistant Professor, Dept. of Environmental Science, Karnataka State Open University, Mysuru and Dr. N. C. Tharavathy, Associate Professor, Dept. of Environmental Science/Bioscience, Mangalore University;.

The valuable support from subject experts Dr. B. S. Prabhakar, Associate Professor, St. Joseph's (Autonomous) College, Bengaluru and Dr. M. Kumar, Dept. of Environmental Science, Bangalore University, Bengaluru in the preparation of

syllabus, compiling the report and overall editing is appreciated.

Subject experts teaching post-graduate and under-graduates courses from various universities and colleges were involved in the discussion and preparation of the curriculum - Dr. S. V. Krishnamurthy, Professor, Dept. of Environmental Science Kuvempu University, Shakaraghatta; Dr. Prakash Kariajjanavar, Dept. of Environmental Science, Gulbarga University, Kalburghi; Dr. Yogendra K & Sri Nagendra Naik, Dept. of Environmental Science, Kuvempu University, Shankaraghatta; Dr. K. Harish Kumar, Assistant Professor, Dept. of Environmental Science, Government First Grade College, Hosakote; and Dr. Girish Lal, Bahadur College, Sagara; Dr. Alakananda J. Adur, Assistant Professor, Surana College, Peenya, Bengaluru; Dr. K. L. Prakash, Associate Professor, Dept. of Environmental Science, Bangalore University, Bengaluru; Dr. Helen Roselene, Associate Professor, Mount Carmel (Autonomous) College, Bengaluru; Dr. M. Raghavendra, Sri. Vivek Amuthan, Dr. S. Sivasakthivel, Dr. Shilpashree Mayachar K and Sri. S. Niranjankumar from Department of Environmental Science, Bangalore University, Bengaluru and Dr. Parisara Nagaraj, Assistant Professor, Sahyadri Science College (Autonomous), Shivammoga; and Dr. H. Raja Naika, Tumkur University were involved in the curricular frame work for four years B.Sc. (Hons.) Programme as per NEP-2020 pertaining to the subject of Environmental Science.

I take this as privilege to thank the authorities of Government of Karnataka for giving us an opportunity to be a part of curriculum framework design and implementation of NEP-2020.

- **Dr. N. Nandini**
Professor
Department of Environmental Science
Bangalore University, Bengaluru

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 weight age 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 geosciences, 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 modeling, 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 pages 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 Forty Six (46) papers to be completed in four years/eight semesters. The credits will be distributed as 20 papers constituting Core Courses, 3 papers of Discipline Specific Elective, 4 papers comprising Open Elective Courses, 2 papers of vocational courses, 1 Internship, 2 papers of Ability Enhancement Courses, comprising of 8 languages, 4 Skill based and 8 Valued based as Skill Enhancement Courses, 1 Research Methodology and 1 Research Project. Courses on Environmental Studies and Constitution of India are included as per the earlier UGC directives.

1. To ensure the interdisciplinary spirit of the proposed curriculum, teaching must be carried out by the faculty with M.Sc. in Environmental Science and Ph.D. Degree in the **'Environmental Science'** subject. A candidate who is qualified with UGC-NET/K-SET in the area of Environmental Science will be well-equipped to teach this curriculum.
2. Further, the existing number of UGC-NET Fellowships in the field of Environmental Sciences is highly inadequate; it is proposed to increase the number of Fellowships in this area. An Environmental Science programme at the undergraduate level will be successful only when independent Department of Environmental Science 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 committee may like to pursue the matter with Universities/Colleges and 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 with Higher order thinking skills following graded approach over year (30%:70%, 40%:60%, 50%:50%, 60%:40% for theory course and 50%:50% for Laboratory, Field Works, Projects, Internship and Education tour over the Years).

