GOVERNMENT OF KARNATAKA

Report on

Proposed Curricular Framework for Undergraduate Programme in Universities of Karnataka State in ENVIRONMENTAL SCIENCE

Submitted to

Karnataka State Higher Education Council
Government of Karnataka
Bengaluru

June 2023

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Report on

Proposed Curricular Framework for Undergraduate Programme in Universities of Karnataka State

in

ENVIRONMENTAL SCIENCE

Submitted by

Dr. N. Nandini **Chairperson, Subject Expert Committee - Environmental Science,** Professor, Dept. of Environmental Science, Bangalore University, Bengaluru	**Smt. Akshatha Chandra, G. R.,** **Member Convenor, Subject Expert Committee - Environmental Science** Special Officer, Karnataka State Higher Education Council Bengaluru and Coordinator, Environmental Science Committee

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. K. L. Prakash**, Professor, Department of Environmental Science, Bangalore University, Bengaluru.
3. **Dr. S. Suresha**, Professor, Department of Environmental Science, Yuvaraja's College (Autonomous), University of Mysore, Mysuru.
4. **Dr. B. S. Prabhakar,** Associate Professor, Department of Environmental Science, St. Joseph's University, Bengaluru.

June 2023

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 – SEC 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.

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. K. L. Prakash	Professor Department of Environmental Science, Bangalore University, Bengaluru	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 Department of Environmental Science, St. Joseph's University, Bengaluru	Member
Smt. Akshatha Chandra, G. R.	Special Officer Karnataka State Higher Education Council, Government of Karnataka	Member Convenor

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 have 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, St. Joseph's University, 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, 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, Department of Environmental Science, Bengaluru University, Bengaluru; **Dr. J. S. Chandrashekar**, Assistant Professor, 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, 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**, Assistant Professor, St. Joseph's University, Bengaluru, Bengaluru; **Dr. M. Raghavendra, Sri. S. Niranjan Kumar, Smt. Neethi Nair** and **Sri. Vishnu, H. V.,** from Department of Environmental Science, Bangalore University, Bengaluru. This work progressed under the guidance of **Shri. L. S. Ramesh and Dr. Jayappa, M.,** Special Officers, Karnataka State Higher Education Council, Government of Karnataka, initially and later steered by **Smt. Akshatha Chandra, G. R.,** Special Officer, Karnataka State Higher Education Council, Government of Karnataka.

The valuable support from subject experts **Dr. B. S. Prabhakar**, Associate Professor and Head, Department of Environmental Science, St. Joseph's University, 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 .

Prof. N. Nandini

Chairperson
Subject Expert Committee – Environmental Science
Karnataka State Higher Education Council
Government of Karnataka

MODEL CURRICULUM

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

Discipline Core: **Environmental Science**

Total Credits for the Programme: **193**

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

B1. Curriculum and Credit Framework for Undergraduate Programme with two core subjects with practicals (Say A & B) in the first two years, and choosing one of them as Major (A) in the 3rd year and the other as minor (B).

Sem.	Discipline Specific - Core (DSC), Elective (DSE) Courses (Credits) (L+T+P)	Minor/ Multidisciplinary/ Open Elective (OE) Courses (Credits) (L+T+P)	Ability Enhancement Courses (AEC)(Credits) (L+T+P) (Languages)	Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship.		Total Credits
I	DSC Env. Science-A1(4), A2(2) Other Core-B1(4), B2(2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	**SEC-1**: Digital Fluency (2) (1+0+2)/ Env. Studies (3)	Health, Wellness & Yoga (2) (1+0+2)	25/26
II	DSC Env. Science-A3(4), A4(2), Other Core-B3(4), B4(2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Env. Studies (3)/ SEC-1: Digital Fluency (2)(1+0+2)	Sports/NCC/NSS/R&R(S&G) / Cultural (2) (0+0+4)/ SEC (2)	26/25
Students exiting the programme after securing 46 credits will be awarded UG Certificate in Disciplines A and B provided they secure 4 credits in work based vocational courses during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during the first year.						
III	DSC Env. Science-A5(4), A6(2), Other Core-B5(4), B6(2)	OE-3 (3)/ India and Indian Constitution (3)	L1-3(3), L2-3(3) (4 hrs. each)	**SEC-2**: AI/Financial Edu. & Inv. Aw. (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
IV	DSC Env. Science-A7(4), A8(2), Other Core-B7(4), B8(2)	India and Indian Constitution (3) / OE-3(3)	L1-4(3), L2-4(3) (4 hrs. each)	**SEC-3**: Financial Edu. & Inv. Aw. /AI (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
Students exiting the programme after securing 92 credits will be awarded UG Diploma in Disciplines A and B provided they secure additional 4 credits in skill based vocational courses offered during the first- or second- year summer term.						

V	DSC Env. Science-A9(4), A10(2), A11(4), A12(2), A13(4); DSE Env. Science E1(3)	Vocational-1(3) or Vocational-1(3)		**SEC-4**: Cyber Security (2) (1+0+2)/Internship (2)		24
VI	DSC Env. Science-A14(4), A15(2), A16(4), A17(2), A18(4); DSE Env. Science-E2(3)	Vocational-2(3) or Vocational-2(3)		**SEC-5**: Relevant SEC (2) (1+0+2)/ Internship (2)		24
Students exiting the programme after 3-years will be awarded UG Degree in Discipline A with Discipline B as Minor upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed.						

