

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

### ES6T1: 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 5	60 Hrs
<b>Unit – 1</b>	<b>15</b>
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.	
<b>Unit – 2</b>	<b>15</b>
Aquatic Microbiology: Definition. Water related diseases - Bradley's classification - <i>water-borne diseases, water-washed diseases, water-based diseases and water-related diseases</i> . Infection, pathogens, symptoms, treatment and preventive measures – Disinfection of water for potable purposes. Coliforms – <i>Citrobacter, Enterobacter, Escherichia</i> and <i>Klebsiella</i> . Total and Faecal coliforms. Role of microbes in wastewater treatment: Activated Sludge Process and Trickling Filter; Septic tank and Biomethanisation.	
<b>Unit – 3</b>	<b>15</b>
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.	



<p>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.</p>	
<b>Unit - 4</b>	<b>15</b>
<p>Application of microbes in Environment:  Bio fertilizers and biopesticide: Introduction, scope and importance, Biofertilizer-<i>Rhizobium</i>, <i>azotobactor</i>, <i>azospirillum</i>, Blue green algae, <i>azolla</i>, <i>mycorrhizae</i>. 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 in organic solid waste management: Composting – anaerobic and aerobic (Windrow method, accelerated composting, Bio-mechanical composting machines). Role of inoculum in composting and Vermicomposting.</p>	

#### 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 Intern
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. Mitchell, 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.

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



### List of Experiments to be conducted

### ES 6P1: ENVIRONMENTAL MICROBIOLOGY

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

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

### References

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

Formative Assessment – Practical Internal Assessment = 50% (25 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	50% (25 Marks)
Total	100% (50 Marks)

*Arha*

*Ranjit Bhandari*

*Ch*

*Rajeev*

*Pranav*



## ES6T2: 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 instill a knowledge on methodologies used for assessing Environmental Impact.
PSO 3	To motivate and inspire to acquire contemporary understanding and skills leading to issue identification and conservation.
PSO 4	To inculcate creativity and innovative spirit in identifying appropriate assessment tools.

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

Content of Theory Course 5	60 Hrs
<b>Unit – 1</b>	<b>15</b>
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, Noise, 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.	
<b>Unit – 2</b>	<b>15</b>
EIA Methodologies: Rapid and Comprehensive EIA. Characteristics of methods of Impact Identification. Criteria for the selection of EIA methodology – General, impact identification, impact measurement, impact interpretation and evaluation and impact communication. Methods of Impact Identification - Adhoc methods, Checklist methods, Matrices methods, Networks methods and Overlay methods. Environmental index using factor analysis, Cost-benefit analysis, Predictive or Simulation methods. Case Studies: Industry, Housing and Multipurpose Dams.	
<b>Unit – 3</b>	<b>15</b>
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.	



