DAVANGERE UNIVERSITY

Department of Studies in Environmental Science

B. Sc., ENVIRONMENTAL SCIENCE SEP-SYLLABUS

(Case 1: 3 Majors with a General Degree)

Implemented from the academic year - 2025-26

BOARD OF STUDIES IN ENVIRONMENTAL SCIENCE
Department of P.G. Studies in Environmental Science
Davangere University Shivagangotri
Karnataka, INDIA.

Prof. M. Govindappa
Dean-Science & Technology
Davangere University
Shivagangotri, Davangere-577007

Registrar
Davangere University
Shivagangotri, Davangere

Undergraduate Environmental Science SEP- Syllabus

(Case 1: 3 Majors with a General Degree) for 2025-26

Proposed Semester (V to VI)-wise distribution of the course structure

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week
SEMESTER – V				
UGES-T-V	Theory-V	Environmental Pollution and Control	4	4
UGES-T-VI	Theory-VI	Solid waste Management	4	4
UGES-P-V	Practical-V	Environment pollution and Solid waste management	2	4
UGES-MC	Mandatory Course	Elementary Research Methodology	2	2
SEMESTER – VI				
UGES-T-VII	Theory-VII	Environmental microbiology and Biotechnology	4	4
UGES-T-VIII	Theory-VIII	Environmental impact Assessment, risk assessment and Audit.	4	4
UGES-P-VII	Practical-VI	Environmental, Microbiology, Biotechnology and EIA	2	4
UGES-P-D/P	P/I/D	Project/Internship/dissertation	2	4

Curriculum Structure for Undergraduate Programme (From 2024-25)

(Course Structure, Scheme of Teaching and Evaluation (From 2024-25) Curriculum Framework for UG Programs as suggested by KSHEC, Govt. of Karnataka

(As per G.O. No.: ED 166 UNE 2023, Bengaluru, dated: 08-05-2024)

Continuous Assessment Programme/Internal Assessment/Formative Assessment

Sl. No.	Continuous Assessment Programme/Internal Assessment	Maximum Marks
01	Two Session Tests with a proper record for assessment (5+5 = 10)	10
02	Assessment of Skill Development activities/Seminars/Group Discussion/ Assignment etc., with proper record	05
03	Attendance with proper record*	05
TOTAL MARKS		20

*** Attendance Marks-breakup**

<75%		-00 Marks
75-80%	-	01 Mark
80-85%	-	02 Marks
85-90%	-	03 Marks
90-95%	-	04 Marks
>95%	-	05 Marks

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SEMESTER-V
UGES-T-V: PAPER-V: ENVIRONMENTAL POLLUTION AND CONTROL

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week	Exam Hours	Exam Marks
UGES-T-V	Theory-V	Environmental Pollution and Control	4	4	3	80

Note: Ende semester exam= 80 Marks; Internal assessment = 20 Marks

Course learning Objectives:

a. To develop competency in understanding the concepts of pollution and pollutants.
b. To instill an introductory knowledge of engineering concepts for controlling the pollution.
c. To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
d. To develop knowledge on act and rules related to pollution.

Course Outcome:

a. Demonstrate an entry level competence in understanding the environmental pollutants and their impacts.
b. Demonstrate the ability to carry out air and water quality analysis in the laboratory and interpret the results.
c. Ability to understand the harmful impact of pollutants on environment and human health.
d. Be able to understand the existing treatment technologies and scope of developing these methods.

Unit 1	**Meteorology:** Definition. Significance of meteorology. **Meteorological parameters:** Solar radiation, Temperature, Humidity (Absolute, Specific & Relative), Wind speed & direction, Pressure and Precipitation. **Air Pollution and its control methods:** Definition. Sources of air pollution (Point and non-point). Classification of air pollutants – Particulates, aerosols and gaseous air pollutants. **Meteorology of air pollution**: Air shed – Concept and Scope. Atmospheric stability, Temperature inversions, Plume Behavior. 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	16 Hrs

