JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY

M.Sc. ENVIRONMENTAL BIOTECHNOLOGY (III SEMESTER)

2023-2024

Environmental Biotechnology Lab-III

Subject Code: 20M35BT211

Course Code	**20M35BT211**	**Semester Odd**	**Semester III** **Session** 2021-22 **Month from July to December**
Course Name	Environmental Biotechnology Lab-III		
Credits	0-0-4	**Contact Hours**	8

COURSE OUTCOMES Students will be able to		**COGNITIVE LEVELS**
CO1	Implement various bioinformatics tools for environmental Biotechnology	Level III (Apply)
CO2	Analyze Biochemical waste treatment methods	Level IV (Analyze)
CO3	Analyze bacterial transformation techniques	Level IV (Analyze)
CO4	Evaluate cloning technique and screening of recombinants	Level V (Evaluate)

Module No.	**Title of the Module**	**List of Experiments**
1.	**Bacterial Transformation**	Competent cells preparation and Transformation of plasmid DNA of into *E. coli*, calculation of transformation efficiency
2.	**Cloning and screening of recombinants**	Restriction digestion of vector and insert; ligation of gene of interest in standard plasmid vectors; Transformation; Screening of recombinants
3.	**Waste Management**	Field visit to ETP: Primary, chemical and biological treatment; calculation of kinetics of microbial degradation of waste; bioreactors; pollution control case study
4.	**Bioinformatics**	Application of bioinformatics tools and resources in environmental biotechnology

Evaluation Criteria Components
Maximum Marks
Mid Term Exam 20
End Term Exam 20
Day to Day 60
Total 100

PBL: Group of students can prepare reports on various bioinformatics tools applications in Environmental Biotechnology. Students can also work on the calculations related to transformation efficiency.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

Shah, Shachi, 2022, MEVL-013 Environment Science Lab Course-3, Indira Gandhi National Open University, New Delhi, http://egyankosh.ac.in//handle/123456789/87882.

Singh DP, Singh SK and DP Dwivedi, (2005). Environmental Microbiology and Biotechnology. New Age International (P) Limited, Publishers.

Thakur IS, (2012). Environmental Biotechnology: Basic Concepts and Applications (2nd Second Edition). I. K. International Publishing Housing, New Delhi.

Alexander N Glazer and Hiroshi Nikaido, (2007). Microbial Biotechnology: Fundamentals of Applied Microbiology (2nd Edition).

Environmental Policy, Ethics & Legislation

Course Code	**20M31BT211**	**Semester** Odd **(specify Odd/Even)**	**Semester** III **Session** 2023 -2024 **Month from** July to December
Course Name	**Environmental Policy, Ethics & Legislation**		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Prof. Indira P. Sarethy
	Teacher(s) (Alphabetically)	Dr. Ankish Vijay, Prof. Indira P. Sarethy

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Explain and interpret ethics	**Understand (C2)**
CO2	Correlate ethics with respect to environment	**Apply (C3)**
CO3	Evaluate environmental policy and legislation as applied in different countries	**Evaluate (C5)**
CO4	Analyze commercialization with respect to environment and policy	**Analyze (C4)**

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Introduction**	What is ethics? What is the environment? Ethics and the Environment	**2 [CO1]**
2.	**Environment vs ethics**	Environmental problems as ethical problems, environmental ethics approaches and world views; A brief history of environmental ethics	**3 [CO1]**
3.	**Environmental Justice**	Equal and fair treatment for all people, with respect to development, implementation; enforcement of environmental laws, regulations, and policies.	**5 [CO2]**
4.	**Anthropocentric environmental ethics**	Population growth, pollution, and resource overexploitation as tragedies of the (unregulated) commons. : Humans, other animals, and speciesism, diets, Biocentrism and biocentric individualism. Biodiversity, species preservation, and ecological tradeoffs.	**4 [CO2]**