<p>Water audit, Energy audit, Health &amp; Safety audit and Waste &amp; Waste Minimisation audit.</p> <p>Audit procedure: Pre-audit activities, On-site activities and Post-audit activities.</p> <p>Evaluation of Audit data and Preparation of audit report. Auditor profile.</p> <p>Environmental Audit Notifications (with latest amendments) ISO 14010 - EA- General Principles of Environmental Auditing</p> <p>ISO 14011 - EA- Auditing of Environmental Management Systems ISO 14012 - EA- Qualification Criteria for Environmental Auditors</p> <p>ISO 14013 - Management of Environmental Audit Programmes</p>	
<p>Environmental Audit: Concept, Aims and Objectives; Elements of Environmental audit - Internal and External audit.</p> <p>Types of Environmental Audit: Environmental Compliance Audits, Environmental Management Audits and Functional Environmental Audits.</p> <p>Water audit, Energy audit, Health &amp; Safety audit and Waste &amp; Waste Minimisation audit.</p> <p>Audit procedure: Pre-audit activities, On-site activities and Post-audit activities.</p> <p>Evaluation of Audit data and Preparation of audit report. Auditor profile.</p> <p>Environmental Audit Notifications (with latest amendments) ISO 14010 - EA- General Principles of Environmental Auditing</p> <p>ISO 14011 - EA- Auditing of Environmental Management Systems ISO 14012- EA- Qualification Criteria for Environmental Auditors</p> <p>ISO 14013 - Management of Environmental Audit Programmes</p>	
<b>Unit - 4</b>	<b>20</b>
<p>Environmental Risk Assessment</p> <p>Hazard identification and risk assessment - Quantitative and Qualitative risk assessment.</p> <p>Quantitative - Hazard Identification and Risk Analysis (HIRA).</p> <p>Qualitative - Hazard and Operability Analysis (HAZOP), Job Safety Analysis (JSA), Fault Tree Analysis (FTA) and Event Tree Analysis (ETA).</p> <p>Disaster management plan - Off-site emergency plan and On-site emergency plan</p> <p>Occupation, Health and Safety Management Plan, PPEs, Fire Safety,</p> <p>Chemical and Biological Hazards. Safety Management and Laws - Factories Act; Manufacture, Storage and Import Hazardous Chemical Rules. OSHAS.</p>	

#### 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.
  - a. McGraw Hill.
7. Santra, S. C. 2001. Environmental Science, New Central Book Agency (P) Ltd. Shrivastava, A. K. 2003. Environment Impact Assessment. APH Publishing
  - a. Corporation.
8. Trivedi, P. R. 2004. Environmental Impact Assessment. APH Publishing Corporation

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



## List of Experiments to be conducted

### ES 6P2: 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

1. Arts, J., & Morrison-Saunders, A. (Eds.). (2012). *Assessing impact: handbook of EIA and SEA follow-up*. Routledge.
2. Barton, H., & Bruder, N. (2014). *A guide to local environmental auditing*. Routledge.
3. Carroll, B., & Turpin, T. (2002). *Environmental impact assessment handbook: A practical guide for planners, developers and communities*. Thomas Telford.
4. Erickson, P. A. (1994). *A practical guide to environmental impact assessment*. Academic Press Inc..
5. Munier, N. (2004). *Multicriteria environmental assessment: a practical guide*. Springer Science & Business Media.
6. Nelson, D. D. (1998). *International environmental auditing*. Government Institutes. Rathi, A. K. A. (2021). *Handbook of Environmental Impact Assessment: Concepts and Practice*. Cambridge Scholars Publishing.
7. Thompson, D., & Wilson, M. J. (1994). Environmental auditing: theory and applications. *Environmental Management*, 18(4), 605-615.

Formative Assessment – Practical Internal Assessment = 50% (25 Marks)	
Assessment Occasion/ type	Weightage in Marks
End Semester Examination	50% (25 Marks)
Total	100% (50 Marks)

*Amma*

*Ramya* *Bruders*

*20/01/2021*  
*10/1/2021*





I/II/III/IV/V/VI/VII/VII Semester B. Sc. Examination..... MONTH ..... YEAR  
**Practicals**

**Environmental Science**  
**Paper title**  
**Scheme of Examination**

**Duration: 3 Hrs**

**Max. Marks: 25**

Q.1. Conduct the given Experiment; 1×12=12  
Write Aim, Principle, Procedure and Tabulation, calculations and results.

Q.2. Identify and give critical comments on given Specimens: 4×2 = 08  
A.  
B.  
C.  
D.

Q.3. Viva-Voce 05

**Members of BOS;**

1. Dr. Prakash Kariyajjanavar, GUK
2. Prof. Vijaykumar K, GUK
3. Dr. B. Ramakrishna Reddy
4. Dr. Shaila Hiremath
5. Dr. Nagaraj Parisara
6. Dr. Harish Kumar
7. Dr. Tirumala S
8. Dr. Basavaraja D

Chairman

Member, Internal

Member, Internal

Member, Internal

Member, External

Member, External

Member, External

Member, External