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. IN ENVIRONMENTAL SCIENCE

Total Credits for the Programme: **193**

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

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

Discipline/Subject: **Environmental Science**

Programme Articulation Matrix

PROPOSED CURRICULUM STRUCTURE FOR UNDERGRADUATE IN ENVIRONMENTAL SCIENCE DEGREE PROGRAMME

B1. Curriculum and Credit Framework for Undergraduate Programme with two core subjects with practicals (Say A & B) in the first two years, and choosing one of them as Environmental Science (A) in the 3rd year and the other as minor (B).

Semester	Title /Name of the course & Credits	Programme outcomes that the course addresses (not more than 3 per course)	Pre-requisite course (s)	Pedagogy	Assessment
1	**DSC ENV C1-T- 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%
	DSC ENV C2-P-WATER QUALITY ANALYSIS (2)	Be able to analyse the vital physicochemical parameters of water, interpret and suggest suitable treatment methods.		Hands-on-training	

	ENV OE1-T- ENVIRONMENTAL CONSERVATION MOVEMENTS (3) **OR** **ENV OE1-T-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	**DSC ENV C3-T- 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%
	DSC ENV C4-P-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	
	ENV OE2-T-CLIMATE CHANGE AND ITS IMPLICATIONS (3) **OR** **ENV OE2-T-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 (51 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	**DSC ENV C5-T-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%
	DSC ENV C6-P-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	
	ENV OE3-T-WOMEN AND ENVIRONMENT (3) OR ENV OE3-T-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	

	***Note: Universities are free to opt for one of the papers among OE3 OR India and Indian Constitution in third semester.** **Universities which have chosen OE3 in third semester will offer India and Indian Constitution in the fourth semester and visa-versa.**

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	**DSC ENV C7-T-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%
	DSC ENV C8-P-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	
	ENV OE3-T-WOMEN AND ENVIRONMENT (3) **OR**	Be able to get an introductory account of the chosen open elective paper and use the acquired		Theory, Case studies and Self-study	

	ENV OE3-T-ENVIRONMENTAL DISASTERS AND MANGEMENT (3)	knowledge in decision making and hence add to quality of life.			
	***Note: Universities that have opted for one of the OE3 in the third semester will offer India and Indian Constitution in the fourth semester.** **Universities which have chosen India and Indian Constitution in the third semester will offer one of the OE3 in the fourth semester.**				
Exit option with Diploma in Science (101 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	**DSC ENV C9-T-AIR POLLUTION, WATER POLLUTION AND ENVIRONMENTAL ENGINEERING (4)**	Have developed knowledge and understanding of Air, Water and Land Pollution and Application of control measures.	Diploma in Science with Environmental Science as a subject and a total credit score of 100	Theory, Self-study and Case studies	Continuous internal assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	DSC ENV C10-P-AIR AND WASTEWATER ANALYSIS (2)	Be able to analyse vital parameters of Wastewater, interpret and suggest suitable treatment methods, analyse vital air pollutants, interpret and suggest suitable control methods.		Hands-on-training	
	DSC ENV C11-T-NOISE, LAND, RADIATION POLLUTION AND SOLID WASTE MANAGEMENT (4)	Have developed knowledge and understanding of Noise, Land, Radiation Pollution and Solid Waste Management		Theory, Self-study and Case studies	
	DSC ENV C12-P-SOIL ANALYSIS, NOISE MEASUREMENT AND SOLID WASTE ANALYSIS (2)	Be able to analyse noise levels, identify and categories land pollution and be capable of developing a solid waste management plan for urban areas.		Hands-on-training	
	DSC ENV C13-T- ENVIRONMENTAL CHEMISTRY AND INSTRUMENTATION (4)	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, Flame Photometry and Atomic Absorption Spectroscopy.		Theory, Self-study and Case studies	
	DSE- ENV E1-T-ENVIRONMENTAL EDUCATION (3) **OR**	Have developed knowledge about the surroundings Or		Theory and seminar/term paper	

	DSE ENV E1-T-ENVIRONMENTAL PSYCHOLOGY AND ETHICS (3)	Have developed knowledge Environment psychology, effect of environment on human health and Ethics.			
	ENV V1-T-LANDSCAPE ECOLOGY, URBAN PLANNING AND ECOTOURISM (3) **OR** **ENV V1-T- URBAN WASTE AND HAZARDOUS WASTE MANAGEMENT (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. Or Have developed knowledge and understanding of Urban and Hazardous waste management		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	**DSC ENV C14-T ENVIRONMENTAL MICROBIOLOGY (4)**	Have developed knowledge and understanding of Environmental Microbiology.		Theory and practices	Continuous internal assessment (Formative assessment) - 40%. End Semester Examination (Summative assessment) - 60%
	DSC ENV C15-P ENVIRONMENTAL MICROBIOLOGY (2)	Be able to culture and identify Bacteria and Fungi; be able to detect the faecal contamination of drinking water.		Hands-on-training and practices	
	DSC ENV C16-T-ENVIRONMENTAL IMPACT ASSESSMENT AND RISK ASSESSMENT (4)	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	
	DSC ENV C17-P-METHODS OF ENVIRONMENTAL IMPACT ASSESSMENT 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	
	DSC ENV C18-T-OCCUPATIONAL HEALTH AND SAFETY (4)	Be able to understand the risks and health impacts at work place and find to find safety measures. Have developed knowledge of work environments, understand exposure risks and have an exposure to legal requirements.		Theory, Self-study and Case studies	
	DSE ENV E2-T-ENVIRONMENTAL CONTAMINATION AND REMEDIATION TECHNOLOGIES (3) **OR**	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. Or		Theory, Self-study and Case studies	