5.	**International Environmental Policies**	Introducing laws to protect the environment; major environmental laws globally and in India; Nature of Environmental Policies; Stockholm Conference(1972); Rio Conference (UNCED)(1992); Merits of the Conference (Agenda 21); Failures of the Conference.	**4 [CO3]**
6.	**International Agreements and Treaties**	Concept of agreement and treaty; Need of international agreements and treaties; Johanesburg treaty; GAAT and Environment; CITES; Montreal Protocol	**5 [CO3]**
7.	**National Policy on Environment**	National Committee on Environment and Planning (NCEP); Tiwari committee; Establishment of MoEF; National Forest Policy; National Water Policy and National Energy Policy; CPCB and SPCBs.	**4 [CO3]**
8.	**Constitutional provisions for Environmental Protection**	Historical Background of constitutional provisions; Article 14, 15, 19, 21, 32, 39, 47, Article 48(A), 49, 51A(g) as fundamental duties of citizen and directive principles of state policy, Article 243, 243(G) and (W); Art. 246, 248 and other articles related to Environment; Writ provisions for the protection of environment.	**5 [CO3, CO4]**
9.	**National Environmental Legislation**	The Water(Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution), Act, 1981; The Environment (Protection) Act, 1986; Aims, objectives and major contents and Sec. 12 of Mining Act, 1952. The Forest (conservation) Act, 1980; The Wildlife (Protection) Act, 1972; The Biodiversity (Protection) Act, 2002; Aims, objectives and major contents with amendments.	**5 [CO3, CO4]**
10.	**Environmental Legislation related to CRZ & PIL**	Concept and need of public interest litigation; Jurisdiction of High Courts and Supreme Court; Need of CRZ rules for regulation the activities in coastal zone; Statutory provisions in IPC and CrPC; Common law remedies for environmental safeguard; Environment related provisions in Public Liability Insurance Act.	**5 [CO3, CO4]**
		Total number of Lectures	**42**
Project-Based Learning: Analysis of a case study involving environmental legislation violation (CO3)			

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Assignments 1, 2. Presentation 1)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10: https://www.ipcc.ch/apps/njlite/srex/njlite_download.php?id=6471; https://www.un.org/en/development/devagenda/sustainable.shtml
2.	Anti-Pollution Actshttp://www.lawsindia.com/Industrial%20Law/list%20of%20Acts/Pollutioin%20act%20list/POLLUTION%20ACTS%20%20LIST.htm

3.	Constitution of India (referred articles from Part-III, Part-IV and Part-IV-A)https://www.mea.gov.in/Images/pdf1/Part3.pdf; https://www.mea.gov.in/Images/pdf1/Part4.pdf
4.	P. Leelakrishnan, Environmental Law in India**,** Lexis Nexis; 4th edition (26 July 2016)

Biosensors(17M12BT111)
Course Description

Course Code	17M12BT111	**Semester** Odd	**Semester MSc/Integ. Mtech** III/VII **Session** 2023-2024 **Month from:** July-December
Course Name	Biosensors		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Prof.Sudha Srivastava
	Teacher(s) (Alphabetically)	Prof.Sudha Srivastava

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Explain principle and working of biosensors and characterization techniques	Understand Level(C2)
CO2	Evaluate different methods of immobilization and their effect on biosensor performance	Evaluate Level (C5)
CO3	Analyze performance of a biosensor for disease diagnosis, environmental pollution, pathogen quantification	Analyze Level (C4)
CO4	Design strategy for fabrication of a given biosensor with high sensitivity and wide detection range	Create Level (C6)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Introduction:**	Sensors and biosensors, definitions, types of sensors, markets, target analytes, glucose and other medical sensors	2
2.	**Biosensor Advancements and nanotechnology**	First-, second-, third generation biosensors, Nanotechnology and present day biosensors	3
3.	**Basic Design Considerations**	Calibration, dynamic Range, signal to noise, sensitivity, selectivity, interference.	3

4.	**The biological component**	Whole cell sensors, enzymes – sensing substrates or inhibitors, antibodies (Mab, Fab). And other binding proteins, oligonucleotides and aptamers.	3
5.	**Types of biosensors**	Optical biosensors, Electrochemical biosensors, Piezoelectric biosensor, Calorimetric biosensors	8
6.	**Immobilization method**	Non-covalent immobilization - entrapment and multipoint electrostatic attachment. Covalent attachment via thiol, amino and hydroxyl groups. Affinity interactions - avidin/biotin, , complementary oligonucleotides.	4
7.	**Techniques for sensing : Physical and chemical**	Absorbance, fluorescence, chemi/bioluminescence and phosphorescence, Surface Plasmon Resonance (SPR), quartz crystal microbalance, cyclic voltammetry	8
8.	**Sensor stabilization**	Storage and operational stability. Polyols, polymers and low Mw compounds as stabilizing agents for drying and long term storage. Stabilization mechanisms.	3
9.	**Applications**	Pharmaceutical**,** agricultural, food safety, biomedical applications, food processing: state of the field, market potential, unique design criteria and needs, current sensors in use.	8
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Class Test, Presentation)
Total	**100**

