Bangalore University

Curriculum Framework for Four year Undergraduate Multidisciplinary Programme (Honours) & Master Programme in Colleges and Universities of Karnataka State under NEP 2020

5th and 6th Semester Syllabus

For

B.Sc in
Environmental Science

Bangalore University
Bangalore

BANAGALORE UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL SCIENCE
BANGALORE - 560056

Proceedings of the Board of Studies (UG) meeting held on 19th of August 2023 in the Department of Environmental Science, Bangalore University, Bengaluru - 560056

A meeting of BOS (UG) was convened on 19th of August 2023 10.30am in the Department of Environmental Science, Jnana Bharathi Campus, Bangalore University, Bengaluru – 560056.

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

1. Approval of Under Graduate third year syllabus (V & VI Semester) for implementation from the academic year 2023-24 as per the New National Education Policy (NEP – 2020)
2. Course pattern and Scheme of Examination, 2023-24

Members have examined the scheme and syllabus submitted by Expert Committee constituted by Government of Karnataka. The committee members have discussed and approved the scheme and syllabus for fifth and sixth semester UG course for implementation from the academic year 2023-24. The meeting ended with vote of thanks by the chairman.

Members Present

1. Dr. Nagaraja Parisara
2. Dr. Alaknanda J Adur 19/8/23
3. Dr. Rinku Verma Rinku Verma 19/8/23

Members Absent

Dr. Kavitha K R

Dr. Helene Roseline

19/08/2023

(Dr. K.L. Prakash)
Chairman

Dr. K.L. PRAKASH Ph.D.
Professor & Chairman
Dept. of Environmental Science
Bangalore University
Bengaluru - 560 056.

PROPOSED CURRICULUM STRUCTURE FOR UNDER GRADUATE ENVIRONMENTAL SCIENCE DEGREE PROGRAMME

IIA.Model Programme structure for Bachelor of Science(Basic/Hons.) with practical with two major subjects

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),	DSC -B9(4), B10(2), B11(4), B12(2)		**SEC-4**: Employability Skills/Cyber Security (3)		27

	A11(4), A12(2)			(2+0+2)		
VI	DSC Env. Science-A13(4), A14(2), A15(4), A16(2)	DSC -B13(4), B14(2), B15(4), B16(2)		Internship (2)		26
Students exiting the programme after 3-years will be awarded UG Degree in Discipline A with Discipline B as Major 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.

Numbers in the parenthesis refer to credits.

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

Syllabus Aims

The aim of the syllabus describes the B.Sc in Environmental Science at 5th and 6th semester. These aims outline the educational context in which syllabus content should be viewed. Most of the objectives are delivered by adopting suitable case studies, through application of Environmental Science skills along with Practical and field visits.

The B.Sc Environmental Science aims to enable students to

1. Better understanding the significance of studying Environmental Science
2. To enhance the knowledge and ability to use and apply appropriate skills and techniques including field work/visit
3. To understand the processes and functioning at various scales within physical and human environments.
4. To understand the relationship between humans and the environment to establish a sustainable future.
5. To focus on the importance of Environmental Sustainability.
6. To investigate and to solve complex environmental issues
7. To tackle the major environmental problems locally and globally over time.
8. Develop and enhance essential skills such as critical thinking, problem-solving, and creative thinking.
9. Develop a concern for accuracy and objectivity in extracting, recording, processing, presenting, analysing and interpretation of the data.
10. To Improve a logical approach, to present a structured scientific and systematic coherent and evidence based discussion.