	DSE ENV E2-ENVIRONMENTAL ISSUES AND CLIMATE CHANGE (3)	Have acquired knowledge about Environmental Issues , diseases, policies framed to combat climate change.			
	ENV V2-T-ENVIRONMENT AND GREEN MARKETING (3) **OR** **ENV V2-T-QUALITY ASSURANCE AND QUALITY CONTROL IN ENVIRONMENTAL ANALYSIS (3)**	Have acquired knowledge on sustainable business practices, eco-friendly products, eco-friendly packaging etc. Or Have developed knowledge of total quality management protocols and develop skills of monitoring and interpreting industrial reporting procedures.		Theory and seminar/term paper	

Exit option with Bachelor of Science, B.Sc. Degree in Environmental Science (149 credits) o

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

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

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

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

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

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

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

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

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

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

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

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

DSC ENV C10-P-AIR AND WASTEWATER ANALYSIS

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

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

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

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B.Sc. Semester 5

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

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

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

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

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

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

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

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

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

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

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

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

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B.Sc. Semester: 5

Title of the course: DSC ENV C13-T-ENVIRONMENTAL CHEMISTRY AND INSTRUMENTATION

Number of theory credits	Number of lecture hours/semester
4	**60**

Programme Specific Objectives	
PSO 1	To develop competency in understanding the chemistry and the processes in environment.
PSO 2	To instil knowledge about the chemistry of soil and water.
PSO 3	To develop competency in understanding the instruments used for analysis and the principles for developing the instruments.
PSO 4	To be able to employ the developed skills in real-time situations.

Programme Outcomes	
PO 1	Demonstrate competence in understanding the concepts and chemistry of elements interacting in the environment.
PO 2	Demonstrate the ability to carry out data collection procedures and analysis in field conditions/laboratories and make appropriate interpretations.
PO 3	Be able to develop competence and academic skills in handling advance instruments.
PO 4	To be able to apply skills in accordance with guidelines/standards prescribed by statutory authorities.

Content of Theory course	**60 Hours**
Unit – 1	**15**
Fundamentals of Environmental Chemistry: Concept and scope of Environmental chemistry, Environmental segments, Structure of atoms, Gibbs energy, chemical potential, acid-base reactions, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes in the environment. Fundamentals of chemical thermodynamics and solution formation - Laws of thermodynamics, heat transfer processes, mass and energy transfer across various interfaces, material balance.	
Unit – 2	**15**
Atmospheric chemistry: Composition of elements in the atmosphere. Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and	

organic particulate matters. Thermochemical and photochemical reactions in the atmosphere. CFCs, Oxygen and Ozone chemistry, Chemistry of air pollutants (Primary and secondary) and aerosols, Photochemical smog, London Smog and other case studies.	
Unit – 3	**15**
Water and Soil chemistry: Properties of water, water pollutants - sources and types - heavy metals, metalloids, types of reactions in various water bodies including marine environment, hydrological cycle; concepts of pH and their variations in waters, pesticides in water. Distribution of inorganic and organic components in soil, Chemical properties of Soil - Saline, Acidic and Alkaline soils; Major, minor and micro nutrients of soil. Nutrient Pathways - Nitrogen, Carbon, Phosphorus and Potassium pathways in the soil.	
Unit – 4	**15**
Advanced instrumentation: Various ranges of electromagnetic radiation, Interaction of electromagnetic radiation with matter, Introduction to UV and X-ray spectroscopy and its applications in Environmental Science, Nephelometry, Atomic Absorption Spectroscopy and Atomic emission spectroscopy and Flame emission spectroscopy-Principle, instrumentation and applications in Environmental sample analysis, Concept of Solvent extraction, Thin Layer Chromatography and Ion Exchange Chromatography, Basic concept of HPLC and Gas chromatography.	

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B.Sc. Semester: 5

Title of the Course: **DSE- ENV E1-T-ENVIRONMENTAL EDUCATION**

Number of Theory Credits	Number of lecture hours/semester
3	**45**

Programme Specific Objectives	
PSO 1	To instil knowledge and awareness about Environment and the process of interaction of elements of Environment.
PSO 2	To develop competency in understanding the ecological principles governing the biosphere.
PSO 3	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 Environment and the processes related to it.
PO 2	Ability to understand and appreciate the role of each element of ecosystem.
PO 3	Be able to develop competence and academic skills in contributing towards environment and its conservation.

