KUMARAGURU COLLEGE OF TECHNOLOGY

(An Autonomous Institution affiliated to Anna University, Chennai-25)

COIMBATORE – 641 049.

M. Tech BIOTECHNOLOGY

REGULATION 2024

I to IV Semesters

DEPARTMENT OF BIOTECHNOLOGY

VISION

To be a globally recognized biotechnology program advancing education, research, and ethical innovation for health, sustainability, and societal well-being.

MISSION

M1: Deliver a competency-driven curriculum that blends scientific fundamentals with emerging biotechnological advancements.

M2: Integrate hands-on research and industry exposure to develop problem-solving and innovation skills

M3: Foster entrepreneurial thinking, ethical practice, and leadership in diverse biotechnological domains.

M4: Equip students to advance biotechnology with societal responsibility and global impact.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives of Master of Technology (M. Tech) in Biotechnology Program are toprepare the graduates:

PEO1: To apply professional knowledge and skills in academia, industry and research careers.

PEO2: To be competent to evaluate real life problems and to propose biotechnological solutions with economic and social impact.

PEO3: To have intellectual independence to provide innovative solutions.

PROGRAM OUT COMES (POs)

Graduates of the M. Tech Biotechnology Program should have the ability to:

PO1: An ability to independently carry out research / investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report / document.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program.

PO4: An ability to apply contemporary techniques to address issues related to health care sector.

PO5: An ability to apply sustainable methodologies to address environmental issues.

PO6: An ability to apply modern engineering tools and techniques to execute interdisciplinary projects.

KUMARAGURU COLLEGE OF TECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY
REGULATION 2024
M. Tech BIOTECHNOLOGY- Curriculum

Semester I

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24MAI501	Statistical methods for Engineers	Embedded	BS	3	0	2	0	4
2	24INT501	Research Methodology and IPR	Theory	ES	3	0	0	0	3
3	24MBT501	Bioprocess Modeling and Simulation	Theory	PC	3	0	0	0	3
4	24MBT502	Gene Expression and Analysis	Theory	PC	3	0	0	0	3
5	24MBI503	Animal, Plant and Microbial Cell Culture	Embedded	PC	1	0	4	0	3
6	24MBT504	Bioproduct Separation and Purification Engineering	Theory	PC	3	0	0	0	3
7	24MBP505	Bioproduct Development Lab I	Practical	PC	0	0	4	0	2
								Total Credits	**21**
								Total Contact Hours/week	**26**

Semester II

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24MBI506	Computational Biology	Embedded	PC	3	0	2	0	4
2	24MBT507	Regulatory Affairs in Bioproduct Manufacturing	Theory	PC	3	0	0	0	3
3	24MBP508	Bioproduct Development Lab II	Practical	PC	0	0	2	0	1
4	24MBP509	Biotechnology Professional Practices lab	Practical	PC	0	0	2	0	1
5	24MBJ510	Technical Seminar	Practical	PC	0	0	0	2	1
6	24MBE0--	Professional Elective-I	Theory	PE	3	0	0	0	3
7	24MBE0--	Professional Elective-II	Theory	PE	3	0	0	0	3
8	24MBE0--	Professional Elective-III	Theory	PE	3	0	0	0	3
								Total Credits	**19**
								Total Contact Hours/week	**23**

Semester III									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24MBJ601	Social Immersion project	Project	PW	0	0	0	4	2
2	24MBJ602	Project Phase I /Industry Internship	Project	PW	0	0	0	20	10
3	24MBE0--	Professional Elective-IV	Theory	PE	3	0	0	0	3
4	24MBE0--	Professional Elective-V	Theory	PE	3	0	0	0	3
5	24MBE0--	Professional Elective-VI	Theory	PE	3	0	0	0	3
Total Credits									**21**
Total Contact Hours/week									**33**

Semester IV									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24MBJ603	Project Phase II/ Industry Project	Project	PW	0	0	0	40	20
Total Credits									**20**
Total Contact Hours/week									**40**
Total Credits									**81**