PROGRAM OUTCOME (POS) BY THE END OF THE PROGRAM THE STUDENTS WILL ABLE TO			
PO1	Environmental knowledge	:	Give an explanation of most of the relevant terms and concept of Environmental Science.
PO2	Environment and Society	:	To address the environmental and societal issues and compare Spatio-temporal regions of the environments and people.
PO3	Multi- disciplinary approach	:	To integrate geographical evidence, ideas and discussion with multi-disciplinary setting.
PO4	Modern tool	:	Application of modern tools and techniques to interpret the processes to bring changes in systems distributions and environment.
PO5	Research of complex Problems	:	To demonstrate skills of analysis and synthesis of Environmental information based on the Field survey and laboratory analysis.
PO6	Communications	:	To recognise human activities, to identify trends and patterns, environmental data globally by using effective communication.
PO7	Project Management	:	Recognise Environmental Principals, theories and models to manage projects and achieve its objectives.
PO8	Problem analysis	:	Find solution to environmental and Human issues.
PO9	Environmental ethics	:	Develop ethical principles and commit to professional ethics and responsibilities and norms of scientific practices.
PO10	Continuous learning	:	Understand the effects of Environmental processes and change on physical and human environments and continuous learning of environmental studies in implementation
PO11	Environment and sustainability	:	Conflicts of interest and other factors interaction, management of physical and human environments to bring environmental sustainability
PO12	Design/ Developments of solutions	:	Carry out investigation into the complex and interactive nature of physical and human environments.

Program Name	**B.Sc in Environmental Science**	Semester	**5**
Course title	**AIR POLLUTION, WATER POLLUTION AND ENVIRONMENTAL ENGINEERING**		
Course Code	**DSC ENV A9-T**	No of Credits	**4**
Contact Hours	**60 hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment marks	**40**	Summative Assessment marks	**60**

Course Pre-requisite(s): No Pre-requisite Course (s)	
Course Outcome (COs) After the successful completion of the course, the student will be able to :	
CO1	To develop competency in understanding the concepts of pollution and its impacts.
CO2	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
CO3	To understand environmental quality analysis and techniques.
CO4	To develop knowledge on act and rules related to pollution.
CO5	To encourage an introductory knowledge of engineering concepts for controlling the pollution

Contents	**60hrs**
Unit -1 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, CO2, SOx, NOx, PAN, Ground level Ozone, PM<10µm, PM<2.5µm, PM<1µm, Acid rain, Thermo-chemical – CO2, and Photochemical reactions - O3 & 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.	**15**

Unit 2 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.	**13**
Unit 3 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.	**12**
Unit 4 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	**20**

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.	

Course Articulation Matrix: mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (Cos)/Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	-	-	1	1	-	-	2	1	-	-	-
CO 2	1	-	3	1	1	-	-	1	-	-	1	-
CO 3	-	-	3	1	1	-	-	-	-	-	-	-
CO 4	3	-	1	-	3	-	-	-	-	-	1	1
CO 5	3	1	1	-	2	2	-	-	1	-	1	1

Pedagogy:

Teaching Strategies: Interactive Lectures, Inquiry-based learning, group discussions, quiz, group work, Field –based study, Study tour, case studies and debates, hands on training.

Continuous Assessment and Evaluation: Formative and Summative Assessments, Feedback and oral examinations Use of Digital tools and platforms for teaching, learning and research/ dissertation analysis.

Formative Assessment for Theory	
Assessment occasion/type	**Marks**
Sessional Tests- 1	10
Sessional Tests- 2	10
Seminars/presentations/ Assignment	10
Case study/ Field work	10
Total	**40marks**
Formative Assessment as per NEP Guidelines are compulsory	

Program Name	**B.Sc in Environmental Science**		Semester	**5**
Course title	**AIR AND WASTEWATER ANALYSIS**		Practical Credits	**02**
Course Code	**DSC ENV A10-P**		Contact Hours	**60 hours**
Formative Assessment		**25 marks**	Summative Assessment	**25 marks**

Course Pre-requisite(s): No Pre-requisite Course (s)	
Course Outcome (COs) After the successful completion of the course, the student will be able to :	
CO1	To develop competency in understanding the concepts of Air pollution and pollutants.
CO2	To instil an introductory knowledge of water engineering concepts for controlling the pollution.
CO3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
CO4	To develop knowledge on Meteorological parameters.
CO5	To understand the existing treatment technologies and scope of developing these methods.