	fuels – Biobutanol, Dimethyl ether, Methanol and Renewable hydrocarbon biofuels. Electric Vehicles – issues and management. Internal Combustion Engines (Two stroke and four stroke: Carburetor and Fuel Injection systems). Mild hybrid, Full hybrid and Plug-in hybrid engines. Effects and control of automobile pollution.	
Unit 2	**Air Pollution control methods:** Monitoring and Control of Air Pollution: Scope and significance. **Air Sampling:** Ambient and Indoor, Gaseous and particulates. National Ambient Air Quality Monitoring Program (NAQMP) – Introduction. 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. Control of Gaseous pollutants – Absorption, dsorption 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 Program-2019 and latest amendments. **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. **Fertilizer 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 3	**Water and Wastewater treatment:** 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. Sewage treatment: - Preliminary, Primary, secondary and tertiary treatment: Chlorination, Reverse Osmosis and Activated Carbon. **Monitoring of water pollutants**: Scope and significance. Salient features of Water Pollution (Prevention and Control) Act, 1974; Water Quality Standards – Drinking	16 Hrs

	water - IS 10500 & Surface water - IS 2296.	
Unit 4	**Noise Pollution**: Definitions of sound and noise. Sources of noise – Transport, neighborhood industrial and indoor. Noise, Vibration and Harshness. Decibel scale. Metrics of noise – pressure, intensity and frequency. Sound pressure level (SPL), 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, transmission path and protection at the receiver end. Engineering and administrative controls. Noise standards. The Noise Pollution (Regulation and Control) Rules. **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.	16 Hrs

References

1) J. Paul Guyer. (2021). *An Introduction to Air Pollution Control Engineering*. UNICORN Publishing Group. 1-182.
2) Perkins, H. C. (1974). *Air Pollution*. Mc Graw – Hill Kogakusha Ltd.
3) Phiri, N. B. (2021). *Factors Affecting Tutoring Effectiveness in Finance-RelatedModules*. University of Johannesburg (South Africa).
4) Rao, M. N. and Rao, H. V. N. (1988). *Air Pollution*. Tata McGraw – Hill Publishing Co. Ltd.
5) Santra, C. S. (2001). *Environmental Science*. (1st Ed.), New Central Book Agency
6) Stern, A. C. (1986). *Air pollution* Vol. I – VIII. Academic Press Inc.
7) Anjaneyulu Yerramilli. (2019). *Air Pollution Prevention and Control Technologies*. BS Publications. 1-828.
8) Bhatia, S. C. (2003). *Managing Industrial Pollution*. Macmillan India Ltd.
9) Crites, R. and George, T. 1998). *Small and Decentralised Wastewater Management Environmental Noise Pollution and its Control*. Anmol Publications.
10) Garg, S.K. (1990). *Environmental Engineering Vol I &II Sewage Disposal and Air Pollution Engineering*, Khanna Publ. Delhi.

SEMESTER-V
UGES-T-VI: PAPER-VI: SOLID WASTE MANAGEMENT

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week	Exam Hours	Exam Marks
UGES-T-VI	**Theory-VI**	**Solid Waste Management**	**4**	**4**	**3**	**80**

Note: Ende semester exam= 80 Marks; Internal assessment = 20 Marks

Course learning Objectives:

a. To develop competency in understanding of the soil pollution.
b. To instill a knowledge of types of waste and develop skill for waste management.
c. To motivate and inspire to acquire contemporary understanding and skills leading to issue identification.
d. To inculcate creativity and innovative spirit in the domain of human-environment interface leading to vocation/entrepreneurial opportunities.

Course Outcome:

a. Demonstrate an entry level competence in understanding about the land pollution and its control measures.
b. Demonstrate the ability to carry out sampling/monitoring and analysis in field conditions/laboratories and make appropriate judgements.
c. Ability to understand different types of waste and their management.
d. Be able to understand the demands of the society with respect to waste management.

Unit 1	**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.* Solid Waste Management Rules, 2016 and amendments. **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.	16 Hrs
Unit 2	**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, 2022, E-Waste Amendment-2025. **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, Amendment rules,2025.	
Unit 3	**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.	16 Hrs
Unit 4	**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. **Soil Pollution**: Soil Characteristics - Physical, Chemical and Biological characteristics; Soil profile, 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 Fertilizer and Pesticide Pollution - Causes, effects and control; Effects of industrial and urban wastes (solid and liquid) on soil. Soil erosion-Definition, classification and control measures. **Methods of Soil Management**: Farm Yard Manure (FYM), Biopesticides, Integrated Pest Management (IPM), Phytoremediation technology.	16 Hrs

