**Kuvempu University**

**Department of Environmental Science**

Jnana Sahyadri Campus

Shankaraghatta –577451

**Syllabus for**

# V&VI Semester
# Environmental Science Papers
# Under-Graduate(UG)Program
# Framed according to the National Education Policy(NEP -2020)

**August -2023**

# PROPOSED CURRICULUM STRUCTURE FOR UNDERGRADUATE 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**

# Programme Articulation Matrix

| Semester | Title /Name of the course | Programme outcomes that the course addresses (not more than 3 per course) | Pre-requisite course(s) | Pedagogy | Assessment |
|---|---|---|---|---|---|
| 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 | |

| 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 | |

Exit option with Bachelor of Science, B.Sc. Degree in Environmental Science (149 credits) or continue studies with Major in the Fourth year

**Job opportunities for the Exit option with Bachelor of Science Degree**

- Assistants in Central and State Pollution Control Boards
- Environmental Health and Safety Assistant in industries
- Occupational Health and Safety Assistant in industries/theme parks
- Public Health/Waste Management Officers in Municipalities
- Wastewater Treatment Plant Managers
- Environmental/Production Quality Assurance Executive - Junior
- Environmental Analyst (Validation)
- Research Assistant/Staff
- R&D Lab Assistant

- Water testing labs or chemical suppliers/ Entrepreneurship
- Liaison Officer
- Watershed Management Assistant
- Mineral/Energy Resource Exploration Assistant
- Solar energy/alternate energy Executives
- Micro irrigation Executives
- Organic Farming Executives/Entrepreneurship
- NGOs/Consultancy firms
- Teachers in Schools
- Self-employment

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

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

Title of the Course:**DSC ENV A9-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.<br>Meteorological parameters: Solar radiation, Temperature, Humidity (Absolute, Specific & Relative), Wind speed & direction, Pressure and Precipitation.<br>**Air pollution**: Definition. Sources of air pollution (Point and non-point). | |

| | |
|---|---|
| Classification of air pollutants – Particulates, gaseous and aerosols.<br><br>Meteorology of air pollution: Airshed – Concept and Scope. Atmospheric stability, Temperature inversions. Plume Behaviour.<br><br>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.<br><br>Respiratory and cardiovascular diseases, neuropsychiatric complications, the eyes irritation, skin diseases and long-term chronic diseases. Pneumoconiosis.<br><br>Necrosis, Chlorosis and Senescence.<br><br>Discoloration, Stone cancer and material loss.<br><br>**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.<br><br>Internal Combustion Engines (Two stroke and Four stroke: Carburettor and Fuel Injection systems) – Exhaust emissions, Evaporative emissions and Crankcase blow-by.<br><br>Mild hybrid, Full hybrid and Plug-in hybrid engines.<br><br>Effects and control of automobile pollution. | |
| **Unit – 2** | **13** |