Semester-wise Credits	
Semester - I	21
Semester - II	19
Semester - III	21
Semester - IV	20
Total Credits	**81**

Electives									
S.No	**Course code**	**Course Title**	**Course Mode**	**Course Type**	**L**	**T**	**P**	**J**	**C**
1	24MBE001	Biorefinery and Sustainable Technology	Theory	PE	3	0	0	0	3
2	24MBE002	Advanced Wastewater Treatment	Theory	PE	3	0	0	0	3
3	24MBE003	Bioremediation Technology	Theory	PE	3	0	0	0	3
4	24MBE004	Enzymes in Food and Feed Industry	Theory	PE	3	0	0	0	3
5	24MBE005	Cell Culture and Vaccine Technology	Theory	PE	3	0	0	0	3
6	24MBE006	One Health - an integrative approach to interconnected health challenges.	Theory	PE	3	0	0	0	3
7	24MBE007	Nanomaterials and Applications	Theory	PE	3	0	0	0	3
8	24MBE008	Molecular Diagnostics and Biomedical Imaging	Theory	PE	3	0	0	0	3
9	24MBE009	Human Physiology and Clinical Endocrinology	Theory	PE	3	0	0	0	3
10	24MBE010	Big Data Analytics and Next Generation Sequencing	Theory	PE	3	0	0	0	3
11	24MBE011	RNA Biology[#]	Theory	PE	3	0	0	0	3
12	24MBE012	Fermented Foods and Microbial Technology	Theory	PE	3	0	0	0	3
13	24MBE013	DNA Fingerprinting and Applications	Theory	PE	3	0	0	0	3
14	24MBE014	Introduction to Developmental Biology[#]	Theory	PE	3	0	0	0	3

[#]- NPTEL

Course Types	**Course Code type**	**Credits**
Basic Science	**BS**	4
Engineering Science	**ES**	3
Professional Core	**PC**	23
Professional Electives	**PE**	18
Project/Industry Internship/ Technical Seminar	**PW**	33
Total Credits		**81**

SEMESTER I

24MAI501	STATISTICAL METHODS FOR ENGINEERS (Common to CN, EN, MB)	L	T	P	J	C
		3	0	2	0	4
BS		SDG	9, 10, 13			
Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	Nil			

Course Objectives**:	The purpose of taking this course is to:
1	learn key statistical concepts and apply estimation techniques
2	perform hypothesis testing for large and small samples
3	build knowledge in using correlations techniques and regression models
4	develop student's skills in experimental design and multivariate data analysis

**Min requirements- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed

Course Outcomes***:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO1	apply different method and techniques to estimate statistical parameters	Ap
CO2	apply various statistical methods for hypothesis testing of sample data	Ap
CO3	apply hypothetical testing to compare and assess the independence of attributes	Ap
CO4	apply multiple and partial correlation analysis, least squares regression in determining the factors relating engineering data	Ap
CO5	analyse the effectiveness of experimental designs through Analysis of Variance	An
CO6	apply the multivariate concepts and compute covariance and correlation matrices	Ap

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental issues**	**Modern engineering tools, interdisciplinary implementation**
1.	3	3	3		3	
2.	3	3	3			
3.	3		2	3		3
4.	3	3		3		3
5.	3	3				
6.	2	2			3	