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	**30**	**70**
Practical	**15**	**35**
Projects/Experiential Learning (Internships etc.)	**Viva-voce = 30**	**Report = 70**

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 BASED (Credits) (L+T+P)	VALUE BASED (credits) (L+T+P)		TOTAL CREDITS
I	ES A1 (4+2) Other subject B1 (4+2)	OE-1 (3)	L1-1 (3), L2-1 (3), (4hrs. each)	-	SEC-1 Digital Fluency(2) (1+0+2)	Physical Education for fitness (1) (0+0+2)	Health & Wellness (1) (0+0+2)	25
II	ES-A2 (4+2) Other subject B2 (4+2)	OE-2 (3)	L1-2 (3), L2-2 (3), (4hrs. each)	Environmental Studies (2)	-	Physical Education – Yoga (1) (0+0+2)	NCC/NSS/R &R(S&G)/ Cultural (1) (0+0+1)	25
Exit option with Certificate in Science (50 credits)								
III	ES A3 (4+2) Other subject B3 (4+2)	OE-3 (3)	L1-3 (2) L2-3 (2) (4hrs. each)	-	SEC-2: Artificial Intelligence (2) (1+0+2)	Physical Education – Sports (1) (0+0+2)	NCC/NSS/R &R(S&G)/ Cultural (1) (0+0+1)	25
IV	ES-A4 (4+2) Other subject B4 (4+2)	OE-4 (3)	L1-4 (3) L2-4 (3) (4hrs. each)	Constitution of India (2)	-	Physical Education – Games (1) (0+0+2)	NCC/NSS/R &R(S&G)/ 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	ES A 5 (3+2) ES A 6 (3+2) Other subject B5 (3+2)	Vocational - 1 (3)	-	-	SEC - 3: SEC such as Cyber Security (2) (1+0+ 2)	-	-	**20**
VI	ES A 7 (3+2) ES A 8 (3+2) Other subject B6 (3+2)	Vocational - 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	ES A 9 (3+2) ES A 10 (3+2) ES A 11 (3)	ES E1 (3) ES E2 (3) Research Methodology (3)	-	-	-	-	-	**22**
VIII	ES A 12 (3+2) ES A 13 (3+2) ES A 14 (3)	ES E3 (3) Research project (6)*	-	-	-	-	-	**20**
Award of Bachelor of Science Honors Degree, B.Sc. (Hons.) Degree in Environmental Science (184 credits)								

*L+T+P= Lecturing in Theory + Tutorial + Practicals. Numbers in the parenthesis refer to credits.

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

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

Total Credits for the Programme: **184**

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

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

Discipline/Subject: **Environmental Science**

Programme Articulation Matrix

Semester	Title /Name of the course	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course(s)	Pedagogy	Assessment
1	**ES 1T1** – Divisions of Environment	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) - 30%. End Semester Examination (Summative assessment) - 70%
	ES 1P1 – Water quality analysis	Be able to analyze the vital physicochemical parameters of water, interpret and suggest suitable treatment methods.		Hands-on-training	
	ES OE1 – Environmental Conservation Movements **OR** **ES OE1** – Environment and Sustainable Agriculture **OR** **ES OE1**– Environmental Pollution	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	Have developed sound knowledge of Basic and Applied Ecology.	-	Theory, case studies and course projects	Continuous internal assessment (Formative assessment) - 30%. End Semester Examination (Summative assessment) - 70%
	ES 2P1 – Ecological analysis	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 OE2 – Climate Change and Its Implications **O R** **ES OE2** – Environment and Public Health in Contemporary Society **O R** **ES OE2**– Wildlife and Conservation	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	Have developed a sound knowledge and understanding of Natural Resources and Application of various management practices.	Certificate in Science with Environmental Science as a subjectand a total credit score of 50	Theory, case studies and problem solving methods	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (Summative assessment)-70%
	ES 3P1 – Mineralogy, Petrology, Energy Resources and Medicinal Plants	Be able to Identify Major Rock forming Minerals and Rocks. Learn basic skills of mapping and cartography.		Hands-on-training and field studies	
	ES OE3 – Women and Environment **O R** **ES OE3** – Food Adulterants and Safety **O R** **ES OE3** – Environmental Disasters of India	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	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) - 30%. End Semester Examination (Summative assessment) - 70%
	ES 4P1 – Meteorology, Biodiversity Assessment, Ecosystem Services and conservation case studies	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 quadrates, line transects and mark-release-recapture methods.	'	Data handling and Hands-on-training	
	ES OE4 Environmental Education **O R** **ES OE4** – Environment and Green Marketing **O R** **ES OE4** – Modern Technologies for Environmental 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	
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	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) - 30%. End Semester Examination (Summative assessment) - 70%
	ES 5P1 – Environmental Microbiology, Environmental Biotechnology, Environmental Statistics	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	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	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 **OR** **ES 5V1** – Urban Waste and Hazardous Waste Management	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	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)-30%. End Semester Examination (Summative assessment) -70%
	ES 6P1 – Soil analysis, Noise measurement and Solid waste	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	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	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 **O** **R** **ES 6V1** – Disaster Management	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. **O** **R** 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	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 atotal credit score of 142	Theory, Self-study and Case studies	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (Summative assessment) -70%
	ES 7P1 – Bioassay, Acute and Sub-acute toxicity tests	Be able to setup simple bioassay test procedures leading to LD50, LC50 assessments.		Hands-on-training	
	ES 7T2 – Applications of RemoteSensing and Geographical Information Systems	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	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	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 andUrban Planning	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/termpaper	
	ES 7R1– Research Methodology	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** – Environmental Economics, Sustainable Development and Business	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	Continuous internal assessment (Formative assessment)-30%. End Semester Examination (Summative assessment) -70%
	ES 8T2 – Environmental Law and Environmental Management Systems	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 8T3 – Climate Change and Mitigation	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	
	ES 8E3 – Quality Assurance and Quality Control in Environmental Analysis	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	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 Sustainability	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)-30%. End Semester Examination (Summative assessment) -70%
	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)-30%. End Semester Examination (Summative assessment) -70%
	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	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	52Hrs
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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Formative Assessment – Continuous Internal Assessment = 30% (30 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (70 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 / CO_2 – NaOH titration 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

