Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2021 – 2022

COURSE HANDOUT (PART II)

Date: 07.09.2021

In addition to Part – I (General Handout for all courses) printed on Page 1 of the timetable book; this portion gives further specific details regarding the course.

Course Number : **BIO G525**

Course Title : **ENVIRONMENTAL BIOTECHNOLOGY AND WASTE MANAGEMENT**

Instructor In-charge : **P. SANKAR GANESH** (http://universe.bits-pilani.ac.in/hyderabad/psankarganesh/Profile)

Instructor : **P. Sankar Ganesh, Aishwarya Natarajan, Minali Singh, Vartika Singh**

Description of the course :
This course gives overall information on the application of biotechnology to the management of environmental problems and for enhanced plant & animal production through biological insecticides, herbicides resistance, mineral cycling, conservation of genetic resources and biological nitrogen fixation. The waste management portion focuses on the use of biotechnological processes for pollution control, bioremediation of toxicants and treatment of domestic and industrial wastes. Ethical issues related to the release of genetically modified organism and the intellectual property rights are also briefly discussed.

Scope of the course :
This course is designed to impart knowledge on application of biotechnological processes for the betterment of environment as a whole. In this pursuit, the student will understand various biological phenomena, which can be exploited to save environment from eventual deterioration, mainly in terms of waste management. Ample importance will be given towards practical application of theoretical knowledge gained in the course through hands-on sessions and real life examples.

Intended learning outcomes :
After successful completion of this course, students will be able to, but not limited to:

- Identify sources of pollutants and monitor them in the environment
- Compare and contrast various biotechnological methods of sewage treatment
- Understand bioremediation of organic and inorganic pollutants
- Design bioreactors that are used for biological treatment of waste and wastewater
- Demonstrate knowledge of clean technology
- Outline development of bioresource technologies
- Explain the influence of agricultural biotechnology
- Relate ethical issues with growth of environmental biotechnology, specifically in India

Text Book :
T: Alan Scragg, ***Environmental Biotechnology***, Oxford University Press, 2009 reprint.

Reference Books :
R1: Rehm H J and Reed G, ***Biotechnology, a comprehensive treatise***, VCH Verleg, Germany, 1999.

R2: A K Chaterjee, ***Introduction to Environmental Biotechnology***, PHI, India, 2000.

R3: Andrew D Eaton, Lenore S Clesceri, Eugene W Rice and Arnold E Greenberg, ***Standard Methods*** – For the Examination of Water and Wastewater, American Public Health Association, 2005.

R4: Raina M Maier, Ian L Pepper and Charles P Gerba, ***Environmental Microbiology***, 2nd Ed., Academic Press, 2009.

R5: Bimal C. Bhattacharyya and Rintu Banerjee, ***Environmental Biotechnology***, Oxford Higher Education, 2007.

R6: Godfrey Boyle, ***Renewable Energy*** – Power for a sustainable future, 2nd Ed, Oxford, Indian Edition, 2011 reprint.

R7: Anjaneyulu Y, ***Introduction to Environmental Science***, BS Publications, 2004.

R8: Laxmi Lal and DK Gupta, ***Composting Technology***, Agrotech Publishing Academy, 2008.

R9: Howard S Peavy, Donald R Rowe, George Tchobanoglous, ***Environmental Engineering***, Mc Graw-Hill International Editions, Civil Engineering Series, 1985.

R10: LL Somani, ***Vermicomposting and Vermiwash***, Agrotech Publishing Academy, 2008.

Course Plan :