Content of Theory Course	**45 Hours**
Unit - 1	**15**
Environmental Education: Definition (Cerovsky, 1971), Evolution of Environmental Education: Stockholm Declaration; Belgrade Charter; Tbilisi Declaration. Multidisciplinary nature of Environmental Education. Man as an integral product and part of Nature. Role of UNESCO/UNEP International Environmental Education Programme (IEEP) in Environmental Education. Global Environmental Education Programme (GEEP). The South Asia Co-Operative Environment Programme (SACEP); The South and Southeast Asia Network for Environmental Education (SASEANEE).	

Institutions involved in Environmental Education in India: Centre for Environment Education (CEE), World Wide Fund for Nature (WWF-India), and other locally relevant institutions/NGOs. Introduction to Article 48A and 51A(g) of Indian Constitution. Principles of Environmental Education: Resource principles - Effective utilization of resources; Soil Principles - Protecting soil and preventing its degradation; Wildlife Protection Principles – Nature conservation and Protection of wildlife; Environmental Management Principles - Effective environmental management; and Cultural, Historical & Heritage Principles. Characteristics of environmental education: Integrated, Interdisciplinary, Holistic and Providing solutions to practical problems. Approaches to Environmental Education: Environmental deterministic approach; Teleological approach; Possibilistic approach; Economic deterministic approach; Ecological approach, and Geographical approach.	
Unit – 2	**15**
Overall Objectives of Environmental Education: Learning about the environment; Learning through the environment; and Learning for the environment – Awareness, Knowledge, Attitudes, Skills & Capacity Building and Participation. Specific Objectives of Environmental Education according to Habitat and Learning-National Curriculum Framework, 2005: Learning rather than teaching; Building capacity for critical thinking and problem solving; Locale specificity in the context of a global vision; Multidisciplinary approach; Multi-sourced and accessed, rather than top-down, controlled and orchestrated in nature; Participatory with broad involvement of peers and other community members; Life long and continuous in character; Sensitivity to diversity, equity and gender; Knowledge generation; and Empowerment, rather than indoctrination. Types of Environmental Education: Formal and Non-Formal Education. Approaches to formal environmental education: Primary, Secondary and Tertiary levels – infusion of environmental concepts into existing curricula; development of specific curriculum for environment – environmental studies, environmental science and environmental engineering. Approaches to non-formal environmental education: Characteristics – Voluntary, Open access, Participatory, Learner-centred, Individual and group learning, Continuous and Lifelong. Objectives non-formal environmental education: Nature appreciation, Awareness creation and enabling contemporary environmental problem solving.	

Tools of non-formal environmental education: Personal reading, Newspaper articles, Poetry, Skits, Celebration of specific environmental events, Posters and Essay-writing Competitions, Hands on activities, Nature-club activities, Exhibitions, seminars, Nature camps, Mobile exhibitions, Eco development camps and Use of social media. Environmental Education and Participatory Conservation: Conservation Education; Community-Based Monitoring; Community-Based Conservation Reserves; Community-Based Anti-Poaching Efforts. Case studies - Chipko and Appiko Movements; Silent Valley Movement; Amur Falcon conservation; Community conservation reserves in Karnataka - Mydhanahalli Black Buck Conservation Reserve; Melapura Bee Eater Bird Conservation Reserve; Thungabhadra Otter Conservation Reserve; Shalmala Riparian Eco-System Conservation Reserve; Puttenahalli Lake Bird Conservation Reserve; Kolar Leaf-nosed Bat Conservation Reserve; Bankapura Peacock Conservation Reserve; any other locally relevant case studies. Environmental Education and Movements: Clemenceau Ship Action-India; Plachimada Movement; Steel Flyover Beda Campaign in Bengaluru; any other locally relevant case studies.	
Unit – 3	**15**
Issue Based Environmental Education Climate Change: Earth's climate system; Differences between climate change and global warming; Global, Regional and Local consequences of climate change; Role of human activities in climate change. Mitigation and adaptation strategies. Biodiversity Conservation: Biodiversity; Types, Values, Causes for Depletion; *In-situ* and *Ex-situ* Conservation; Bio-piracy – Case Studies. Water Scarcity and Pollution: Water resources and their distribution; Sources and impacts of water pollution; and Sustainable water management practices. Air Pollution and its Health Impacts: Major air pollutants and their sources; Effects of air pollution on human health and ecosystems; and Air quality monitoring and control measures. Land Degradation and Desertification: Land degradation processes and causes; Consequences for intensive agriculture; Sustainable land management techniques. Waste Management and Recycling: Types of waste and their environmental impacts; Recycling and waste reduction strategies; Circular economy principles. Energy Sources and Sustainability: Fossil fuels vs. renewable energy sources; Transitioning to a sustainable energy future; The role of individuals and governments in promoting clean energy.	

Urban Ecosystems: Issues and Challenges; Human sustainability; Social sustainability; Economic sustainability; Environmental sustainability. Curitiba - case study. Environmental Ethics and Environmental Justice: Ethical considerations in environmental decision-making; Environmental justice and its importance; Advocacy and community engagement.	

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B.Sc. Semester: 5

Title of the Course: **DSE-ENV E1-T-ENVIRONMENTAL PSYCHOLOGY AND ENVIRONMENTAL ETHICS**

Number of Theory Credits	Number of lecture hours/semester
3	**45**

Programme Specific Objectives	
PSO 1	To develop competency in understanding psychology in the perspective of environment.
PSO 2	To instil a knowledge about human interactions with the environment and its impact on human minds.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and conservation.