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

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

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Formative Assessment – Practical Internal Assessment = 30% (15 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (35 Marks)
Total	100% (50 Marks)

Date Course Co-ordinator Subject Committee Chairperson

ES OE1: ENVIRONMENTAL CONSERVATION MOVEMENTS

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

Content of OPEN ELECTIVE Theory Course 1	42Hrs
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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Nepal, Padam. (2009). Environmental Movements in India: Politics of Dynamism and Transformations, Authors press, Delhi.

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Formative Assessment – Continuous Internal Assessment = 30% (30 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (70 Marks)
Total	100% (100 Marks)

Date Course Co-ordinator Subject Committee Chairperson

ES OE1: ENVIRONMENT AND SUSTAINABLE AGRICULTURE

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

Content of OPEN ELECTIVE Theory Course 1	**42Hrs**
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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Campanhola, C., & Pandey, S. (Eds.). (2018). Sustainable food and agriculture: An integrated approach. Academic Press.

de Zeeuw, H., & Drechsel, P. (Eds.). (2015). Cities and agriculture: Developing resilient urban food systems. Routledge.

Eric Lichtfouse, Mireille Navarrete, Philippe Debaeke, Souchere Veronique, Caroline Alberola. (2009). Sustainable Agriculture. Springer Science & Business Media.

Kazim B. Rahim Debash Sarkar Bidhan Chand. (2012). Sustainable Agriculture and Environment. New Delhi Publishers.

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

Songstad, D. D., Hatfield, J. L., & Tomes, D. T. (Eds.). (2014). Convergence of food security, energy security and sustainable agriculture (Vol. 67). New York: Springer.

Formative Assessment – Continuous Internal Assessment = 30% (30 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (70 Marks)
Total	100% (100 Marks)

Date Course Co-ordinator Subject Committee Chairperson

ES OE1: ENVIRONMENTAL POLLUTION

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

Content of OPEN ELECTIVE Theory Course 1	42Hrs
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.	

References

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Formative Assessment – Continuous Internal Assessment = 30% (30 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (70 Marks)
Total	100% (100 Marks)

Date Course Co-ordinator Subject Committee Chairperson

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

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

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

Programmespecific 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	52Hrs
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, Topography 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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Formative Assessment – Continuous Internal Assessment = 30% (30 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (70 Marks)
Total	100% (100 Marks)

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 WienerIndex
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.

Rolan, R. G. (1973). Laboratory and Field Investigations in General Ecology. Macmillan Co.

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

Subrahmanyam, N. S. and Sambamurty, A. V. S. S. (2000). Ecology. Narosa Publishing House.

Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publications.

Formative Assessment – Practical Internal Assessment = 30% (15 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (35 Marks)
Total	100% (50 Marks)

Date Course Co-ordinator Subject Committee Chairperson

ES OE2: CLIMATE CHANGE AND ITS IMPLICATIONS

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

Content of OPEN ELECTIVE Theory Course 2	**42Hrs**
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-Nino, 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.	

References

Abhishek Tiwary and Jerem Colls. (2010). Air Pollution: Measurement, Modelling and Mitigation. III Edition, Routledge Publication.