PBL: Students would be presenting and/or submit report in a group of 3-4, about biosensors for various application , their fabrication, performance characterization.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Ligler, F.S. and Rowe Taitt, C.A. 2002. Optical Biosensors: Present & Future. Elsevier, The Netherlands. ISBN: 0-444-50974-7.
2.	Yang, V.C. and T.T. Ngo. 2000. Biosensors and Their Applications. Kluwer Academic/Plenum Publishers, New York, NY. ISBN: 0-306-46087-4.
3.	Recent research articles

19M21BT212	**Semester:** Odd	**Semester:** III **Session :** 2023 -2024 **Month from:** July to December
Recombinant DNA Technology		
3	**Contact Hours**	**3**

Faculty (Names)	**Coordinator(s)**	1. Dr. Pooja Choudhary
	Teacher(s) (Alphabetically)	1. Dr. Pooja Choudhary 2. Dr. Shalini Mani

COURSE OUTCOMES		**COGNITIVE LEVELS**
C230.1	Summarize the fundamental concepts of RDT, cloning vectors, prokaryotic vs. eukaryotic hosts and expression systems	**Understand Level, C2**
C230.2	Illustrate different methods of gene transfer, cloning, genomic libraries and molecular tools for microbes, plants and animals	**Apply level, C3**
C230.3	Analyse RDT tools, techniques and its applications in environment, Medicine and agriculture	**Analyze level, C4**
C230.4	Identify importance as well as ethical and biosafety issues related to transgenics	**Understand Level, C2**

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	**Introduction**	Basic Concepts of Recombinant DNA technology, origin of RDT, pioneering discoveries and significance of tailoring microbes, model plants and animals in present context	4
2.	**Enzymes, Vectors and Hosts for Cloning**	Restriction enzymes and other DNA modifying enzymes; Cloning vectors, expression vectors, prokaryotic and eukaryotic expression systems, bacterial, fungal and plant hosts for cloning, methods of gene transfer	6

3.	**Recombinant DNA**	Basic techniques of gene manipulation, - Gel electrophoresis, DNA transformation techniques, Cloning	6
	Technology	of PCR products, Construction of Genomic and cDNA libraries, Screening Libraries with Gene Probes, Screening Expression Libraries, Positional Gene Cloning, Subtractive cloning, Functional cloning	
4.	**Molecular tools supporting RDT**	PCR, RT-PCR, Blotting techniques, Sequencing methods, NGS, Gene editing, Mutagenesis, Gene expression techniques, Regulation of gene expression, microRNAs, Microarrays	4
5.	**Methods & Applications of Plant Genetic engineering**	Molecular Biology of DNA transfer in Plant through *Agrobacterium tumefaciens*, methods for artificial gene transfer, Applications in agriculture such as golden rice, BT Cotton, Nif and Nod gene clusters and Nitrogen fixing, etc.	5
6.	**RDT for Environmental Biotechnology**	Environmental Applications: biodegradation and bioremediation Energy based applications: Biogas, biodiesel and bioethanol production by microorganisms. Biotechnological applications. Biotechnological applications.	5
7.	**RDT in Medicine & Therapeutics**	Production of recombinant vaccines and antibiotics, phytopharming, microbes as cell factories for production of therapeutic molecules, insulin and other major discoveries, gene therapy	6
8.	**Animal cloning & Issues**	Transferring gene in animal oocytes, eggs embryos and specific animals tissues, Application of rDNA technology in animal cell lines, tailoring model animals, Controlling the expression of transgene in time and space, case studies exposing risks of animal cloning	4
9.	**Ethics & Biosafety in RDT**	Ethical issues, Biosafety guidelines and regulations	2
Total number of Lectures			**42**

PBL Component (C230.3): Students assigned topics in group of 2 to 3 members. A review of literature-based project on latest advancements in Recombinant DNA Technology and genetic engineering. PBL involves real-time learning based on published scientific papers, involves constructive

analytical thinking and peer learning. Students submit their report/e-poster/PowerPoint presentation of their review work.