Course Content	
ESTIMATION THEORY Estimators: Unbiasedness, Consistency, Efficiency, and Sufficiency – Maximum Likelihood Estimation – Method of Moments. **Practical Component** 1. Introduction to R programming 2. Mean, Median and standard deviation	**9 Hours**
TESTING OF HYPOTHESIS Testing of hypothesis for large samples (single mean, difference of means, single proportion, difference of proportion) – Small samples – t – test (single mean, difference of means, paired t- test) – F – test (variance ratio test) – Chi-square test – Tests for independence of attributes. **Practical Component** 1. Conduct t-tests for small sample sizes, including single mean, difference of means, and paired t-test. 2. Perform F-tests to compare variances of two samples. 3. Implement Chi-square tests for independence of attributes.	**9 Hours**
CORRELATION AND REGRESSION Multiple and Partial Correlation - Method of Least Squares- Plane of Regression - Properties of Residuals - Coefficient of Multiple Correlation - Coefficient of Partial Correlation - Multiple Correlation with total and partial	**9 Hours**

correlations- Regression and Partial correlations in terms of lower order coefficients. **Practical Component** 1. Applications of Correlation coefficient 2. Applications of partial correlation and Multiple Correlation	
DESIGN OF EXPERIMENTS Principles of experimental design – Completely randomized design– Randomized block design –Latin square design. **Practical Component** 1. ANOVA – one-way classification 2. ANOVA – two-way classification	**9 Hours**
MULTIVARIATE ANALYSIS Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components–Principal components from standardized variables. **Practical Component** 1. Perform PCA on multivariate data and interpret principal components.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**30**	**Project Hours:**	**0**	**Total Hours:**	**75**

Learning Resources*

Textbooks

1. Devore, J. L. *Probability and Statistics for Engineering and the Sciences*. 8th ed. Boston: Thomson and Duxbury, 2012.
2. Freund, J. E. *Mathematical Statistics*. 5th ed. New Delhi: Prentice Hall of India, 2001.
3. Gupta, S. C., and J. N. Kapur. *Fundamentals of Mathematical Statistics*. 10th rev. ed. New Delhi: Sultan & Chand Publishers, 2002.
4. Johnson, R. A., and D. W. Wichern. *Applied Multivariate Statistical Analysis*. 6th ed. Singapore: Pearson Education Asia, 2007.
5. Johnson, R. A. *Miller & Freund's Probability and Statistics for Engineers*. 7th ed. Singapore: Pearson Education, 2005.
6. Spiegel, M. R., and L. J. Stephens. *Schaum's Outlines: Statistics*. 3rd ed. New York: Tata McGraw-Hill, 2000.

Reference books/ Web Links

1. 1. Johnson, R.A., and Wichern, D.W., Applied Multivariate Statistical Analysis, Pearson
2. Education, Asia, 6th Edition, 2007.
3. 2. Johnson. R. A., Miller & Freund's Probability and Statistics for Engineers, 7th

Edition, Pearson

4. Education, Delhi, 2005.
5. 3. Spiegel, M.R. and Stephens, L.J. Schaum's outlines, Statistics, Tata McGraw-Hill, 3rd Edition, 2000.

Online References:

1. https://www.khanacademy.org/math/statistics-probability
2. https://archive.nptel.ac.in/courses/103/106/103106120/
3. https://onlinecourses.nptel.ac.in/noc21_ma74/preview

Assessment (Embedded course)
SA, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE), Lab Workbook, Experimental Cycle tests, viva-voce

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**	
Mr. Ramesh V.S., STEPS Knowledge Services Private Limited, Coimbatore. 2. Mr.Jayakumar Venkatesan, Valles Marineris International Private Limited- Chennai. 3. Mr. Imran Khan, GE Transportation Company, Bangalore.	Dr.T.Govindan, Government College of Engineering, Srirangam, Trichy. 2. Dr.C.Porkodi, PSG College of Technology, Coimbatore. 3. Dr.P.Paramanathan, Amrita Vishwa Vidyapeetham, Coimbatore.	Dr.S.Meenapriyadarshini, Mathematics. Dr.D.Arivuoli, Mathematics.	
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

24INT501	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**
ES		**SDG**	**9**			

Pre-requisite courses	**Nil**	**Data Book / Codes / Standards (If any)**	**Nil**

Course Objectives:**	**The purpose of taking this course is to:**
1	Equip students with the knowledge and skills necessary to design, conduct and critically evaluate research
2	Draft research reports and present effective research findings
3	Foster an understanding of intellectual property rights and ethical considerations essential for successful research and innovation