Agarwal K.M, Sikdar P.K. and Deb S.C. (2002). A text book of Environment – MacMiller India Ltd., Calcutta

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

Donald Ahrens.C. (2008). Essentials of Meteorology: An Invitation to the Atmosphere. Cengage Learning publication.

Howard J. Critchfield. (1983). General Climatology (Fourth Edition), Phi Learning Pvt Ltd.

IPCC. (2006). Guidelines for National Greenhouse gas Inventories. Published by the Institute for Global Environmental Strategies (IGES), Hayama, Japan on behalf of the IPCC.

John E. Oliver, John J. Hidore. (2002). Climatology: An Atmospheric Science, Second Edition. Prentice Hall publication.

John T. Hardy. (2003). Climate Change: Causes, Effects and Solution. John Wiley & Sons publications.

Mann, M. E. (2021). The New Climate War: the fight to take back our planet. Hachette UK.

Nicholas Stern. (2008). The Economics of Climate Change: The Stern Review. Cambridge University Press. Great Britain.

Rajit Sengupta and Kiran Pandey. (2021). State of India's Environment 2021: In Figures. Centre Science and Environment, New Delhi.

Roger G. Barry and Richard J. Chorley. (2007). Atmosphere, weather and Climate, 8th Edition, Routledge Publishers.

Romm, J. (2018). Climate Change: What Everyone Needs to Know®. Oxford University Press.

Formative Assessment – Continuous Internal Assessment = 30% (30 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (70 Marks)
Total	100% (100 Marks)

Date Course Co-ordinator Subject Committee Chairperson

ES OE2: 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	**42Hrs**
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

Akhtar, R. (Ed.). (2019). Extreme weather events and human health: International case studies. Springer Nature.

Bedi and Yashpal. (1971). Handbook of Hygiene and Public Health. Atma Ram & Sons, Delhi.

Kessel, A. (2006). Air, the environment and public health. Cambridge University Press.

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Nandini N. (2018). Environment and public Health. Sapna Book House, Bengaluru.

O'Carroll, P. W., Yasnoff, W. A., Ward, M. E., Ripp, L. H., & Martin, E. L. (Eds.). (2003). Public health informatics and information systems.

Park, K. (2009). Park's Textbook of Preventive and Social Medicine, 20th Edition. Misc Publication.

Rajit Sengupta and Kiran Pandey. (2021). State of India's Environment 2021: In Figures. Centre Science and Environment, New Delhi.

Van den Bosch, M., & Bird, W. (Eds.). (2018). Oxford textbook of nature and public health: The role of nature in improving the health of a population. Oxford University Press.

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

Formative Assessment – Continuous Internal Assessment = 30% (30 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (70 Marks)
Total	100% (100 Marks)

Date Course Co-ordinator Subject Committee Chairperson

ES OE2: WILDLIFE AND CONSERVATION

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

Content of OPEN ELECTIVE Theory Course 2	**42Hrs**
Unit – 1	**14**
Wildlife: Definition, significance – Values of wildlife: Ecological, Economic, Cultural, Aesthetic, Scientific, Recreational and Medicinal. Biogeographical zones of India. Significant wildlife of India. Causes for wildlife depletion – HIPPO (Habitat destruction, Invasive species, Pollution, Population (human overpopulation), Overharvesting by hunting and fishing. Forest fires and wildlife depletion. Effects of depletion of wildlife – Ecological, Economic Socio-cultural. Urban wildlife. Human-wildlife conflict and management. Categories of Wildlife: IUCN Red data categories - Extinct, Extinct in wild, Critically endangered, Endangered, Vulnerable, Near threatened, Least concerned, Data deficient, Not evaluated. IUCN Red data book. Keystone species, Flagship species, Umbrella species. Priority species, Indicator species.	
Unit - 2	**14**
Wildlife conservation: Need for conservation of wildlife. History of wildlife conservation in India. Biosphere reserves, National parks, Wildlife sanctuaries, wildlife reserves, protected areas, privately owned wildlife reserves &, Single species/single habitat-based conservation areas, Area of special scientific interest (ASSI). Conservation practices - *Ex-situ* and *in-situ* conservation. Captive breeding - Role of Zoos in conservation. Community conserved areas – *Devarakadu* and *Pavitra Vana*. Case studies: Project tiger, Project elephant. Role of BSI and ZSI in conservation. People and conservation: Traditional knowledge, Traditions and cultures, Women and people's participation in managing protected areas. Role of NGOs in conservation. Conservation Institutions – Bird Life International, GEF, IUCN, UNEP, WCS, WWF; BNHS, WTI.	
Unit - 3	**14**
Wildlife tourism: Definition, scope and relevance. Role of Zoos and Botanical parks in tourism and awareness creation. Bird and butterfly watching. Positive and negative impacts of wildlife tourism. Conflicts related to wildlife tourism.	