References

1. Anjaneyulu Yerramilli, Valli Manickam. (2021). Environmental Impact Assessment Methodologies. BS Publications. 1-588.
2. B. B. Hosetti. (2006). Prospects and Perspective of Solid Waste Management. New Age International (P) Limited. 1-216.
3. Bhatia, S.C. (2003). Managing Industrial Pollution. Macmillan India Ltd.
4. Carla Di Stefano, Gabriella Marfe. (2020). Hazardous Waste Management and Health Risks. Bentham Science Publishers. 1-226.
5. Davis, M. L. and Cornwell, D. A. (1991). Introduction to Environmental Engineering. McGraw – Hill International.
6. Duggal, K. N. (1985). Elements of Public Health Engineering. S. Chand and Co. Ltd.
7. Francis, C. W. and Auerbach, S. I. (1983). Environment and Solid Wastes. Butterworth Publishers.
8. Grover, V. I., Guha, B. K., Hogland, W. and McRae, S. G. (eds.) (2000). Solid Waste Management. Oxford – IBH Publishing Co. Pvt. Ltd.
9. Metcalf and Eddy, Inc. Revised by Tchobanoglous, G. and Burton. (2019). Wastewater Engineering– Treatment, Disposal and Reuse. McGraw Hill Inc.
10. Mishra, P. C. (1989). Soil Pollution and Soil Organisms. Ashish Publishing House.
11. R.K. Trivedy, V.S. Kulkarni, S.N. Kaul. (2019). A Handbook of Environment Impact Assessment. Scientific Publishers. 1-203.
12. Ramesha Chandrappa, Diganta Bhusan Das. (2012). Solid Waste Management Principles and Practice. Springer Berlin Heidelberg. 1-414.
13. Rao M. N. and Dutta A. K. (1987). Wastewater Treatment. Oxford – IBH Publishing Co.
14. Rao, M.N. and Datta, A.K. (2022) Waste Water Treatment. III ED., CBS Publ. Bengaluru
15. Rumana Riffat, Taqsim Husnain. (2022). Fundamentals of Wastewater Treatment and Engineering. CRC Press. 1-430.
16. Santra, S. C. (2001). Environmental Science, New Central Book Agency (P) Ltd.
17. Schilling, R. S. F. (Ed.) (1986). Occupational Health Practice. Butterworths.
18. Simon Watson Pain. (2018). Safety, Health and Environmental Auditing - A Practical Guide, Second Edition. CRC Press, Taylor & Francis Group. 1-286.
19. Smith, W. J. (ed.). (1983). The Control of Oil Pollution. Graham and Trotman Publishers.
20. Stephen Asbury, Peter Ashwell. (2007). Health and Safety, Environment and Quality Audits. Butterworth-Heinemann publishers. 1-230.
21. Subhash Anand.(2010). Solid Waste Management. Mittal Publications. 1-405.
22. Tchobanoglous, G., Theisen, H., & Eliassen, R. (1977). Solid wastes: Engineering principles and management issues.
23. Thomas H. Truitt. (1983). Environmental Audit Handbook - *Basic Principles of Environmental Compliance Auditing.* Executive Enterprises Publications. 1-363.
24. 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.

SEMESTER-V
UGES-P-V: PRACTICAL-V: POLLUTION CONTROL AND SOLID WASTE MANAGEMENT

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week	Exam Hours	Exam Marks
UGES-T-VI	Practical-V	Pollution control and solid waste management	42	4	3	40

Note: Ende semester exam= 40 Marks; Internal assessment = 10 Marks

Practical design for the laboratory experiments (Minimum of 10 to 12 has to be conducted in a semester session)

1. Sampling techniques of air
2. Calculate Air Quality Indies from secondary data sources
3. Sampling techniques of waste water
4. Determination of total solids in wastewater
5. Determination of free Carbon di oxide in given water sample.
6. Determination of total hardness in given water sample.
7. Determination of DO and BOD
8. Measurement of Noise.
9. Sampling techniques of Soil
10. Determination of Soil Moisture and Texture
11. Determination of Water Holding Capacity of Soil
12. Characterization of Solid Wastes
13. Determination of density of solid waste.
14. Determination of moisture of solid waste.
15. Determination of pH and Electrical Conductivity in Soil/Refuse matter
16. Determination of Organic Carbon in Soil/Refuse matter
17. Field visit: Water treatment plant, polluted waterbodies, Meteorological station, Vermicompost site, Solid waste management site.