**Min requirements- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed

Course Outcomes***:	**After successful completion of this course, the students shall be able to**	**Bloom's Taxonomy Level (BTL)**
CO 1	Apply the scientific method and research planning steps to formulate research problems and objectives	Ap
CO 2	Analyse different research designs and ethical considerations to classify research types and ensure ethical integrity	An
CO 3	Evaluate the structure and components of research reports to organize and present research findings effectively	E
CO 4	Interpret data collection tools and statistical methods to visualize and analyse biological research data	An
CO 5	Create a research proposal incorporating IPR principles to develop innovative and ethically sound research plans	C

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental**	**Modern engineering tools, interdisciplinary implementation**
1.	3	3		3	3	
2.	3	3		3		
3.	3			3		
4.	3	3		3		3
5.	3	3		3		3

Course Content	
INTRODUCTION TO RESEARCH METHODS Definition and Objectives of Research, Scientific Method, Various Steps in Scientific Research, Research Planning, Selection of a Problem for Research, Formulation of Selected Problems, Purpose of the Research, Formulation of Research Objectives, Formulation of Research Questions, Hypotheses Generation and Evaluation, Literature Search and Review Process.	**9 Hours**
RESEARCH DESIGN AND ETHICS Types and Methods of Research, Classification of Research, Research Ethics:	**9 Hours**

Informed Consent, Confidentiality, Data Protection, Sampling Techniques, Methods of Collecting Primary Data, Use of Secondary Data, Experimentation, Design of Experiments, Survey Research, Construction of Questionnaires, Pilot Studies, and Pre-tests, Data Collection Methods, Processing, Editing, Classification, and Coding Validity, Reliability, Ethical Dilemmas and Solutions.	
RESEARCH REPORTS Components of Research Articles, Manuscripts, Thesis, and Review Papers, Preparation of Thesis Documents: Referencing, In-text Citations, Tools like Endnote, Mendeley, Writing Techniques: CARS Model, Organizing Literature Review, Materials, and Methods, Critical Thinking for Writing the Discussion Section.	**9 Hours**
DATA COLLECTION AND ANALYSIS FOR RESEARCH Tools for Data Collection: Clinical Trials, Surveys, Questionnaires, Observational Methods, Data Management and Preparation, Overview of Statistical Concepts, Descriptive Statistics: Mean, Median, Mode, Variance, Standard Deviation, Data Visualization Techniques. Case Study: Journal Club on Research Papers Published in Tier 1 Journals.	**9 Hours**
INTELLECTUAL PROPERTY RIGHTS (IPR) AND RESEARCH GRANTS Introduction to Intellectual Property Rights: Patents, Trademarks, Copyrights, Trade Secrets, Importance of IPR in Research and Innovation, Developing a Research Proposal: Components, Do's and Don'ts, Writing Winning Research Proposals, Peer Review, and Feedback, Finalizing Research Plans. Case Study: Evaluating Successful Research Proposals and Understanding the Role of IPR.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	45

Learning Resources*

Textbooks

1. Cooper, D. R., Schindler, P. S., & Sharma, J. K. (2012). Business Research Methods (11th ed.). Tata McGraw Hill Education.
2. Hazari, A. (2023). Research Methodology for Allied Health Professionals. Springer Nature Singapore.
3. Goh, K.M. (2023). Research Methodology in Bioscience and Biotechnology. Springer.
4. Ganguli, P. (2017). Intellectual Property Rights: Unleashing the Knowledge Economy. McGraw Hill Education.