Lecture Number	Learning Objectives	Topics to be covered	Reference Chap (Book)
1	Introduction to environmental biotechnology	Basic concept of environment and its components. Biotechnology for environment; definitions and facts.	1(T); 1(R2); 1(R7); 1(R5)
2	Environmental pollution	Sources of various pollutants and their environmental impact.	1(T); 12, 13, 14, 15, 16, 17(R7)
3-4	Environmental monitoring	Methods for measurement of environmental pollution. Physical, chemical and biological methods. Nucleic acid based techniques for analyses of diversity, Concept of biomarkers.	3(T); 5(R2); 4(R5); 8,9,10,11,12, 13(R4)
5-6	Basics of microbiology in relation to environment	Microbial groups, characteristics; Microbial metabolism in relation to waste treatment.	2 (T); 3(R2); 2(R4); 3(R5)
7-11	Biotechnology of sewage treatment	Basics of sewage treatment processes. Functions of various treatment systems. Microbiology of sewage treatment.	4(T); 4(R2); 24(R4); 5(R9)
12-15	Bioremediation of organic pollutants	Aerobic and anaerobic degradation of organic pollutants. Principles, biochemical pathways and genetic regulation. Degradation of aliphatic, aromatic, polyaromatic and chlorinated compounds.	5(T); 7(R2); 20(R4); R1
16-18	Bioremediation of inorganic pollutants (nitrate and phosphate)	Biological removal of nitrogen and phosphate.	5(T)
19-20	Bioremediation of inorganic pollutants (heavy metals and radionuclides)	Microbial interactions. Metal toxicity. Molecular mechanism of metal resistance. Biosorption and biotransformation of metals and radionuclides. Recent developments in metal bioremediation.	5(T); 6(R2); 21(R4); R1
21-23	Phytoremediation	Use of plants for removal of organic & metallic pollutants.	5(T); R1
24-25	Biomining of metals and radionuclides	Concepts of bioleaching, microbial aspects, regulatory factors and process application.	8(T); 8(R2)
26-28	Bioreactors	Reactor configuration. Processing and operation. Comparison of different bioreactors.	R1; 6(R5)

29-30	Development of clean technology (minimization of waste generation)	Fundamentals of clean technology. Integrated pest management and bio-control of plant diseases. Microbial polymer production and bio-plastic technology.	4(T)
31-34	Bioresource technology development	Biotechnology for energy production – basic concept. Biological energy sources and bio-fuels. Biotechnology for enhanced oil recovery.	7(T); 10(R2); 4(R6); 3(R5)
35-37	Bioprocessing of solid waste	Composting, vermicomposting and role of termites in waste processing, Recent developments in waste treatment.	4(T); 10(R2); R8; R10
38-40	Agricultural biotechnology for safe environment	Methods and application for plant and animal improvement. Biotechnology of nitrogen fixation.	9(T)

Evaluation Scheme : All the evaluation components are **Open Book**

Evaluation Component	*Duration*	*Weightage, %*	*Date and Time*
Midterm Test	90 Mins	30%	23/10/2021 11:00 AM to 12:30 PM
Research oriented activities/ Class work#	Diverse	10%	Continuous Evaluation
Practical	Diverse	20%	Continuous Evaluation
Comprehensive Examination	120 Mins	40%	24/12/2021 10:00 AM to 12:00 PM

#This component includes one or more of the following: Literature Survey, Seminars/ Presentations, Research Summaries, Design/ Development of processes/ products/ artifacts, Experimental or Quantitative Analysis of processes/ products/ phenomena, Design of Experiments, Surprise Quiz, etc.

Proposed List of Experiments

1. Estimation of alkalinity
2. Estimation of chloride content
3. Estimation of hardness
4. Estimation of chemical oxygen demand (COD)
5. Estimation of biological oxygen demand (BOD)
6. Microbiological analysis [(i) MPN analysis & (ii) Coliform test]
7. Estimation of volatile fatty acids (VFA)
8. Estimation of heavy metals (Lead and Iron)
9. Estimation of total nitrogen (Total Kjeldahl Nitrogen method)
10. Estimation of ammoniacal nitrogen
11. Estimation of total phosphorous

Pedagogical approach: The course will be primarily run based on active learning pedagogical methods and the students are requested and expected to actively participate in the course.

Grading policy: Award of grades will be guided in general by the histogram of marks. Decision on border line cases will be taken based on individual's sincerity, student's regularity in attending classes, and the instructor's assessment of the student.

Make-up policy: Make-up for midterm test will be given only in genuine (medical emergency) cases of absence. If the absence is anticipated, before the examination, prior permission of the Instructor-in-charge is necessary. Make-ups for class tests/ quizzes and assignments are not given. Also refer to Clause 4.07 of BITS *Academic Regulations* for more details. Please keep checking CMS & email for the updated information on this aspect.

Notices: All notices/ announcements regarding this course shall be displayed only in the Course Management System (CMS).

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Prof. P. Sankar Ganesh
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BIO G525
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