References

1. Baruah, T. C. and Barthakur, H. P. 1997. *Textbook of Soil Analysis*. Vikas Publishing House Pvt. Ltd.
2. Daji, J.A. 1988. *Textbook of Soil Science*. Media Promoters and Publishers.
3. Firman, E. B. 1964. *Chemistry of Soils*. Oxford IBH Publishing Co.
4. Jackson, M. L. 1973. *Soil – Chemical Analysis*. Prentice Hall Publications.
5. Miller, R. W. and Donahue, R. L. 1992. *Soils – Introduction to Soils and Plant Growth*. Prentice Hall of India.
6. Rowell, T. L. 1994. *Soil Sciences – Methods and Applications*. Longman Scientific and Technical.
7. WHO.
8. NEERI Manual. 1982. Air Quality Monitoring. NEERI Publications.
9. Sawyer, C. N. and Mc Carty, P. L. 1978. Chemistry for Environmental Engineering. McGraw Hill.
10. Stern, A. C. 1986. Air pollution Vol. I – VIII. Academic Press Inc.
11. Standard Methods for Examination of Water and Wastewater. 2012. APHA – WEF.

SEP BSc-V Semester: Elementary Research Methodology

(for Biochemistry, Biotechnology, Botany, Chemistry, Electronics, Environmental Science, Food Technology, Microbiology, Zoology)

Subject	**Elementary Research Methodology**	Semester	V
Number hr/week	2 hours	Total hours	32
Duration of the exam	2 hours	Credits	2

Learning Outcomes:

After the completion of this course the learner will be able to:

1. Describe the basic concepts of research and its methodologies.
2. Identify the appropriate research topics and set up hypothesis.
3. Perform literature survey using library (print) and internet (online) sources.
4. Design experiments/surveys, collect data and represent data in table and figure forms.
5. Analyze data with appropriate software tools, internet results and draw conclusions.
6. Write scientific report/ review and prepare seminar/ conference presentations oral or poster.
7. Understand the methods of citations and referencing styles, check plagiarism.
8. Identification of lacuna (finding gap-areas), hypothesis formulation, framing objectives, and preparation of questionnaire.

Unit-1	***Scientific Methods and Research:*** Concept, Definitions of research; Purpose, importance, steps levels and rigor of research; different paradigms of research. ***Types of Research:*** Fundamental/Applied research, Descriptive/Analytical research, Quantitative /Qualitative research, Conceptual/Empirical research, Diagnostic/Hypothesis testing research, Conclusion oriented/Decision oriented research, Theoretical / Action research, Longitudinal /Cross sectional research ***Research Question:*** Introduction, types and identification; ***Research Problem:*** Definition, identification of problem, ways of understanding problem, criteria of a good problem, guidelines for selecting meaningful problem; ***Research Objective:*** Definition, broad and specific objectives, goals; ***Research Hypothesis:*** Meaning of research hypothesis, sources of hypothesis, qualities of workable hypothesis, utilities of hypothesis;	8 hrs
Unit-2	***Introduction and review of sampling***: Definition, needs, steps; Definitions of population, sample, sampling unit, sampling frame, sampling error and non sampling error; Steps in sampling; Fundamentals, characteristics, advantages and disadvantages of sampling. ***Types of sampling***: Probability (simple, stratified, systematic , cluster and multistage –in brief), Process of selecting random sample; non probability sampling (convenience, purposive, quota, snowball, self selecting); Advantages and disadvantages (brief discuss only) ***Size of sample***: Factor affecting size of sample, Testing the reliability of sample, Methods of estimating sample size, Process of selecting random sample	8 hrs

Unit-3	***Designing of research work:*** Introduction, Purposes, Characteristics of a research design, Principles of designing a research, conceptual framework and its operationalization, Sectors of research design, Research methods as research designing, similarities and differences between Research design and research method. ***Conventional research method:*** Principle and Importance conventional methods, Scientific methods as conventional methods, Characteristic of a scientific method; Aspects of scientific Method, Evolution of scientific Studies Steps in scientific methods,	8 hrs
Unit-4	***Historical Research Method:*** Nature and Steps in Historical method, Importance and fundamentals of Historical method, Sources of Historical data, Limitations. ***Experimental Research Method:*** Introduction, Types of experiments, steps in experimental research, Problems in experimentation; Ex-post facto research: definition and technique. ***Survey Research Method:*** Introduction, and Importance of survey method, Comparison of survey method with other methods; Objectives of social and survey and technical survey, types of social and technical survey, Steps in social and technical surveys, Pilot survey ***Case study:*** Introduction, Types of case studies: Exploratory and Hypothesis testing; Steps in case studies, Sources of case data, limitations.**Analysis of data**- introduction, data analysis tools. Project time line, literature review and references, research report structure, plagiarism.	8 hrs