Wildlife trade and legislation: Wildlife trade and impacts. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITIES). Wildlife Trade Monitoring Network (TRAFFIC). Salient features of Indian wildlife act 1972.	

References

Bindra, P. S. (2017). The Vanishing: India's Wildlife Crisis. Penguin Random House India.

Donald Letcher Goddard and Sam Swope. (1995). Saving Wildlife: A Century of Conservation. Wildlife Conservation Society.

E.P. Gee. (2002). The Wild Life of India. HarperCollins India

Goutam Kumar Saha , Subhendu Mazumdar. (2017). Wildlife Biology: An Indian Perspective, PHI Learning Pvt. Ltd. India

Herbert H. T. Prins, Jan Geu Grootenhuis and Thomas T. Dolan. (2000). Wildlife Conservation by Sustainable Use. Springer publication.

Jedediah F. Brodie, Eric S. Post, and Daniel F. Doak. (2012). Wildlife Conservation in a Changing Climate. The University of Chicago Press.

Manfredo, Michael J. (2008). Who Cares About Wildlife?. Springer publication.

Morrison, M.L., Block, W.M., Strickland, M.D., Collier, B.A., Peterson, M.J. (2008). Wildlife Study Design, Springer publication.

Nagendra, H., & Mundoli, S. (2019). Cities and canopies: trees in Indian cities. Penguin Random House India Private Limited.

Roth, Harald H., Merz, Gu nter (Eds.). 1997. Wildlife Resources - A Global Account of Economic Use. Springer publication.

Underkoffler, Susan C, Adams, Hayley R. (Eds.). (2021). Wildlife Biodiversity Conservation - Multidisciplinary and Forensic Approaches, Springer publication.

Formative Assessment – Continuous Internal Assessment = 30% (30 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	70% (70 Marks)
Total	100% (100 Marks)

Date Course Co-ordinator Subject Committee Chairperson

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)
ENVIRONMENTAL STUDIES

The module consists of 8 units in which the first seven units will cover 45 lectures which are classroom based to enhance knowledge skills and attitude to environment. Unit 8 is based on field activities which will be covered in 5 lecture hours and would provide students first-hand knowledge on various local environmental aspects.

1. Environmental Studies (AECC) is made compulsory core module syllabus framed by UGC for all the Indian Universities as per the directions given by the honorable Supreme court, which believed that, conservation of environment should be a national way of life and to be inculcated into the education process. The committee proposes a staggered implementation for this course as shown below. This facilitates the distribution of the teaching workload of an institution.

Subject	Environmental studies Ability Enhancement Compulsory Courses(AECC)	Semester
Course	B.Sc./ B.A./ BCA	I
	B.Com./B.B.A/B.H.M	II

2. To ensure the interdisciplinary spirit of the proposed curriculum, teaching must be carried out by the faculty who are trained at post-graduate (M.Sc.) and Ph.D. in the 'Environmental Science' subject only. A candidate who is qualified with UGC-NET/K-SET in the area of Environmental Science will be well- equipped to teach this curriculum.

3. The scheme of Examination and the question paper pattern for AECC – Environmental Studies will be multiple choice questions (MCQ) for 70 marks and 30marks for internal assessment with 3 hours of teaching per week with 2 credits.

AECC - ENVIRONMENTAL STUDIES SYLLABUS

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

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

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

	and cultures in environmental conservation Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).	
Unit 8	**Field work**	**5**

Reference

Carson, R. (2002). Silent Spring. Houghton Mifflin Harcourt.

Gadgil, M., & Guha, R. (1993). This Fissured Land: An Ecological History of India. Univ. of California Press.

Gleeson, B. and Low, N. (eds.) (1999). Global Ethics and Environment, London, Routledge.

Glejck, P. H. (1993). Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.

Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. (2006). Principles of Conservation Biology. Sunderland: Sinauer Associates.