Programme Outcomes	
PO 1	Demonstrate competence in understanding the effect of environment on human minds.
PO 2	Demonstrate the ability to analyse the impact of disasters and risk on human and role of creating awareness.
PO 3	Ability to understand and appreciate the role of Environment movements in preserving the environments.

Content of Theory Course	**45 Hours**
Unit – 1	**15**
Environmental Psychology: History and Scope, Defining the field of environmental psychology. Origins and history. Environmental psychology's links with other disciplines. Key theoretical perspectives in environmental psychology. Complexity, time, and change. Environmental 'influences' on human cognition and behaviour. Place-related theories in environmental psychology. Urban Environments; Overcoming Stressors with Opportunities: The urban stress. People and Nature: An intrinsic interconnectedness of people and nature. The restorative capacity of natural environments. Anthropocentric, biocentric, and ecocentric views of the world. The New Environmental Paradigm. Connectedness with nature. Environmental change: impacts on human health and well-being. Conservation Psychology.	

Unit – 2	15
Environmental Risks and Interventions: Natural disasters and ecological threats: environmental risk and risk perception, the role of cognition and emotions, human behaviour in the face of risks, risk awareness and resilience. Interventions in human habitats: acceptance and the NIMBYism; Finding the right balance for the common good. The Psychology of Pro-Environmental Action Environmental and climate change; a pressing agenda. Psychological drivers of pro-environmental action: environmental attitudes, social representations, norms, beliefs, values, identity, environmental knowledge, the role of direct experience. Models explaining environmental behaviour. The role of habits and social practices. Behaviour spill over: a myth or a possibility? Encouraging environmental behaviour through interventions. The role of environmental education. Pro-environmental action in organizations.	
Unit – 3	**15**
Environmental Ethics: Introduction, Silent Spring and the Rise of the Environmental Movement, Religion & Environmental Ethics, Main Positions in Environmental Ethical Theory, Conflict & Convergence in Environmental Ethics, Case Studies: Sea World & Orcas in Captivity/wild horse management, Aldo Leopold & A Sand County Almanac, Faking Nature (Ethics of Restoration) The Wilderness Idea , Critique of the Wild, Biodiversity & Conservation Ethics, The Impacts and Ethics of Industrial Agriculture, Ethics of Alternative Agriculture, Science and Impacts of Climate Change, Climate Change as an Ethical Issue, Case Study: Geo engineering Ethics, Case Study: Coral Reefs in Peril, Living in the Anthropocene.	

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B.Sc. Semester: 5

Title of the Course: **ENV V1-T-LANDSCAPE ECOLOGY, URBAN PLANNING AND ECOTOURISM**

Number of Theory Credits	Number of lecture hours/ semester
3	**45**

Programme Specific Objectives	
PSO 1	To develop competency in understanding Landscape ecology and its applications.
PSO 2	To instil knowledge about the urbanization and the practices.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and conservation.

Programme Outcomes	
PO 1	Demonstrate competence in understanding Ecology and applying it for sustainable human needs.
PO 2	Demonstrate the understanding in development of Urban spaces and its benefits.
PO 3	Be able to develop competence and academic skills in contributing towards environment and its conservation.

Content of Theory Course	**45 Hours**
Unit - 1	**15**
Landscape Ecology: Introduction, definition, concepts – connectivity, corridor, cover type, edge, fragmentation, heterogeneity, matrix, patch, scale. Spatial relationships among landscape elements, flow of energy, mineral and nutrient cycling, species among elements, ecological dynamics of landscape mosaic through time. Interdisciplinary approach to landscape ecology. Linkages between community ecology and ecological restoration. Applications of landscape ecology: Concept of remote sensing and GIS. Ecological modelling.	
Unit – 2	**15**
Urbanization: Definition and causes. Challenges in urban areas – proliferation of slums, water supply and drainage, solid waste disposal, transportation. Urban sprawl and its impact on environment. Urbanization pattern in Karnataka and India.	

Urban ecosystem: Introduction, importance and overview of urban areas. Urban Heat Islands. Urban hydrology. Urban biodiversity Urban infrastructure and its challenges – energy, water, sewage and sanitation, solid waste disposal, transportation, telecommunication. Urban planning and design: Ecological principles in planning and urban design. Urban land use planning and policies in India. Sustainable Cities. Urban Green Spaces – Concept and benefits. Urban farming Urban forestry. Nature Conservation in Urban areas. Urban Renewal – Cultural, Environmental, Social, Economic and Physical. Strategies for Urban renewal – Redevelopment, Rehabilitation, Preservation, Revitalisation – advantages of urban renewal.	
Unit – 3	**15**
Ecotourism development - Sustainable Ecotourism. Resource Management, Socio-economic Development. Ecotourism Policies, Planning and Implementation. Eco-friendly Facilities and Amenities. Carrying Capacity, Alternative Tourism & Responsible Ecotourism- Ecotourism Programming. Ecotourism Development Agencies- Role of the International Ecotourism Society – the UNWTO, UNDP, WWF - Department of Forest and Environment - Government of India, ATREE, EQUATIONS. Conservation of Ecotourism Protected Area Management through Ecotourism - Community Participation - Types of Participation, Issues and Challenges - Ecotourism Projects - Case Studies on Bhadra Wildlife Sanctuary, Bandipur National Park, Nandadevi Biosphere Reserve, Corbett National Park, Kaziranga National Park, Thenmala Eco-Project, Similipal Ecotourism Project, Sunderbans Ecotourism Project, Gulf of Mannar, and Kruger National Park.	