References

1. C.R. Kothari: *Research Methodology: Methods and Techniques*. A standard textbook covering basic and advanced concepts with statistical examples.
2. Ranjit Kumar: *Research Methodology: A Step-by-Step Guide for Beginners*. Specifically designed for students with no prior research experience.
3. John W. Creswell: *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Essential for understanding different research paradigms.
4. Vinod Chandra: *Research Methodology*. Covers problem definition, literature review, and questionnaire design in detail.
5. Prabhat Pandey & Meenu Mishra Pandey: *Research Methodology: Tools and Techniques*. Provides a foundational view of research as a progress-driving tool.
6. Earl Babbie: *The Practice of Social Research.* A comprehensive look at the process and ethics of scientific inquiry.
7. Robert A. Day: *How to Write and Publish a Scientific Paper*. Focused on the technical aspects of scientific communication.
8. Uwe Flick: *Introducing Research Methodology: A Beginner's Guide to Doing a Research Project.* Focuses on the practical process of producing undergraduate projects.
9. Mark Saunders et al.: *Research Methods for Business Students*. Useful for students needing a skill-building approach to practical applications.
10. Catherine Dawson: *Practical Research Methods*. A practical guide to the techniques used in data collection and analysis.

SEMESTER-VI
UGES-T-VII: PAPER-VII: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week	Exam Hours	Exam Marks
UGES-T-VII	**Theory-VII**	**Environmental Microbiology and Biotechnology**	**4**	**4**	**3**	**80**

Note: Ende semester exam= 80 Marks; Internal assessment = 20 Marks

Course learning Objectives:

a. To develop competency in understanding the microbes of Environment.
b. To develop competency in understanding the application of biotechnology in bioremediation
c. To instill a knowledge about roles of microbes in the Environment.
d. To motivate and inspire to acquire contemporary understanding and using the knowledge for remediation.
e. To inculcate creativity and innovative spirit in identifying appropriate measures for recycling and conservation.

Course Outcome:

a. Demonstrate competence in understanding the microbes of Environment.
b. Demonstrate competency in understanding the biotechnology in Environmental conservation
c. Demonstrate competence in understanding the microbes in water and their impact on human health.
d. Ability to understand and appreciate the role of microbes in enhancing the quality of life of human.
e. Ability to understand the role of various techniques of biotechnology in bioremediation, biofertilizers.
f. Demonstrate the ability to carry out data collection procedures and analysis in field conditions/laboratories and make appropriate interpretations using the microbes.

Unit-1	**Environmental Microbiology:** Definition, scope and significance. History of microbiology. 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.	16 Hrs
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	16 Hrs

	– 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	**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.	16 Hrs
Unit-4	**Environmental Biotechnology and its application:** Introduction, scope and importance of Biotechnology in Environmental science **Bioremediation:** Definition, types and Xenobiotic pollutants, bioremediation methods for contaminated soils and aquifers, marine oil slick and air pollutants. Biosensors and their applications. **Bio fertilizers and biopesticide:**Introduction, scope and importance, Biofertilizer- *Rhizobium, azotobactor, azospirilium,* Blue green algae, *azoll*a, *mycorrhizae*. Phosphate solubilizing microorganisms, advantage and disadvantages. Bio-control agents-Bio insecticide, bio herbicide, disease control, advantage and disadvantages.	16 Hrs

References

1. Atlas, R. M. and Bartha, R. 1998. Microbial Ecology – Fundamentals and Applications. Benjamin/Cummings Science Publishing.
2. Bitton, G. 1994. Wastewater Microbiology. Wiley-Liss Inc. McGraw Hill International Editions.
3. Hurst, C. J. (Ed.). (2017). Modeling the transmission and prevention of infectious disease. Springer International Publishing.
4. Hurst, C. J. (Ed.). (2019). The structure and function of aquatic microbial communities (Vol. 7). Springer.
5. Hurst, C. J. (Ed.). (2019). Understanding Terrestrial Microbial Communities. Springer International Publishing.
6. Mitchel, R. (Ed.) 1992. Environmental Microbiology. Wiley-Liss Inc.
7. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. 1993. Microbiology – Concepts and Applications. McGraw-Hill Book Co.
8. Sharma, P. D. (2016). Microbiology. Rastogi Publications, Meerut.
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.