Practical Contents

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

Course Articulation Matrix: mapping of Course Outcomes (COs) with Program Outcomes (POs1-12)

Course Outcomes (Cos)/Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	-	3	1	1	2	-	-	-	-	-	-	-
CO 2	-	-	1	1	1	-	1	-	-	3	-	-
CO 3	2	-	2	1	1	1	-	-	1	-	1	-
CO 4	3	1	1	1	-	-	-	-	1	1	1	1
CO 5	2	2	1	1	1	1	-	2	1	1	1	1

Pedagogy:

Teaching Strategies: Interactive Lectures, Inquiry-based learning, group discussions, quiz, group work, Field –based study, Study tour, case studies and debates, hands on training.

Continuous Assessment and Evaluation: Formative and Summative Assessments, Feedback and oral examinations Use of Digital tools and platforms for teaching, learning and research/ dissertation analysis.

Formative Assessment for Theory	
Assessment occasion/type	**Marks**
Sessional Tests- 1	**05**
Sessional Tests- 2	**05**
Case study/Assignment/ Field activity/ project work etc	**05**
Practical Record Maintenance	**10**
Total	**25 marks**
Formative Assessment as per NEP Guidelines are compulsory	

References	
1	Anjaneyulu Yerramilli. (2019). *Air Pollution Prevention and Control Technologies*. BS Publications. 1-828.
2	Donn, W. L. 1975. Meteorology. McGraw – Hill Book Co.
3	Garg, S.K. (1990). *Environmental Engineering Vol I &II Sewage Disposal and Air Pollution Engineering*, Khanna Publ. Delhi.
4	Harrison, R. M. and Perry, R. 1986. Handbook of Air Pollution Analysis. Chapman and Hall.
5	Kazt, M. 1969. Measurement of Air Pollutants. WHO.
6	NEERI Manual. 1982. Air Quality Monitoring. NEERI Publications.
7	Paul Guyer. J. (2021). An Introduction to Air Pollution Control Engineering. UNICORN Publishing Group. 1-182.
8	Sawyer, C. N. and Mc Carty, P. L. 1978. Chemistry for Environmental Engineering. McGraw – Hill International.
9	Stern, A. C. 1986. Air pollution Vol. I – VIII. Academic Press Inc
10	Standard Methods for Examination of Water and Wastewater. 2012. APHA – WEF.
11	NEERI Manual. 1982. Air Quality Monitoring. NEERI Publications.

Program Name	**BSc in Environmental science**	Semester	**5**
Course title	**NOISE, LAND, RADIATION POLLUTION AND SOLID WASTE MANAGEMENT**		
Course Code	**DSC ENV A11-T**	No of Credits	**4**
Contact Hours	**60 hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment marks	**40**	Summative Assessment marks	**60**

Course Pre-requisite(s): No Pre-requisite Course (s)	
Course Outcome (COs) After the successful completion of the course, the student will be able to :	
CO1	To develop competency in understanding the concepts of pollution and its impacts.
CO2	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
CO3	To understand environmental quality analysis and techniques.
CO4	To develop knowledge on act and rules related to pollution.
CO5	To encourage an introductory knowledge of engineering concepts for controlling the pollution

Contents	**60hrs**
Unit -1 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.	**15**
Unit 2 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.	**15**

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 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 - Source 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.	**15**
Unit 4 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 – Landfarming, Bioreactors and Anaerobic decomposition; and Physical treatment – Solidification, 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	**15**

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.	

Course Articulation Matrix: mapping of Course Outcomes (COs) with Program Outcomes (POs1-12)

Course Outcomes (Cos)/Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	-	3	1	1	-	-	-	-	-	-	-	-
CO 2	-	-	1	1	2	-	1	-	-	3-	-	-
CO 3	2	-	2	1	2	-	-	-	1	-	1	-
CO 4	3	1	1	1	-	-	-	-	1	1	1	1
CO 5	3	1	2	1	2	-	1	-	2	-	1	1

Pedagogy:

Teaching Strategies: Interactive Lectures, Inquiry-based learning, group discussions, quiz, group work, Field –based study, Study tour, case studies and debates, hands on training.