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B.Sc. Semester: 5

Title of the Course: ENV V1-T-URBAN WASTE AND HAZARDOUS WASTE MANAGEMENT

Number of Theory Credits	Number of lecture hours/ semester
3	**45**

Programme Specific Objectives	
PSO 1	To develop the understanding of urban waste and hazardous waste.
PSO 2	To instil a knowledge of handling and processing of waste.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and management of urban and hazardous waste.
PSO 4	To inculcate creativity and innovative spirit in the domain of human-development and waste management.

Programme Outcomes	
PO 1	Demonstrate competence in understanding the types of waste and the sources.
PO 2	Demonstrate the ability to carry out the process of recycling and disposal methods of E-waste and plastic waste.
PO 3	Demonstrate competence in understanding the site selection and management of the landfill.
PO 4	Demonstrate the ability to understand the source and management of nuclear waste and biomedical waste.

Content of Theory Course	**45 Hours**
Unit - 1	**15**
Urban Waste: Classification of waste (Domestic Waste, Industrial Waste, Inert Waste, Non-hazardous Waste, Biodegradable Waste): Municipal Solid Waste Management, Classification, Principle of Integrated Solid Waste Management (ISWM) to Municipal Waste. Waste reduction and effective management of waste. Case study of Municipal Solid Waste and Construction & Demolition waste.	

E-waste: Introduction, E-waste characteristics; E-waste generation, collection, transport, recycling and disposal methods. Effects of E-wastes on the society and environment. E-waste waste management rules. Plastic waste: Sources, Production, Global and Indian Context; Plastic Waste Management Practices – Plastic management- recycling, energy production, landfilling and other applications.	
Unit – 2	**15**
Hazardous waste: Definition, sources, identification and classification. Collection, handling, storage and transport. TSDF concept of Hazardous waste. Hazardous waste management rules and regulations. Hazardous waste treatment technologies: Physical, chemical, Physico-chemical treatment, and thermal treatment; Solidification, chemical fixation, encapsulation, pyrolysis and incineration. Hazardous waste disposal: Hazardous waste landfills- Site selections, design and operation. Hazardous waste reduction, recycling and reuse. Remediation of hazardous waste contaminated sites. Management of different Hazardous wastes.	
Unit – 3	**15**
Nuclear waste: Characteristics – Types – Nuclear waste – Uranium mining and processing – Power reactors – Refinery and fuel fabrication wastes – spent fuel – Management of nuclear wastes – Decommissioning of Nuclear power reactors – Health and environmental effects. Biomedical waste: Introduction, sources, classification, collection, segregation, treatment and disposal. Biomedical Waste Management Rules.	

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B.Sc. Semester 6

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

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

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

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

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

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

References

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Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2009). Industrial microbiology: an introduction. John Wiley & Sons.

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

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

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

References

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Benson, H. J. 1998. Microbiological Applications – Laboratory Manual in General Microbiology. McGraw-Hill Publications.

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

B.Sc. Semester 6

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

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

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

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

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

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

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

References

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

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

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

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

References

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B.Sc. Semester: 6

Title of the Course: **DSC ENV C18-T-OCCUPATIONAL HEALTH AND SAFETY**

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

Programme Specific Objectives	
PSO 1	To develop competency in understanding occupational diseases and safety measures.
PSO 2	To instil a knowledge about the training programmes and assessment loads etc.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and safety measures to prevent it.
PSO 4	To inculcate creativity and innovative spirit in identifying appropriate skill to make the work place a safer place.

Programme Outcomes	
PO 1	Demonstrate competence in understanding the Health Management with relation to occupation.
PO 2	Demonstrate the ability to carry out necessary relevant training programmes required for different occupation.
PO 3	Demonstrate the ability to identify different hazards and measures to rectify it.
PO 4	Be able to understand the role of safety department and its functioning.

Content of Theory Course	**60 Hours**
Unit-1	**15**
Key elements of a safety and Health Management System- Policy & commitment, Planning, Implementation and Operation, Measuring Performance, Auditing and Reviewing Performance Initial Safety and health Management System, Definition of Occupational Health as per WHO/ILO, Occupational Health and Environmental Safety Management - Principles practices. Common Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.	

Unit-2	15
Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit. Ergonomics-Introduction, Definition, Objectives, Advantages. Ergonomics Hazards. Musculoskeletal Disorders and Cumulative Trauma Disorders. Physiology of respiration, cardiac cycle, muscle contraction, nerve conduction system etc. Assessment of Workload based on Human physiological reactions. Permissible limits of load for manual lifting and carrying. Criteria or fixation limits.	
Unit-3	**15**
Occupational Health and Environment Safety Management System, ILO and EPA Standards. Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures. Chemical Hazard: Introduction to chemical hazards, dangerous properties of chemical, dust, gases, fumes, mist, Vapours, Smoke and aerosols. Route of entry to human system, recognition, evaluation and control of basic hazards, concepts of dose response relationship, bio-chemical action of toxic substances. Concept of threshold, limit values.	
Unit-4	**15**
Fire Safety – Principles, Prevention, Detection and Communication, Occupant Protection, Containment and Extinguishments. Bureau of Indian standards on Safety and Health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, Role of safety department, Safety committee and function.	