SEMESTER-VI
UGES-T-VIII: PAPER-VIII: ENVIRONMENTAL IMPACT ASSESSMENT, RISK ASSESSMENT AND AUDIT

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week	Exam Hours	Exam Marks
UGES-T-VII	**Theory-VIII**	**Environmental Impact Assessment, Risk Assessment and Audit**	**4**	**4**	**3**	**80**

Note: Ende semester exam= 80 Marks; Internal assessment = 20 Marks

Course learning Objectives:

a. To develop competency in understanding the process of assessing the Environmental Impact.
b. To instill a knowledge on methodologies used for assessing Environmental Impact.
c. To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and conservation.
d. To inculcate creativity and innovative spirit in identifying appropriate assessment tools.

Course Outcome:

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

Unitt-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.	16 Hrs
Unit-2	**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	16 Hrs

	methods, Matrices methods, Networks methods and Overlay methods. Environmental index using factor analysis, Cost-benefit analysis, Predictive or Simulation methods.	
Unit-3	**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 Minimization 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 Program.	16 Hrs
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.	16 Hrs

References

1. Anjaneyalu, Y. and Valli Manickam. 2014. Environmental Impact Assessment Methodologies. BS Publications, Hyderabad.
2. Baldwin, J. H. 1988. Environmental Planning and Management. International Book Distributors.
3. Barthwal, R.R.2009. Environmental Impact Assessment. New Age International publication.
4. Canter, L. W. 1996. Environmental Impact Assessment. McGraw Hill Inc.
5. Rao, P. S. B. and Rao, P. M. (Eds). 2001. Environment Management and Audit. Deep and Deep Publications Pvt. Ltd.
6. Rau, J. G. and Wooten, D. C. 1980. Environmental Impact Analysis Handbook. McGraw Hill.
7. Santra, S. C. 2001. Environmental Science, New Central Book Agency (P) Ltd.
8. Shrivastava, A. K. 2003. Environment Impact Assessment. APH Publishing Corporation.
9. Trivedi, P. R. 2004. Environmental Impact Assessment. APH Publishing Corporation.

SEMESTER-VI

UGES-P-VI: PRACTICAL-VI: ENVIRONMENTAL MICROBIOLOGY, BIOTECHNOLOGY AND EIA

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week	Exam Hours	Exam Marks
UGES-T-VI	Practical-VI	Environmental Microbiology, Biotechnology and EIA	2	4	3	40

Note: Ende semester exam= 40 Marks; Internal assessment = 10 Marks

Practical design for the laboratory experiments (Minimum of 10 to 12 has to be conducted in a semester session)

1. Microscopy – Study of Simple and Compound microscopes
2. Sterilization techniques and preparation of culture media – Broth and Solid media
3. Isolation of Bacteria from Water/Wastewater – Serial dilution technique
4. Identification of Bacteria – Colony characteristics
5. Study of simple staining technique (positive and Negative staining)
6. Identification of Bacteria by gram staining technique
7. Identification of Fungi – Lactophenol cotton blue staining
8. Study of Root Nodule Bacteria – Gram staining
9. Study of recent EIA notification and guidelines
10. Baseline data collection and analysis
11. Study of impact identification methods – Checklists
12. Study of impact identification methods - Matrices
13. Study of cost-benefit analysis of development project
14. Study of Environmental Risk Assessment – Data sheet method
15. Study of Environmental audit methods - Water audit
16. Study of Environmental audit methods - Energy audit – Electricity
17. Case Study: Socio-economic and Health impacts - Questionnaire method

References

1. Aneja, K. R. 1996. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan.
2. Benson, H. J. 1998. Microbiological Applications – Laboratory Manual in General Microbiology. McGraw-Hill Publications.
3. Bhattacharyya, B. N. 1993. Experiments with Microorganisms. Emkay Publications.
4. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, 1st Ed., Chand and Company Ltd., India.
5. Standard Method for Examination of Water and Wastewater. 2017. APHA – WEF.
6. Arts, J., & Morrison-Saunders, A. (Eds.). (2012). *Assessing impact: handbook of EIA and SEA follow-up*. Routledge.
7. Barton, H., & Bruder, N. (2014). *A guide to local environmental auditing*. Routledge.
8. Carroll, B., & Turpin, T. (2002). *Environmental impact assessment handbook: A practical guide for planners, developers and communities*. Thomas Telford.
9. Erickson, P. A. (1994). *A practical guide to environmental impact assessment*. Academic Press Inc.