Continuous Assessment and Evaluation: Formative and Summative Assessments, Feedback and oral examinations Use of Digital tools and platforms for teaching, learning and research/ dissertation analysis.

Formative Assessment for Theory	
Assessment occasion/type	**Marks**
Sessional Tests- 1	10
Sessional Tests- 2	10
Seminars/presentations/ Assignment	10
Case study/ Field work	10
Total	**40 marks**
Formative Assessment as per NEP Guidelines are compulsory	

Program Name	**B.Sc in Environmental Science**		Semester	**5**
Course title	**SOIL ANALYSIS, NOISE MEASUREMENT AND SOLID WASTE ANALYSIS**		Practical Credits	**02**
Course Code	**DSC ENV A12-P**		Contact Hours	**60 hours**
Formative Assessment		25 marks	Summative Assessment	**25 marks**

Course Pre-requisite(s): No Pre-requisite Course (s)	
Course Outcome (COs) After the successful completion of the course, the student will be able to :	
CO1	To develop competency in understanding the concepts of Noise pollution and
CO2	To instil an introductory knowledge of Solid waste management concepts for controlling the soil pollution.
CO3	To develop knowledge on Physico- chemical properties of soil parameters.
CO4	To qualitative and Quantitative characterisation of solid waste
CO5	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.

Practical Contents

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

Course Articulation Matrix: mapping of Course Outcomes (COs) with Program Outcomes (POs1-12)

Course Outcomes (Cos)/Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	1	1	1	-	-	-	-	1	1	1	1
CO 2	-	-	1	1	1	-	1	-	-	3	-	-
CO 3	-	3	1	1	2	-	-	-	-	-	-	-
CO 4	2	-	2	1	1	1	-	-	1	-	1	-
CO 5	2	2	1	1	1	1	-	2	1	1	1	1

Pedagogy:

Teaching Strategies: Interactive Lectures, Inquiry-based learning, group discussions, quiz, group work, Field –based study, Study tour, case studies and debates, hands on training.

Continuous Assessment and Evaluation: Formative and Summative Assessments, Feedback and oral examinations Use of Digital tools and platforms for teaching, learning and research/ dissertation analysis.

Formative Assessment for Theory	
Assessment occasion/type	**Marks**
Sessional Tests- 1	**05**
Sessional Tests- 2	**05**
Case study/Assignment/ Field activity/ project work etc	**05**
Practical Record Maintenance	**10**
Total	**25 marks**
Formative Assessment as per NEP Guidelines are compulsory	

References	
1	B. B. Hosetti. (2006). Prospects and Perspective of Solid Waste Management. New Age International (P) Limited. 1-216.
2	Bhatia, S.C. (2003). Managing Industrial Pollution. Macmillan India Ltd.
3	Davis, M. L. and Cornwell, D. A. (1991). Introduction to Environmental Engineering. McGraw – Hill International.
4	Metcalf and Eddy, Inc. Revised by Tchobanoglous, G. and Burton. (2019). Wastewater Engineering– Treatment, Disposal and Reuse. McGraw Hill Inc
5	Mishra, P. C. (1989). Soil Pollution and Soil Organisms. Ashish Publishing House.
6	Ramesha Chandrappa, Diganta Bhusan Das. (2012). Solid Waste Management Principles and Practice. Springer Berlin Heidelberg. 1-414.
7	Rumana Riffat, Taqsim Husnain. (2022). Fundamentals of Wastewater Treatment and Engineering. CRC Press. 1-430.
8	Stephen Asbury, Peter Ashwell. (2007). Health and Safety, Environment and Quality Audits. Butterworth-Heinemann publishers. 1-230.
9	Vasudevan Rajaram., Faisal Zia Siddiqui., Sanjeev Agarwal and Mohammed Emran Khan.2022. Solid and Liquid Waste Management. Waste to Wealth. Asoke K. Ghosh, PHI Learning Pvt.Ltd., New Delhi.
10	Tchobanoglous, G., Theisen, H., & Eliassen, R. (1977). Solid wastes: Engineering principles and management issues

