**Subject Code: 02BT0531**
**Subject Name: Environmental Technology (Elective)**
**M.Sc. Semester- III**

**OBJECTIVE**: To provide the advanced learning of environmental biotechnology dealing with natural resource management, biotreatment of solid and liquid waste, bioremediation and major environment policies.

**Credits Earned:** 4 Credits

**COURSE OUTCOMES**: By the end of this course students should be able to:

1) Describe and comprehend the fundamental concepts of environmental biotechnology.
2) To learn about biodegradation and bioremediation process.
3) To learn about various waste management strategy.
4) To understand the importance of environment and develop major policies towards protection of biodiversity and environment.

**Pre-Requisite of Course:** N.A.

**Teaching Scheme:**

| Teaching Scheme (Hours) | | | Credits | Theory Marks | | | Tutorial/ Practical Marks | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| Theory | Tutorial | Practical | | ESE (E) | IA (M) | CSE (I) | Viva (V) | Practicals/ TW | |
| 4 | 0 | 0 | 4 | 50 | 30 | 20 | 0 | 0 | 100 |

**Contents:**

| Unit | Topics | Contact Hours |
|---|---|---|
| 1 | **Natural Resources**<br>**Natural Resources:** Types of Natural Resources (Biotic, Abiotic), Biotic - Forest, Animals, Microbes, Abiotic - Air, Water, Land, Soil, Renewable and Non Renewable Energy<br>**Sustainability and Resource management:** Extraction, Use, Exhaustibility<br>**Major Environmental Policy and Protocol:** 1972- UN conference on Human Environment at Stockholm, 1987- World Commission on Environment and Development (WCED)-Brundtland commission, 1987-Montreal Protocol to Vienna Convention, 1992-UN conference on Environment and Development / earth summit at Rio, (UNFCC, UNNCCD, CBD), 1997-Kyoto Protocol, 2002-World Summit on Sustainable Development/Rio, 2012-UN conference on Sustainable Development/Rio | 6 |
| 2 | **Waste management Strategy**<br>**Solid waste management:** Collection, Sorting and Treatment, Waste to energy: Direct Combustion, Pyrolysis (Bio-oil, Char), Conventional Gasification, Plasma arch gasification (Syngas and Hydrogen), Biogas production ($CH_4$), Fermentation (ethanol, lactic acid, hydrogen), Landfilling, Recycling, Bio-Composting, Vermi-Composting and Bio-drying<br>**Waste water management: (a) Primary**-Screening, Aerating (DAF), Sludge removal, **(b) Secondary**-Biofiltration (Trickling filters), Rotating biological contactors, Activated Sludge, Sequencing Batch reactors, Membrane Bioreactors, Aerobic granulation, Surface-aerated lagoons or ponds, Constructed wetlands **(c) Tertiary treatment** – Filtration (Activated carbon, RO filtration, Ultra-filtration), Disinfection (UV, Ozone, Chlorine) | 24 |
| 3 | **Environment Toxicology and Bioremediation**<br>**Environment Toxicology -** Environment Contaminants (PCBs, Heavy metals, Pesticides, micro-pollutants, EDCs) and their fate, Acute and Chronic Lethal Effects to Individuals, Effects on populations, community and ecosystems, Dose response – LD50.<br>**Microbial Bioremediation** – Aerobic, Anaerobic, Bio-Degradation of Basic Structures found in Hydrocarbons & Xenobiotics, PCBs, DDT, Nitrobenzene<br>**Mycoremediation** – Role of Mycorrhizal fungi, Use of fungal enzymes (Lipases, Lignin peroxidase, Laccases, Mg-peroxidases), Mycofiltration<br>**Phytoremedation** – Phytosequestration, Phytoextraction, Phytostabilization, Phytotransformation, Phytovolatilization, Rhizofiltration, Hyperaccumulators and biotic interaction. | 22 |
| 4 | **Green Chemistry**<br>Biocatalysts, Green chemistry in industries, microbial fuel cell (MFC), electric vehicles, solar energy and hydrogen production, energy from alternate sources; Biofuel production (bio-ethanol and biodiesel), Production of biodegradable materials, concept of green building, Pollution free engineering processes. | 8 |
| | **Total Hours** | **60** |

**References:**


1. Environmental Microbiology, S.K.Agarwal (2009), APH Publishing corporation, New Delhi
2. Introduction to Environmental biotechnology, A.K.Chatterji (2011), PHI Learning private limited, New Delhi.
3. Biodegradation and bioremediation by M.Alexander (1999), Academic press
4. Environment Biotechnology by T.R. Srinivas (2008), New Age Publishers
5. M.H.Fulekar (2005) Environmental Biotechnology Oxford IBH Publishing cooperation.
6. M.H.Fulekar (2010) Bioremediation technology recent advances, Springer
7. N.P Cheremisinoff (1996) Biotechnology for Waste and Wastewater Treatment, William Andrew Publishing, New York.
8. Bruce Rittman, Perry L. McCarty, Environmental Biotechnology: Principles and Applications, 2nd edition, McGraw-Hill, 2000.
9. Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.
10. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
11. Mizrahi & Wezel, Advances in Biotechnological Process
12. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Environmental Microbiology, Academic Press, 2000. Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition
13. Introduction to Green Chemistry, Second Edition, Albert Matlack, CRC Press, 2010


**Suggested Theory distribution:**

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process.

| Distribution of Theory for course delivery and evaluation | | | | | |
|---|---|---|---|---|---|
| Remember | Understand | Apply | Analyze | Evaluate | Create |
| 20% | 20% | 30% | 15% | 10% | 5% |

**Instructional Method:**

a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, etc.

b. The internal evaluation will be done on the basis of continuous evaluation of students in the class-room in the form of attendance, assignments, verbal interactions etc.

c. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.