SEMESTER-VI
UGES-P-VII: Project/Internship/Dissertation Work

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week	Exam Hours	Exam Marks
UGES-T-VI	P?I/D-VII	Project/Internship /Dissertation Work	2	4	3	40

Note: Ende semester exam= 40 Marks; Internal assessment = 10 Marks

Coarse Objectives:

- **Application of Knowledge:** Moving beyond textbooks to practical, real-time observation of ecological processes.
- **Environmental Awareness:** Developing a deeper understanding of human impact on ecosystems.
- **Skill Building:** Learning techniques for environmental monitoring and analysis such as Wate water treatment process, STP, ETP, Solid wate management methods, Vermicomposting, Incineration, Pyrolysis, Methanization, Energy conservation methods.
- **Conservation Advocacy:** Understanding the importance of protecting natural resources, Disaster management, Understanding and hands on training of Sustainable practices
- **Environmental Thinking:** Visiting various ecosystems, Wildlife sanctuary, Sacred groves, Botanical gardens, Zoos etc to make students to think towards nature to develop a sensitivity towards environment.

Coarse Outcomes

- **Observational Precision**: Learning to notice patterns, anomalies, and seasonal changes in natural environments.
- **Critical Problem-Solving**: Brainstorming and testing innovative solutions to real-world environmental challenges like resource depletion.
- **Collaboration**: Working in teams for large-scale projects like community cleanup drives or tree planting initiatives.
- **Scientific Inquiry**: Testing hypotheses through field experiments, such as observing the effects of "acid rain" (using vinegar) on live plants

Critical Context for Field Studies

- **Multidisciplinary Approach**: Effective visits integrate biology, chemistry, and geology with social and legal perspectives (e.g., studying how environmental laws affect a local industry).
- **Long-term Monitoring**: For advanced students, comparing data from the same site over several years (e.g., soil carbon changes) provides deeper insights than a single visit.
- **Safety & Ethics**: Planning must include safety protocols for hazardous sites and ethical guidelines to ensure no harm is done to the ecosystems being studied

Field-Based Skill Development

- Bio-Surveys & Cataloguing: Using apps like Naturalist or Leafsnap during nature walks to identify and map local plant and animal species.
- Pollution Simulations: Conducting "oil spill" cleanups in a controlled tray to understand the difficulty of environmental remediation.

- Watershed Mapping: Investigating local water bodies to identify sources and sinks of pollution and their impact on the community.
- Environmental Audits: Performing "lunchbox" or "trash" audits to quantify waste production and improve recycling habits.

Project/Internship/Dissertation

These key areas offer the most comprehensive data for environmental project/Internship and dissertation.

Study Area	Key Learning Focus	Common Field Activities
Natural Ecosystems	Biodiversity, adaptation, and ecosystem services.	Identifying native flora/fauna, assessing habitat health, and monitoring species diversity. To learn about sacred grooves and traditional conservation.
Polluted Sites	Impact of human waste, industrial runoff, and urban sprawl.	Testing water samples for pH/oxygen, measuring air quality (PM2.5), and documenting soil contamination.
Waste Management	Circular economy, recycling, and sustainable disposal.	Touring recycling centres, landfills, or composting units to witness waste segregation in action. Observation of recycling plants, Vermicompost, to understand waste segregation and sustainable practices.
Sustainable Infrastructure	Renewable energy, green building, and resource conservation.	Visiting solar/wind farms, water treatment plants, or "green" buildings to evaluate energy efficiency.
Agricultural Lands	Soil health, sustainable farming, and food security.	Comparing soil samples from different environments (e.g., organic vs. industrial farms) for nutrients and carbon.
Urban Ecology	Study of Urban Ecology, Heat Islands in urban cities	Studying Urban Ecology, "heat islands" in cities and identifying how urban green spaces mitigate temperature and pollution.
Botanical Gardens, Zoos, Sacred groves	To study Ex-situ conservation methods	Visiting botanical gardens, zoos, or sacred groves to learn about in-situ and ex-situ protection of endangered species.