References

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B.Sc. Semester: 6

Title of the Course: **DSC ENV E2-T-ENVIRONMENTAL CONTAMINATION AND REMEDIATION TECHNOLOGIES**

Number of Theory Credits	Number of lecture hours/ semester
3	**45**

Programme Specific Objectives	
PSO 1	To develop competency in understanding the concepts of Environmental contamination.
PSO 2	To instil a knowledge about the process of Environmental contamination and its harmful effects on living organisms.
PSO 3	To inculcate creativity and innovative spirit in finding methods of remediation.

Programme Outcomes	
PO 1	Demonstrate competence in understanding the nature of contaminants and their classification.
PO 2	Demonstrate competence in understanding the process of contamination and hazards with the contaminants.
PO 3	Be able to develop competence and academic skills in contributing towards the addressing the environmental issues with the help of remediation.

Content of Theory Course	**45 Hours**
Unit - 1	**15**
Environmental Contaminants: Definition, Classification of contaminants based on source: mining and mineral processing; fossil fuel combustion; agriculture, forestry and other biological; industrial production; consumerism. Classification based on chemical nature: organic and inorganic; hazardous; venomous; toxic, pathogenic, genotoxic and carcinogenic *etc.*, Point and non-point sources.	
Unit – 2	**15**
Emerging Classes of Environmental Contaminants: Definition, sources- Pharmaceuticals, personal care products, food industrial products,	

disinfectants, algal-toxins, biocides and metabolites, bioterrorism and disruptive devices (Biological and chemical warfare). Process of Environmental Contamination: Transport of contaminants through air, water, soil, food and other modes. Environmental concentrations of contaminants; bioconcentrations; biotransformation and bioaccumulation. Effect of contaminants: Exposures to environmental contaminants; Potential health hazards of environmental contaminants. Natural and Occupational Exposure. Hazard identification, prevention and remedies.	
Unit – 3	**15**
Remediation: Definition, types of remediation, scope of remediation, importance of remediation, Chemical remediation, phytoremediation, types of phytoremediation, bioremediation. Natural attenuation, Application of remediation technologies. Role of Nanotechnology, Hybridization of Technology.	

References

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B.Sc. Semester: 6

Title of the Course: **DSE ENV E2-T-ENVIRONMENTAL ISSUES AND CLIMATE CHANGE**

Number of Theory Credits	Number of lecture hours/semester
3	**45**

Programme Specific Objectives	
PSO 1	To develop competency in understanding the Global Environmental Issues.
PSO 2	To develop awareness about the Environmental Issues of India.
PSO 3	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	Ability to understand the environmental Impact caused by different projects.
PO 3	Ability to understand the environmental impacts caused by different types of disasters.

Content of Theory Course 6	**45 Hours**
Unit - 1	**15**
Global Environmental Issues -Biodiversity Loss, Climate Change, Ozone Layer Depletion, Sea Level Rise, International Efforts for Environmental Protection. National Action Plan on Climate Change-Eight National Missions – National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for A 'green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change.	
Unit – 2	**15**
Current Environmental Issues in India - Environmental Issues Related to Water Resource Projects - Narmada Dam, Tehri Dam, Almatti Dam, Kaveri	

and Mahanadi, Hydro-power Projects in Jammu & Kashmir, Himachal and North-Eastern States. International Issues related to Rivers. Water Conservation - Development of Watersheds, Rain Water Harvesting, and Ground Water Recharge. National River Conservation Plan - Namami Gange and Yamuna Action Plan. Eutrophication and Restoration of Lakes - Conservation of Wetlands, Ramsar Sites in India. Soil Erosion: Types, Reclamation of Degraded Land, Desertification and Its Control.	
Unit – 3	**15**
Climate Change: Adaptability, Energy Security, Food Security, And Sustainability Forest Conservation: Chipko Movement, Appiko Movement, Silent Valley Movement, and Gandhamardan Movement, People Biodiversity Register Wildlife Conservation Projects: Project Tiger, Project Elephant, Crocodile Conservation, GoI-UNDP Sea Turtle Project, Indo-rhino Vision. Carbon Sequestration and Carbon Credits Waste Management - Swacch Bharat Abhiyan Sustainable Habitat- Green Building, Griha Rating Norms Vehicular Emission Norms in India Epidemiological Issues-Malaria, Dengue, Chikungunya, Zika, Filariasis, H1N1, COVID. 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.	

References

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B.Sc. Semester: 6

Title of the Course: **ENV V2-T QUALITY ASSURANCE AND QUALITY CONTROL IN ENVIRONMENTAL ANALYSIS**

Number of Theory Credits	Number of lecture hours/ semester
3	**45**

Programme Specific Objectives	
PSO 1	To develop competency in understanding quality measures in environmental analysis.
PSO 2	To motivate and inspire to acquire contemporary understanding and skills leading to data collection and analysis.
PSO 3	To inculcate creativity and innovative spirit in the domain of quality control and analysis leading to vocation/entrepreneurial opportunities.