Reference books/ Web Links
1. AJIET. (n.d.). Lecture Notes on Research Methodology & Intellectual Property Rights. Retrieved from https://www.ajiet.edu.in/img/basic-science/21RMI56%20notes.pdf 2. Oxford University Press. (n.d.). Handbook of Intellectual Property Research: Lenses, Methods, and Perspectives. Retrieved from https://academic.oup.com/book/41122 3. Goddard, W., & Melville, S. (2004). Research Methodology: An Introduction for Science & Engineering Students. Juta and Company Ltd. 4. Kumar, R. (2014). *Research Methodology: A Step-by-Step Guide for Beginners* (4th ed.). SAGE Publications
Online Resources
1. https://academic.oup.com/jiplp/article-abstract/19/5/460/7595847 2. https://academic.oup.com/jiplp/issue/

Assessment (Theory course)
CAT, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr. Lipin Dev, Scientific Director , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. N. Selvaraju, Associate Professor, IIT Guwahati, Assam		Dr. K. Kumaravel Assistant Professor III Mr. Nishaant HA Assistant Professor I
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

24MBT501	**BIOPROCESS MODELING AND SIMULATION**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**
PC		**SDG**	**9, 12**			
Pre-requisite courses	**Nil**	**Data Book / Codes / Standards (If any)**	**Nil**			

Course Objectives:	**The purpose of taking this course is to:**
1.	To develop the ability to model and simulate bioprocesses using mathematical and computational techniques for process optimization and performance evaluation.
2.	To equip students with the skills to analyze bioprocess system performance and identify strategies for improvement in efficiency and sustainability.
3.	To enable students to design sustainable and efficient bioprocesses at various scales, addressing real-world challenges in bioprocess operations.

**Min requirements- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed

Course	**After successful completion of this course, the students shall be**	**Bloom's**

Outcomes:	**able to**	**Taxonomy Level (BTL)**
CO 1	Explain the fundamental principles of bioreactor design and scale-up in bioprocess engineering, including kinetic models and process optimization techniques.	U
CO 2	Analyze material and energy balances in bioprocess systems to interpret the efficiency of bioprocesses.	An
CO 3	Utilize numerical and machine learning techniques to solve optimization problems and improve bioprocess efficiency.	Ap
CO 4	Apply principles of bioreactor operation and design to develop solutions for batch, semi-continuous, and continuous bioprocess systems.	Ap
CO 5	Design sustainable and cost-effective bioprocesses through economic and environmental impact analysis.	E

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental**	**Modern engineering tools, interdisciplinary implementation**
1.	3					
2.	3					
3.					3	3
4.		3	3			
5.	3		3		3	3

Course Content	
FOUNDATIONS OF BIOPROCESS ENGINEERING Kinetics of Continuous Microbial Culture: Plug-Flow, Chemostat, Turbidostat, and Fed-Batch Principles; Unstructured Modelling of Bioreactors; Media Optimization, Scale-up, and Scale-down. Case Study: Engineering a Successful Scale-up of a Process.	**9 Hours**