Skill Area	Project/Internship activity	Key Learning Outcome
Water Analysis	Water Quality Testing	Water sampling, Analysis of physical, Chemical and Biological Characteristics like Measuring pH, oxygen levels, Dissolved solids and detecting microplastics or chemical pollutants.
Waste Management	Visit to compost site, Solid waste site, Land fill site and Reporting, Compost Bin Construction, Characterization, Analysis of Waste Density, Moisture etc., Compost pit design, Designing of	Understanding of solid waste management Understanding the decomposition of organic matter into nutrient-rich soil.

	Biodigester, Methane plant and etc, house Survey for solid wate segregation, Visit to hospitals to study biomedical waste management.	
Energy Conservation	Solar Oven Building, Solar panels, Solar equipment, Biofuels collection, Extraction of Biofuels, Ecofriendly stove building.	Exploring renewable energy and harnessing solar power, Biomass energy for practical use.
Biodiversity	Seed Ball Dispersal, Planting techniques, Study of tree species, Herbaria making, Insects mounting, Collection of various seeds, Paddy varieties collection, visit to seedbanks, Agricultural field etc., Making Agrobiodiversity charts. NTFP Collection.	Restoring local flora and supporting pollinator habitats through "rewilding."
Soil, Rock, mineral study	Soil sampling, Soil analysis, Collection and study of different soils, Rock and minerals.	Understanding of soil, Rock and Mineral through field study sample collection and analysis.
Climate Impact	Carbon Footprint Audit, Energy Audit, Water Audit, Waste Audit,	Calculating personal or institutional emissions and identifying reduction strategies.
Ecosystem Study	Field visit, Quadrate method, line transact method, senses method, camera trap method etc	Understanding the structure and function of various ecosystems.
EIA	Preparation of EIA Reports, Study of Case studies	Practical knowledge of preparing EIA reports.

Assessment of Skill Development/Practical Activity/ Field Visit (Max Marks =50)

SI. No	Assessment Method	Marks
1	**Performance-Based Assessment**: Teachers observe students directly during the field visit to evaluate their use of tools (e.g., GPS, water kits) and their ability to follow protocols like quadrat sampling etc.,	**20**
2	**Reflective Journaling**: Students maintain a field diary to record qualitative observations, personal reflections, and "wonderings" about the ecosystem.	**5**
3	**Project Reports**: A formal document (often worth significant marks, that includes the site background, methodology, and a multi-point evaluation of findings.	**10**
4	**Attendance/Peer/Self-Assessment**: Students provide feedback on group dynamics and individual contributions to tasks like site mapping or biodiversity surveys.	**5**

Format for preparation or project/ Internship/Dissertation reports:
Students are often required to document their findings in a structured report. Key sections typically include:

1. **Title Page**: Location and purpose of the visit.
2. **Introduction**: Background on the site and objectives.
3. **Methodology**: Tools used for data collection or observation.
4. **Observations**: Detailed accounts of what was seen (e.g., specific species or industrial processes).
5. **Findings & Analysis**: Interpretation of the data collected.
6. **Conclusion**: Summary of the visit's impact on environmental awareness and responsibility.

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(MODEL QUESTION PAPER 1st to VIth semester)
ENVIRONMENTAL SCIENCE AND ELECTIVES
(MAX MARKS: 100 (C_1:10 + C_2:10 + Semester end exam :80)

Time: 3 hrs **Max. Marks: 80**

Note: 1. Answer all questions
2. Draw neat-labeled diagrams and give examples wherever necessary

SECTION A

1. Answer all the following questions **(2x10=20M)**

a.
b.
c.
d.
e.
f.
g.
h.
i.
j.

SECTION B

Write short notes on any SIX of the following: **(5 X 6 = 30 M)**

2.
3.
4.
5.
6.
7.
8.
9

SECTION C

Answer any THREE of the following: **(10 X3=30 M)**

10.
11.
12.
13.

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Davangere University
Shivagangotri, Davangere

Scheme for Practical Examination for I to VI Semesters and SEC papers (MAX MARKS: 50

(C_1:05 +C_2:05: practical end semester exam: 40)

Time: **3hours** **Max Marks: 40**

I.	**Major Experiment** (Preparation, Identification/ Estimation/Quantification)	**20 Marks**
II.	**Writing a Comments/Procedure**	**10 Marks**
III.	**Record / project write up**	**05 Marks**
IV.	**Viva voce examination**	**05 Marks**

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