| | |
|---|---|
| **Air Pollution Control Engineering**<br>Monitoring and Control of Air Pollution: Scope and significance.<br>Air Sampling: Ambient, Indoor and Stack - Gaseous and particulates.<br>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.<br>Bharat Stage Emission Standards (BSES) – Introduction, Timeline of Implementation of BSES in India. Current Emissions norms.<br>Air Quality Indices.<br>Concept of Air Pollution Tolerance Index and Industrial Greenbelts.<br>Gaseous – Absorption, Adsorption and Condensation.<br>Particulate – Settling Chambers, Inertial Separators, Cyclones, Filters (Baghouse), Electrostatic Precipitators and Scrubbers.<br>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.<br>Heavy metal pollution: Sources/Causes, Effects and Control Measures with reference to Lead and Mercury.<br>Fertiliser pollution: Sources/Causes, Effects and Control Measures with reference to Nitrogen, Phosphorus and Potassium. Agriculture runoff and detergents as pollutants. Eutrophication.<br>Pesticide pollution: Sources/Causes, Effects and Control Measures with reference to Organo-chlorine and Organo-phosphate pesticides.<br>Thermal pollution: Sources/Causes, Effects and Control Measures.<br>Oil pollution: Sources/Causes, Effects and Control Measures.<br>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:<br>Characteristics of potable water: Physical, Chemical and Biological.<br>Treatment of water for potable purposes: Intake, screening, aeration, pre-chlorination, coagulation, flocculation, sedimentation, filtration (SSF and RSF), disinfection and distribution.<br>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.<br><br>Disposal of sewage on land; disposal of sewage by dilution. Aerobic and Anaerobic methods of treatment.<br><br>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.<br><br>Secondary treatment: Activated Sludge Process and Tricking filters. Sludge management.<br><br>Tertiary treatment: Chlorination; Reverse Osmosis, Activated Carbon.<br><br>Advanced treatment methods:Filtration, ion exchange, activated carbon adsorption, electro dialysis, nitrification, de-nitrification and Phosphorous removal.<br><br>Other treatment methods: Oxidation ponds; oxidation ditches; septic tanks Anaerobic lagoons,Anaerobic filter reactors and Up-flow anaerobic digesters.<br><br>Treatment of Industrial Effluents: Dairy and Electroplating industry.<br><br>Monitoring of water pollutants: Scope and significance.<br><br>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 A10-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. 1.Study of meteorological parameters – Light, Temperature, Pressure and Rain fall
2. 2.Study of meteorological parameters – Relative Humidity, Wind Speed and Direction
3. 3.Construction of a Wind rose
4. 4.Sampling techniques of air
5. 5.Determination of Particulate Matter
6. 6.Determination of Sulphur-di-oxide in ambient air
7. 7.Determination of Nitrogen-di-oxide in ambient air
8. 8.Determination of Carbon-di-oxide in ambient air
9. 9.Calculate Air Quality Indices from secondary data sources
10. 10.Sampling techniques of waste water
11. 11.Determination of total solids in wastewater
12. 12.Determination of Chromium in liquid effluents
13. 13.Determination of Copper in liquid effluents
14. 14.Determination of Iron in liquid effluents
15. 15.Determination of BOD
16. 16.Determination of COD

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Standard Methods for Examination of Water and Wastewater. 2012. APHA – WEF.

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

Title of the Course: **DSC ENV A11-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).<br>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.<br><br>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.<br><br>Soil Pollution: Soil Characteristics - Physical, Chemical and Biological characteristics; Macronutrients, Micronutrients and Organic matter; Cation exchange capacity.<br><br>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.<br><br>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.<br><br>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.<br><br>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 – *Landfarming, 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.<br><br>**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.<br><br>**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.<br><br>**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.<br><br>**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.<br><br>**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 A12-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. 1.Sampling techniques of Soil
2. 2.Determination of Soil Moisture and Texture
3. 3.Determination of Specific Gravity of Soil
4. 4.Determination of Particle Density of Soil
5. 5.Determination of Water Holding Capacity of Soil
6. 6.Characterization of Solid Wastes
7. 7.Determination of pH and Electrical Conductivity in Soil/Refuse matter
8. 8.Determination of Calcium and Magnesium in Soil/Refuse matter
9. 9.Determination of Lime Content in Soil/Refuse matter
10. 10.Determination of Organic Carbon in Soil/Refuse matter
11. 11.Determination of available Nitrogen in Soil/Refuse matter
12. 12.Determination of available Phosphorus in Soil/Refuse matter
13. 13.Determination of available Potassium in Soil/Refuse matter
14. 14.Determination of C/N ratio in Soil/Refuse matter
15. 15. Measurement of Noise

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**B.Sc. (Basic/Hons.) Semester 6**

Title of the Course: **DSC ENVA13-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** | **60Hours** |
|---|---|
| **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.<br>Environmental determinants: Definition. Influence of pH, Temperature, Radiation, Pressure and Salinity on microorganisms. Extremophiles; Bioluminescent microbes.<br>Air Microbiology: Definition. Airborne infections – Causative microbes – Control measures; Droplet infection; Sick Building Syndrome. | |
| **Unit – 2** | **15** |