MATERIAL AND ENERGY BALANCE Thermodynamic Preliminaries: System and Process, Steady State and Equilibrium, Laws of Conservation of Mass; Material Balance: Recycle, By-pass, and Purge Streams; Stoichiometry of Growth and Product Formation; Basic Energy Concepts: Intensive and Extensive Properties, Enthalpy Equation, Energy Balance without Reaction; Thermodynamics of Microbial Growth; Energy Balance Equation for Cell Culture.	**12 Hours**
MODELING AND SIMULATION OF BIOPROCESSES Basic Modeling Principles: Uses of Mathematical Modeling, Classification of Modeling Techniques; Fundamental Laws: Energy Equations, Continuity Equation, Equations of Motion, Transport Equations, Chemical Kinetics; Problem Structuring, Process Analysis, and Process Scheme; Modeling Steps, Implementation, and Simulation: Spreadsheet Model, Process Simulator; Uncertainty Analysis: Scenario Analysis, Sensitivity Analysis, Monte-Carlo Simulation.	**9 Hours**
DATA ANALYSIS IN BIOPROCESS ENGINEERING Basics of Data Analysis: Curve Fitting; Solving Problems using MATLAB: Numerical Integration, Euler and Fourth Order Runge-Kutta Methods; Machine Learning in Process Optimization. Case Study: Bioreactor Fault Detection using Data Reconciliation.	**7 Hours**
BIOREACTOR MODELING FUNDAMENTALS, FLOWSHEETING SuperPro Designer Fundamentals: Material and Energy Balance Calculations, Units and Properties; Component Library, Batch and Continuous Operations: Selection Criteria; Introduction to Flowsheeting: Scheduling, Equipment Utilisation Analysis Charts (e.g., Gantt Chart); Report Analysis: Throughput Analysis, Debottlenecking, Cost Analysis and Economic Evaluation, Environmental Impact (Life Cycle Assessment). Case Study: Economic Analysis of Bioprocess at Different Scales.	**8 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources*
Textbooks
1. Doran, Pauline M. Bioprocess Engineering Principles. 2nd ed. Academic Press, 2013. 2. Shuler, Michael L., Fikret Kargi, and Matthew DeLisa. Bioprocess Engineering: Basic Concepts. 3rd ed. Pearson, 2017.
Reference books/ Web Links
1. Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall. Principles of Fermentation Technology. 3rd ed. Butterworth-Heinemann, 2016. 2. Luyben, William L. Process Modeling, Simulation, and Control for Chemical

Engineers. Chemical Engineering Series. McGraw-Hill, 1999.
3. Heinzle, Elmar, Andrew P. Biwer, and Charles L. Cooney. Development of Sustainable Bioprocesses: Modeling and Assessment. Wiley, 2007.
4. Liu, Shang-Tian. Bioprocess Engineering: Kinetics, Sustainability, and Reactor Design. Elsevier, 2017.
5. Li, Yong, and Subhash K. Khanal. Bioenergy: Principles and Applications. John Wiley & Sons, 2016.

Online Resources
1. https://onlinecourses.nptel.ac.in/noc22_bt19
2. https://onlinecourses.nptel.ac.in/noc23_bt16/preview.

Assessment (Theory course)
CAT, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

*Activity and Learning Task(s): assessed through Active Learning Strategies (ALS) Eg: One-minute paper, exit tickets/exit slips, Think-pair-share, Socratic seminar, reflective journal, Low-stakes quizzes, Diagnostic questions, Open-ended questions, Concept map, Homework tasks. Delete Assessment tables that do not apply to this course.

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**	
Dr. Lipin Dev, Scientific Director , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. N. Selvaraju, Associate Professor, IIT Guwahati, Assam	Dr. M. Shanmugaprakash Associate Professor Dr. Ram K Assistant Professor III	
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

24MBT502	**GENE EXPRESSION AND ANALYSIS**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**
PC		**SDG**	**3, 9**			
Pre-requisite courses	**Nil**	**Data Book / Codes / Standards (If any)**	**Nil**			

Course Objectives:**	**The purpose of taking this course is to:**
1	To acquire in-depth knowledge on prokaryotic and eukaryotic genome organization.
2	To understand the complexities and functional organization of eukaryotic genomes.
3	To evaluate the feasibility and applications of gene editing and gene expression tools in genetic manipulation and functional studies.

Course Outcomes*:**	**After successful completion of this course, the students shall be able to**	**Bloom's Taxonomy**

		Level (BTL)
CO1	Apply knowledge of genetic manipulation in expression vectors and analyze methods for recombinant protein analysis to solve problems related to heterologous gene expression and evaluate purification techniques.	Ap
CO2	Evaluate the impact of aberrant splicing, defective DNA methylation, and mitochondrial gene expression on cellular functions to interpret their roles in disease pathogenesis.	E
CO3	Analyze molecular diagnostic techniques, such as RT-PCR and qPCR, to assess their applications in identifying hospital-acquired infections and genetic disorders.	An
CO4	Apply open-source software tools in pharmacogenomics data analysis to design strategies for personalized medicine.	Ap
CO5	Evaluate case studies on genetic and molecular mechanisms to connect theoretical knowledge with practical applications in disease diagnostics and therapeutics.	E