Grumbine, R. Edward, and Pandit, M.K. (2013). Threats from India's Himalaya dams. Science, 339: 36-37.

McCully, P. (1996). Rivers no more: the environmental effects of dams (pp. 29-64). Zed Books.

McNeill, John R. (2000). Something New Under the Sun: An Environmental History of the Twentieth Century.

Nandini, N. (2019). A text book on Environmental Studies (AECC). Sapna Book House, Bengaluru.

Odum, E.P., Odum, H.T. & Andrews, J. (1971). Fundamentals of Ecology. Philadelphia: Saunders.

Pepper, I.L, Gerba, C.P. & Brusseau, M.L. (2011). Environmental and Pollution Science. Academic Press.

Rao, M.N. & Datta, A.K. (1987). Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.

Raven, P.H., Hassenzahl, D.M. & Berg, L.R. (2012). Environment. 8th edition. John Wiley & Sons.

Rosencranz, A., Divan, S., & Noble, M. L. (2001). Environmental law and policy in India. Tripathi 1992.

Sengupta, R. (2003). Ecology and economics: An approach to sustainable development. OUP.

Singh, J.S., Singh, S.P. and Gupta, S.R. (2014). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). (2013). Conservation Biology: Voices from the Tropics. John Wiley & Sons.

Thapar, V. (1998). Land of the Tiger: A Natural History of the Indian Subcontinent. Warren,

C. E. (1971). Biology and Water Pollution Control. WB Saunders.

Wilson, E. O. (2006). The Creation: An appeal to save life on earth. New York: Norton.

World Commission on Environment and Development. (1987). Our Common Future. Oxford University Press.

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 – ENVIRONEMNTAL SCIENCE			
Name	**Designation and address**	**Position**	**Signature**
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	-Sd-
Dr. S. Suresh	Associate Professor, Yuvaraja's College(Autonomous), University of Mysore, Mysuru	Member	
Dr. B. S. Prabhakar	Associate Professor, Department of Environmental Science, St. Joseph's College (Autonomous), Bengaluru	Member	
Sri. L. S. Ramesh	Special Officer, Karnataka State Higher Education Council, Government of Karnataka	Member Convener	

GOVERNMENT OF KARNATAKA

NATIONAL EDUCATION POLICY- 2020

(NEP-2020)

Report on

Proposed Curricular Framework for AECC in
ENVIRONMENTAL STUDIES

Submitted to

Karnataka State Higher Education Council
Government of Karnataka
Bengaluru

September 2021

GOVERNMENT OF KARNATAKA

NATIONAL EDUCATION POLICY- 2020

(NEP-2020)

Report on
Proposed Curricular Framework for for AECC -
ENVIRONMENTAL STUDIES
in Universities of Karnataka State under NEP-2020

Submitted by

Dr. N. Nandini **Professor & Subject Chairperson** Dept. of Environmental Science, Bangalore University, Bengaluru and Chairman, Environmental Science Committee (NEP 2020)	**Shri. L. S. Ramesh** **Member Convener, Environmental Science Committee, NEP 2020** Special Officer, Karnataka State Higher Education Council Bengaluru and Coordinator, Environmental Science Committee, NEP 2020

And

Committee Members of 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. Suresh**, Associate Professor, Yuvaraja's College (Autonomous), University of Mysore, Mysuru.
4. **Dr. B. S. Prabhakar**, Associate Professor, Department of Environmental Science, St. Joseph's College (Autonomous), Bengaluru.

September 2021

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)
ENVIRONMENTAL STUDIES

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AECC - ENVIRONMENTAL STUDIES SYLLABUS

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

	Content of AECC – Environmental Studies	**45 hours**
Unit 1	**Introduction to Environmental Studies**	**2**
	Multidisciplinary nature of environmental studies Scope and importance; Concept of sustainability and sustainable development.	
Unit 2	**Ecosystems**	**6**
	What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems: a) Forest ecosystem, b) Grassland ecosystem, c) Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	
Unit 3	**Natural Resources: Renewable and Non-Renewable Resources**	**8**
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	Levels of biological diversity: Genetic, species and ecosystem diversity; Biogeographic zones of India;	

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Unit 5	**Environmental Pollution**	**8**
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Sri. L. S. Ramesh	Special Officer, Karnataka State Higher Education Council, Government of Karnataka	Member Convener	