6th SEMESTER

B.Sc

ENVIRONMENTAL SCIENCE

Program Name	**B.Sc in Environmental Science**	Semester	**6**
Course title	**ENVIRONMENTAL MICROBIOLOGY**		
Course Code	**DSC ENV A13-T-**	No of Credits	**4**
Contact Hours	**60 hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment marks	**40**	Summative Assessment marks	**60**

Course Pre-requisite(s): No Pre-requisite Course (s)	
Course Outcome (COs) After the successful completion of the course, the student will be able to :	
CO1	To develop competency in understanding the microbes of Environment
CO2	To know better knowledge about roles of microbes in the Environment
CO3	To motivate and inspire to acquire contemporary understanding and using the knowledge for remediation.
CO4	To inculcate creativity and innovative spirit in identifying appropriate measures for recycling and conservation
CO5	To know better knowledge on water and waste water treatment by microbes

Contents	**60hrs**
Unit -1: 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.	**15**
Unit 2: 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. Salient features of Air Pollution (Prevention and Control) Act, 1981 and latest amendments; National Clean Air Programme 2019 and latest amendments.	**15**
Unit 3: 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 –	**15**

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: Application of microbes in Environment: Bio fertilizers and biopesticide: Introduction, scope and importance, Biofertilizer- Rhizobium, azotobactor, azospirilium, Blue green algae, azolla, mycorrhizae. Phosphate solubilizing microorganisms, large scale production, vermicomposting, advantage and disadvantages. Bio-control agents- Bio insecticide, bio herbicide, disease control, advantage and disadvantages. Restoration of Degraded Lands: Reforestation through micro propagation for tropical reforestation on adverse sites; development of stress tolerant plants; use of mycorrhizae in reforestation: use of microbes for improving soil fertility – nitrogen fixing actinomycetes; reforestation of soils contaminated with heavy metals. Role of microbes inorganic solid waste management: Composting–anaerobic and aerobic (Windrows method, accelerated composting, Bio-mechanical composting machines). Role of inoculum in composting. Vermicomposting.	**15**

Course Articulation Matrix: mapping of Course Outcomes (COs) with Program Outcomes (POs1-12)

Course Outcomes (Cos)/Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	-	-	1	1	-	-	2	1	-	-	-
CO 2	1	-	3	1	1	-	-	1	-	-	1	-
CO 3	-	-	3	1	1	-	-	-	-	-	-	-
CO 4	3	-	1	-	3	-	-	-	-	-	1	1
CO 5	2	-	2	1	1	1	-	-	1	-	1	-

Pedagogy:

Teaching Strategies: Interactive Lectures, Inquiry-based learning, group discussions, quiz, group work, Field –based study, Study tour, case studies and debates, hands on training.

Continuous Assessment and Evaluation: Formative and Summative Assessments, Feedback and oral examinations Use of Digital tools and platforms for teaching, learning and research/ dissertation analysis.

Formative Assessment for Theory	
Assessment occasion/type	**Marks**
Sessional Tests- 1	10
Sessional Tests- 2	10
Seminars/presentations/ Assignment	10
Case study/ Field work	10
Total	**40marks**
Formative Assessment as per NEP Guidelines are compulsory	

Program Name	**B.Sc in Environmental Science**	Semester	5
Course title	**ENVIRONMENTAL MICROBIOLOGY**	Practical Credits	02
Course Code	**DSC ENV A14-P**	Contact Hours	60 hours
Formative Assessment	25 marks	Summative Assessment	25 marks

Course Pre-requisite(s): No Pre-requisite Course (s)	
Course Outcome (COs) After the successful completion of the course, the student will be able to :	
CO1	To develop competency in understanding the concepts of Micro biology.
CO2	To instil an introductory knowledge of Bacteria culture concepts.
CO3	To develop knowledge on Microbial equipment techniques.
CO4	To understand the metals impacts on Microbes.
CO5	To know better knowledge on water and waste water treatment by microbes.