Evaluation Criteria:

Components Maximum Marks

T1 20
T2 20
End Semester Examination 35
TA 25

Total 100

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Genes XII: Benjamin Lewin, 2016
2.	Molecular Biology of the Gene, Seventh Edition: James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, 2004 Microbial Biotechnology: Progress and Trends, FarshadDarvishiHarzevili, Hongzhang Chen, First edition CRC Press/Taylor & Francis Group, 2017
3	Molecular biotechnology : principles and applications of recombinant DNA / Bernard R. Glick and Jack J. Pasternak, Cheryl L. Patten. ASM Press
4.	Gene Cloning and DNA Analysis: An Introduction, Seventh Edition-T. A. Brown, John Wiley & Sons Ltd. 2016
5.	Microbial Biotechnology: Progress and Trends, FarshadDarvishiHarzevili, Hongzhang Chen, First edition CRC Press/Taylor & Francis Group, 2014

Detailed Syllabus

Lecture-wise Breakup

Course Code	16B1NBT733	**Semester** ODD **(specify Odd/Even)**	**Semester** III **Session** 2023-2024 **Month from July-December**
Course Name	Waste Management		
Credits	4	**Contact Hours**	3-1

Faculty (Names)	**Coordinator(s)**	Dr. Garima Mathur
	Teacher(s) (Alphabetically)	Dr. Garima Mathur

COURSE OUTCOMES		**COGNITIVE LEVELS**
C432-3.1	Explain the fundamental concepts related to waste management	Understand level (C2)
C432-3.2	Apply basic environmental legislation and Environmental Management System for effective waste management	Apply level (C3)
C432-3.3	Analyze the emerging waste management technologies for sustainable solution	Analyze level (C4)
C432-3.4	Assess the environmental, social and economic aspects in integrated waste management	Evaluate level (C5)

Module No.	**Title of the Module**	**COs**	**Topics in the Module**	**No. of Lectures for the module**
1.	**An introduction to Waste management**	CO1	Definition of waste, sources, general categories of waste in context of Indian legislations, waste generation aspects, waste collection, storage and transport	**4**
2.	**Biological and chemical waste treatment technologies**	CO1, CO2, CO3	Waste incineration and waste to energy (WTE), fundamentals of thermal processing – combustion, pyrolysis, gasification, energy recovery system, aerobic and anaerobic digestion, composting, bio gasification and mechanical biological treatment of wastes.	**7**
3.	**Waste handling and disposal**	CO2	Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment, Landfills**:** Design and operation including: site selection, Geo-environmental investigations, engineered sites, liners and covers, management of landfill leachate and the mining of old landfills, gas recovery and control, including utilization of recovered gas (energy), and landfill monitoring and reclamation, Natural attenuation process and	**7**

			its mechanisms, integrated waste management	
4.	**Source Reduction and waste Recycling**	CO2, CO3	Unit operations for separation and processing, size reduction, separation, density separation.	**8**
5.	**Product recovery and biorefinery**	CO2, CO3, CO4	Recovery of Biological Conversion Products: Composts and Biogas, recovery technologies to deliver added-value products	**5**
6.	**Hazardous Waste: Management and Treatment**	CO2, CO3, CO4	Specific waste streams including healthcare (biomedical wastes), food wastes, mineral and mining wastes, electronic waste, hazardous wastes and producer responsibility wastes.	**6**
7.	**Legal aspects and policy guidelines**	CO2	Regulatory requirements for identification, characterization and disposal of hazardous, nonhazardous and domestic wastes, International treaties addressing waste issues	**3**
8	**Environmental and Economic considerations of waste management**	CO2, CO4	Economics of the on-site v/s off site waste management options	**2**
			Total number of Lectures	**42**

Evaluation Criteria	
Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Assignment 1, Assignment 2, PROJECT BASED LEARNING)
Total	**100**

Project based learning: After gaining knowledge about various aspects of waste management, students will be taking up few successful case studies on effective waste management and government policies and regulations addressing the growing concern associated with waste management.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Waste from wealth- Banwari Lal, Priyangshu M Sarma, The Energy and Resources Institute, 3rd Edition, 2017.
2.	Textbook of solid waste management, Khan, Iqbal H, Ahsan, Naved, CBS Publishers & Distributor 2014
3.	Environmental Waste Management, Ram Chandra, CRC Press, 1st Edition, 2015

COURSE: SUSTAINABLE AGRICULTURE
CODE: 19M12BT113
Elective for B.tech/M.Tech Dual degree / Specialization course

Course Code	19M12BT113	**Semester: Odd**	**Semester: DD-IX & M.Tech-I Session 2023** **Month:** July – December, 2023
Course Name	**Sustainable Agriculture**		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Prof. S Krishna Sundari
	Teacher(s) (Alphabetically)	Prof. S Krishna Sundari

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO.1	Interpret various practices in Indian agriculture, risks, challenges and status of Indian agriculture	Understand Level Level II
CO.2	Outline appropriate certification guidelines and Economic Rules that apply for organic farming and biotechnological farm inputs	Understand Level Level II
CO.3	Relate plant nutrition requirements to soil quality and agriculture yield impacts	Apply Level
CO.4	Examine methods to promote soil health, minimize water use, and decrease pollution in farm soils	Analyze Level Level IV
CO.5	Recommend strategies to avoid degradation of soils on a farm through implementation of sustainable management practices in agriculture	Evaluate Level Level V