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|---|---|
| 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.<br><br>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.<br><br>Role of microbes in soil fertility – Rhizobium and Mycorrhiza.<br><br>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.<br><br>Composting as a method of household solid waste management – case studies. | |
| **Unit – 4** | **15** |
| Application of microbes in Environment:<br>Bio fertilizers and biopesticide: Introduction, scope and importance, Biofertilizer- *Rhizobium*, *azotobactor, azospirilium*, Blue green algae, *azoll*a, *mycorrhizae*. Phosphate solubilizing microorganisms, large scale production, vermicomposting, advantage and disadvantages. Bio-control agents- Bio insecticide, bio herbicide, disease control, advantage and disadvantages.<br><br>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.<br>Roleofmicrobesinorganicsolidwastemanagement:Composting–anaerobicandaerobic(Windrowsmethod,acceleratedcomposting, Bio-mechanical composting machines). Role of inoculum incomposting.Vermicomposting. | |

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

**DSCENV A14-P-ENVIRONMENTAL MICROBIOLOGY**

**(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. 1.Best practices for microbiology laboratories
2. 2.Microscopy – Study of Simple and Compound microscopes
3. 3.Sterilization techniques and preparation of culture media – Broth and Solid media
4. 4.Isolation of Bacteria from Water/Wastewater – Serial dilution technique
5. 5.Identification of Bacteria – Colony characteristics
6. 6.Identification of Bacteria by gram staining technique
7. 7.Isolation of Fungi from Soils – Pour plate method
8. 8.Identification of Fungi – Lactophenol cotton blue staining
9. 9.Study of Root Nodule Bacteria – Gram staining
10. 10.Study of Endomycorrhiza (VAM)
11. 11Estimation of Coliform Group of Bacteria – MPN Technique

    12.Estimation of Coliform Group of Bacteria –MF Technique
12. 13.Estimation of Faecal Coliform in water

    15.14.Construction of bacterial growth curves – pH – Broth culture

13. 16.Minimum Inhibitory Concentrations (MICs) of heavy metals on bacteria

**References**


Aneja, K. R. 1996. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan.

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

Bhattacharyya, B. N. 1993. Experiments with Microorganisms. Emkay Publications.

Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, 1st Ed., Chand and Company Ltd., India.

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


**B.Sc. (Basic/Hons.) Semester 6**

Title of the Course: **DSC ENV A15–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. |

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|---|---|
| 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).<br>Components of EIA – Air, Water, Nosie, Land, Biological environment, Socio-economic and Health Environment. Participants of an EIA.<br>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.<br>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.<br>Case Studies: Industry, Housing and Multipurpose Dams. | |
| **Unit – 3** | **15** |
| Environmental Audit: Concept, Aims and Objectives; Elements of Environmental audit - Internal and External audit.<br>Types of Environmental Audit: Environmental Compliance Audits, Environmental Management Audits and Functional Environmental Audits.<br>Water audit, Energy audit, Health & Safety audit and Waste & Waste Minimisation audit.<br>Audit procedure: Pre-audit activities, On-site activities and Post-audit activities.<br>Evaluation of Audit data and Preparation of audit report. | |

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|---|---|
| Auditor profile.<br>Environmental Audit Notifications (with latest amendments)<br>ISO 14010 - EA- General Principles of Environmental Auditing<br>ISO 14011 - EA- Auditing of Environmental Management Systems<br>ISO 14012 - EA- Qualification Criteria for Environmental Auditors<br>ISO 14013 - Management of Environmental Audit Programmes | |
| **Unit – 4** | **15** |
| Environmental Risk Assessment<br>Hazard identification and risk assessment - Quantitative and Qualitative risk assessment.<br>Quantitative - Hazard Identification and Risk Analysis (HIRA).<br>Qualitative - Hazard and Operability Analysis (HAZOP), Job Safety Analysis (JSA), Fault Tree Analysis (FTA) and Event Tree Analysis (ETA).<br>Disaster management plan - Off-site emergency plan and On-site emergency plan<br>Occupation, Health and Safety Management Plan, PPEs, Fire Safety,<br>Chemical and Biological Hazards. Safety Management and Laws - Factories Act; Manufacture, Storage and Import Hazardous Chemical Rules. OSHAS. | |

**References**


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Shrivastava, A. K. 2003. Environment Impact Assessment. APH Publishing Corporation.

Trivedi, P. R. 2004. Environmental Impact Assessment. APH Publishing Corporation.

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

**DSC ENVA16–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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Munier, N. (2004). *Multicriteria environmental assessment: a practical guide*. Springer Science & Business Media.

Nelson, D. D. (1998). *International environmental auditing*. Government Institutes.

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