Practical Contents

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

Course Articulation Matrix: mapping of Course Outcomes (COs) with Program Outcomes (POs1-12)

Course Outcomes (Cos)/Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	1	1	1	-	-	-	-	1	1	1	1
CO 2	-	3	1	1	2	-	-	-	-	-	-	-
CO 3	2	2	1	1	1	1	-	2	1	1	1	1
CO 4	2	-	2	1	1	1	-	-	1	-	1	-
CO 5	-	-	1	1	1	-	1	-	-	3	-	-

Pedagogy:

Teaching Strategies: Interactive Lectures, Inquiry-based learning, group discussions, quiz, group work, Field –based study, Study tour, case studies and debates, hands on training.

Continuous Assessment and Evaluation: Formative and Summative Assessments, Feedback and oral examinations Use of Digital tools and platforms for teaching, learning and research/ dissertation analysis.

Formative Assessment for Theory	
Assessment occasion/type	**Marks**
Sessional Tests- 1	**05**
Sessional Tests- 2	**05**
Case study/Assignment/ Field activity/ project work etc	**05**
Practical Record Maintenance	**10**
Total	**25 marks**
Formative Assessment as per NEP Guidelines are compulsory	

References	
1	Aneja, K. R. 1996. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan
2	Atlas, R. M. and Bartha, R. 1998. Microbial Ecology – Fundamentals and Applications. Benjamin/Cummings Science Publishing.
3	Benson, H. J. 1998. Microbiological Applications – Laboratory Manual in General Microbiology. McGraw-Hill Publications
4	Bitton, G. 1994. Wastewater Microbiology. Wiley-Liss Inc. McGraw Hill International Editions.
5	Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, 1st Ed., Chand and Company Ltd., India.
6	Hurst, C. J. (Ed.). (2019). The structure and function of aquatic microbial communities (Vol. 7). Springer.
7	Mitchel, R. (Ed.) 1992. Environmental Microbiology. Wiley-Liss Inc
8	Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. 1993. Microbiology – Concepts and Applications. McGraw-Hill Book Co.
9	Southey, C., Kaushik, N. and Trivedi, R. K. (Eds). 2001. Detergents and the Environment. Tata McGraw-Hill Publishing Co. Ltd.
10	Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2009). Industrial microbiology: an introduction. John Wiley & Sons.

Program Name	**B.Sc in Environmental science**	Semester	**6**
Course title	**ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL RISK ASSESSMENT**		
Course Code	**DSC ENV A15-T-**	No of Credits	**4**
Contact Hours	**60 hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment marks	**40**	Summative Assessment marks	**60**

Course Pre-requisite(s): No Pre-requisite Course (s)	
Course Outcome (COs) After the successful completion of the course, the student will be able to :	
CO1	To develop competency in understanding the process of assessing the Environmental Impacts.
CO2	To instil a knowledge on methodologies used for assessment of Environmental Impact.
CO3	To inculcate creativity and innovative spirit in identifying appropriate assessment tools.
CO4	To understand the applications of environmental auditing
CO5	To motivate and inspire to acquire contemporary understanding of Occupational health and safety

Contents	**60hrs**
Unit -1 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.	**15**
Unit 2EIA 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.	**13**
Unit 3 Environmental Audit: Concept, Aims and Objectives; Elements of Environmental audit - Internal and External audit. Types of Environmental Audit: Environmental Compliance Audits,	**12**

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 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	**20**

Course Articulation Matrix: mapping of Course Outcomes (COs) with Program Outcomes (Pos1-12)

Course Outcomes (Cos)/Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	-	-	1	1	-	-	2	1	-	-	-
CO 2	1	-	3	1	1	-	-	1	-	-	1	-
CO 3	2	-	2	1	1	1	-	-	1	-	1	-
CO 4	3	-	1	-	3	-	-	-	-	-	1	1
CO 5	-	-	3	1	1	-	-	-	-	-	-	-

Pedagogy:

Teaching Strategies: Interactive Lectures, Inquiry-based learning, group discussions, quiz, group work, Field –based study, Study tour, case studies and debates, hands on training.