Programme Outcomes	
PO 1	Demonstrate an entry level competence in understanding the methods and methodologies of lab analysis.
PO 2	Demonstrate the ability to carry out ecological analysis in field conditions/laboratories and make appropriate judgements.
PO 3	Ability to understand and handle advance instruments for analysis.

Content of Theory Course	**45 Hours**
Unit - 1	**15**
Definitions of Quality, Quality assurance, Quality control. Difference between quality control and assurance; types of quality control-x bar chart, Taguchi method,100% inspection method, six sigma. Environmental analysis – Good lab practices, laboratory design and maintenance. Standard operating procedures (SOP). Total quality information for environmental analysis ,development of methodology, validation of methodology and data collected, Data management - storage, validation, checks (general and conditional), data	

analysis, presentation and interpretation, quality assessment in laboratories.	
Unit – 2	**15**
Quality Assurance / Quality Control in environmental data collection Field Data. Land use (LU): Procurement of satellite imagery, Ground truthing of study area. Air / water / noise/ Soil - Ensure site specific micro-meteorological data, Procurement of IMD data for the region, Prior meeting with lab staff & field personnel, Random checks at site, verifying siting location of monitoring equipment's, verifying calibration records, inspecting instruments for working conditions at site. Discussions with field staff at site. Review of field data sheets. Power availability at site. Inspections to Lab and discussions with lab personnel. Usage of relevant software for Air. Quality Modelling purpose. Ecology: Verification of field equipment's. Review of field data sheets. Use of latest Forest Working Plans, Type of cameras for the study. Inspections to Lab and discussions with lab personnel (aquatic sample test/analysis. Socio-Economics (SE): Discussion with officers concerned, Procurement of latest Census data, Type of records being collected (Notifications, LA, R&R, Compensation etc.,) Discussions with survey staff.	
Unit – 3	**15**
Accreditation for laboratories, need for accreditation, accreditation bodies in India- NABL, ISO 17025- testing laboratories and calibration, QCI-NABET., Benefits for project proponents and consultants; Environmental consultants: need and role, Accredited laboratories and certification of the consultants, role of CPCB and SPCB in assessment and accreditation, Case studies, preparation of QA and QC reports Data collection and documentation, Calibration of instruments and techniques, Use of statistical tools for data interpretation, Visit to NABL accredited laboratories, Preparation of quality assessment reports, Standards international and national policies and documentation, ISO Auditing procedures and documentation, Accreditation process for laboratories.	

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B.Sc. Semester: 6

Title of the Course **- ENV V2-T-ENVIRONMENT AND GREEN MARKETING**

Number of Theory Credits	Number of lecture hours/ semester
3	45

Programme Specific Objectives	
PSO 1	To develop competency in understanding the Environmental Economics and entrepreneurship.
PSO 2	To motivate and inspire to acquire contemporary understanding and skills leading to Entrepreneurship.
PSO 3	To develop competency in understanding the techniques of Green Marketing.

Programme Outcomes	
PO 1	Demonstrate an entry level competence in understanding the Environmental Economics.
PO 2	Demonstrate an understanding about Eco-Marketing.
PO 3	Demonstrate ability to develop sustainable, clean marketing strategies.

Content of Open Elective Theory Course	45 Hours
Unit-1	**15**
Introduction to Environmental Economics and Entrepreneurship, Types of Green Economics, Principles and Objectives of Environmental economics, Entrepreneurship, Green Business, Green marketing. Entrepreneurship and motivation. Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Green Rating or Green labelling, Rating, Entrepreneurship Development Programs – Need, Objectives. Creativity and entrepreneurship.	
Unit-2	**15**
Business Plan for New Environmental Ventures. Making money by saving the world, Meaning and Objectives of a Business Plan, Small Enterprises – Definition, Classification, Low cost recycling business opportunities, Concept of Non Profit Organizations, NGOs, Companies, Factories, Steps involved in setting up a Business – identifying, Role of Supply and Chain Management in Green Marketing. Selecting a Good Business opportunity, Market Survey and Research, Techno Economic	

Feasibility Assessment, Advantages and cost of preparing a Business Plan, Critical Assessment.	
Unit-3	**15**
Funds and Financing Support for Green marketing, Green Finance, Start-up Public policy for green finance, policy of state and central Government, Bank linkages, Sources of finances, loans, Macro and micro finance, Break Even Analysis, Fundraising and venture capital. Advertising and marketing for sustainability innovation. Foundations of public relations and strategies and tools for gaining media attention for your new venture, introduction to advertising including effective campaign, Green Summit, Environmental practices and customer, satisfaction in services, Marketing and adoption of Environmental friendly products, Obstacles to commercialization of clean technology.	

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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.

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, Department of Environmental Science, Yuvaraja's College (Autonomous), University of Mysore, Mysuru	Member	
Dr. B. S. Prabhakar	Associate Professor, Department of Environmental Science, St. Joseph's University, Bengaluru	Member	
Dr. K. L. Prakash	Professor, Department of Environmental Science, Bangalore University, Bengaluru	Member	
Smt. Akshatha Chandra, G. R.,	Special Officer, Karnataka State Higher Education Council, Government of Karnataka	Member Convenor