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Soil health**	Major types of soil, Soil structure and composition, problems in soils & Soil life	**2**
2.	Soil degradation	Soil structural decline, factors contributing to soil degradation, mechanisms of soil degradation	4
3.	Plant nutrition	Essential requirements for plant growth, micro and macro nutrients, principles of fertilization	4

4.	Synthetic crop chemicals	Types of chemical inputs in modern agriculture, fertilizers, pesticides, insecticides, weedicides, role and mechanism	2
5.	Phytotoxicity	Factors contributing to phyto toxicity, chemical toxicity, soil pollutants, soil antagonists	4
6.	Pest and diseases in Plants	Major categories of plant diseases and associated crop issues, Pest control & Preventative measures, integrated pest management	4
7.	Sustainable ways of farming	Different methods for Sustainable ways of farming, processes involved, advantages, strategy for implementation, Introduction to Land Management programs	6
8.	Organic farming	Natural farming, Safe Cultivation techniques, Cover crops, biofertilizers, biopesticides, bioinoculants, zero chemical input agriculture	5
9.	Tools for Sustainable farming	Irrigation systems & sustainability, Weed Management, cropping seasonal variations, plantation times, crop rotation, energy farming, restoring marginal lands and brown field	3
10	Agriculture economics	Economic principles of agriculture, Financial sustainability & planning, Integrated farmer community dynamics	3
11	Agriculture regulatory matters	Certification & guidelines for crop inputs (organic, biological inputs, hormones and others), IPR in agriculture, Role of Regulatory bodies	3
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (…)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	**Organic Agriculture - A Global Perspective, Editors: Paul Kristiansen, Acram Taji and John Reganold, CSIRO PUBLISHING, Australia**
2.	Sustainable Agriculture– Beyond Organic Farming, editor: Sean Clark, MDPI, Basel, Switzerland,
3.	Sustainable Agriculture, From Common Principles to Common Practice, Edited by Fritz J. Häni, László Pintér and Hans R. Herren, Published by the International Institute for Sustainable Development, ISBN 978-1-894784-05-4

4.	Technical reports of USDA, UNDP, ICAR
5.	Articles from Journals such as: Journal of Sustainable Agriculture; Agriculture, ecosystem & Environment; Agroecology and Sustainable Food Systems

Detailed Syllabus
Lecture-wise Breakup

Course Code	**17M12BT118**	**Semester** **Odd (MSc Micobiology 111)**	**Semester . III. Session** 2023-2024 **Month from** July – Dec 2023
Course Name	**Product Development in Biotechnology**		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	Prof. Neeraj Wadhwa
	Teacher(s) (Alphabetically)	Prof. Neeraj Wadhwa

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Outline various processes relevant for Biobusiness	**Understand Level (C2)**
CO2	Compare marketing techniques and related ethics	**Apply Level (C2)**
CO3	Select appropriate technology for the production of Biological products	**Understand Level (C3)**
CO4	Explain financial, regulatory, health policy aspects for biobased industries	**Understand Level (C2)**

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Biotechnology Industries overview**	Biotechnology as a function of science and business , Functional units Company structure and functions Emerging technology and technical convergences issues	**5**
2.	**Business in the context of biotechnology** **Entrepreneurship-**	Science/development, the idea and its development , Plant tissue culture lab-equipment- glasswares chemical requiremen-- construction,techniquesin culturing and export abroad, Vermitechnology, Mushroom cultivation, single cell protein, Biofertilizer technology-production, Textile processing, leather treatment, leather industry set up Detergent industry, bakery, Unit processes in food industry	**14**

3.	**Product development**	a. Production of commercially important primary metabolites like organic acids, amino acids and alcohol & Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids. b.Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers, Pulp and Paper , SINGLE CELL PROTEIN & Mushroom culture, Bioremediation. Bioprocess strategies in Plant Cell organ culture and Animal Cell culture.	**12**
4.	**Biobusiness plans**	Concerns and oppurtunities, Environmental clearances requirement from government, Quality checks and validation certificates, Packaging concerns, Policy and regulatory concerns,	**6**
5.	**Bioremediation Bioethics and legal issues**	Product development, Sustainability, Environmental concerns of product and their waste.	**5**
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Assignment)
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
2.	Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
3.	Cruger,Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing, 2000
4	Karthikeyan,S and Arthur Ruf." Biobusiness"MJP Publication Chennai India 2009