Continuous Assessment and Evaluation: Formative and Summative Assessments, Feedback and oral examinations Use of Digital tools and platforms for teaching, learning and research/ dissertation analysis.

Formative Assessment for Theory	
Assessment occasion/type	**Marks**
Sessional Tests- 1	10
Sessional Tests- 2	10
Seminars/presentations/ Assignment	10
Case study/ Field work	10
Total	**40marks**
Formative Assessment as per NEP Guidelines are compulsory	

Program Name	**B.Sc in Environmental Science**	Semester	6
Course title	**METHODS OF ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL AUDIT**	Practical Credits	02
Course Code	**DSC ENV A16-P**	Contact Hours	60 hours
Formative Assessment	25 marks	Summative Assessment	25 marks

Course Pre-requisite(s): No Pre-requisite Course (s)	
Course Outcome (COs) After the successful completion of the course, the student will be able to :	
CO1	To develop competency in understanding the concepts of EIA in Development projects.
CO2	To instil an introductory knowledge of EIA report preparation
CO3	To develop knowledge on EIA, EMP and EMS
CO4	To motivate and inspire to acquire contemporary understanding on environmental audits
CO5	To understand the Occupational health impacts

Practical Contents

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

Course Articulation Matrix: mapping of Course Outcomes (COs) with Program Outcomes (POs1-12)

Course Outcomes (Cos)/Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	-	3	1	1	2	-	-	-	-	-	-	-
CO 2	2	2	1	1	1	1	-	2	1	1	1	1
CO 3	3	1	1	1	-	-	-	-	1	1	1	1
CO 4	2	-	2	1	1	1	-	-	1	-	1	-
CO 5	-	-	1	1	1	-	1	-	-	3	-	-

Pedagogy:

Teaching Strategies: Interactive Lectures, Inquiry-based learning, group discussions, quiz, group work, Field –based study, Study tour, case studies and debates, hands on training.

Continuous Assessment and Evaluation: Formative and Summative Assessments, Feedback and oral examinations Use of Digital tools and platforms for teaching, learning and research/ dissertation analysis.

Formative Assessment for Theory	
Assessment occasion/type	**Marks**
Sessional Tests- 1	**05**
Sessional Tests- 2	**05**
Case study/Assignment/ Field activity/ project work etc	**05**
Practical Record Maintenance	**10**
Total	**25 marks**
Formative Assessment as per NEP Guidelines are compulsory	

References	
1	Anjaneyulu, Y. and Valli Manickam. 2014. Environmental Impact Assessment Methodologies. BS Publications, Hyderabad.
2	Barton, H., & Bruder, N. (2014). A guide to local environmental auditing. Routledge.
3	Barthwal, R.R.2009. Environmental Impact Assessment. New Age International publication.
4	Canter, L. W. 1996. Environmental Impact Assessment. McGraw Hill Inc.
5	Erickson, P. A. (1994). A practical guide to environmental impact assessment. Academic Press Inc.
6	Munier, N. (2004). Multicriteria environmental assessment: a practical guide. Springer Science & Business Media.
7	Rathi, A. K. A. (2021). Handbook of Environmental Impact Assessment: Concepts and Practice. Cambridge Scholars Publishing.
8	Shrivastava, A. K. 2003. Environment Impact Assessment. APH Publishing Corporation.
9	Thompson, D., & Wilson, M. J. (1994). Environmental auditing: theory and applications. Environmental Management, 18(4), 605-615.
10	Trivedi, P. R. 2004. Environmental Impact Assessment. APH Publishing Corporation.