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental issues**	**Modern engineering tools, interdisciplinary implementation6**
1.	3		3			
2.	3		3	3		
3.	3	3		3		
4.			3		2	3
5.	3	3		3		

Course Content	
GENE EXPRESSION VECTORS AND PROTEIN PURIFICATION Gene expression systems in prokaryotes and eukaryotes Design and construction of expression vectors Regulatory elements: promoters, terminators, enhancers, selection markers Transformation and transfection methods Recombinant protein expression systems: E. coli, yeast, insect, mammalian Protein purification methods: affinity chromatography, ion exchange, gel	**9 Hours**

filtration.	
EPIGENETICS AND ABERRANT GENE EXPRESSION IN DISEASE DNA methylation: mechanisms and enzymes Histone modifications and chromatin remodeling Aberrant splicing and spliceosome machinery Mitochondrial gene expression Epigenetic dysregulation in disease Experimental approaches: Next Generation sequencing, ChIP, RNA-seq.	**9 Hours**
MOLECULAR DIAGNOSTICS Principles of nucleic acid-based diagnostics PCR, RT-PCR, and quantitative PCR Applications in infectious disease detection Genetic disorder diagnostics Emerging diagnostic platforms: CRISPR, LAMP Case-based diagnostic decision making.	**9 Hours**
PHARMACOGENOMICS AND BIOINFORMATICS TOOLS Introduction to pharmacogenomics and personalized medicine Gene-drug interactions and pharmacogenetic markers Public databases: dbSNP, PharmGKB, ClinVar Open-source tools: Galaxy, GenePattern, UCSC Genome Browser NGS data analysis workflows Case studies in clinical pharmacogenomics.	**9 Hours**
CASE STUDIES IN GENETICS AND DISEASE APPLICATIONS Genetic mutations and disease Cancer genetics and inherited disorders Gene therapy and CRISPR applications Omics data in diagnostics Translational research Ethical and regulatory aspects.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources*

Textbooks

1. Lewin, B. *Genes*. 12th ed. Burlington, MA: Jones & Bartlett Publishers Inc., 2017.

Reference books/ Web Links

1. Lodish, H., A. Berk, S. L. Zipursky, P. Matsudaira, D. Baltimore, and J. Darnell. *Molecular Cell Biology*. 10th ed. New York: W.H. Freeman and Company, 2020.
2. Alberts, B., et al. *Essential Cell Biology*. 2nd ed. New York: Garland Science, 2004.
3. Weaver, R. F. *Molecular Biology*. 3rd ed. New York: McGraw Hill, 2005.
4. Watson, J. D. *Molecular Biology of the Gene*. 5th ed. Singapore: Pearson Education, 2004.
5. Sambrook, J., and D. M. Russell. *Molecular Cloning: A Laboratory Manual*. 4th ed. Cold Spring Harbor, NY: CSHL Press, 2018.

Online Resources
3. https://onlinecourses.nptel.ac.in/noc22_bt59/preview

*Refer to the attached information

Assessment (Theory course)
CAT, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

*Activity and Learning Task(s): assessed through Active Learning Strategies (ALS) Eg: One-minute paper, exit tickets/exit slips, Think-pair-share, Socratic seminar, reflective journal, Low-stakes quizzes, Diagnostic questions, Open-ended questions, Concept map, Homework tasks. Delete Assessment tables that do not apply to this course.

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**	
Dr. Harisankar MK, Scientist, Biocon Biologics, Bangalore	Dr Ananthasubramanian Muthusamy, PSG College of Technology, Coimbatore	Dr. N. Saraswathy Professor Dr. K. Kumaravel Assistant Professor III	
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

24MBI503	ANIMAL, PLANT AND MICROBIAL CELL CULTURE	L	T	P	J	C
		1	0	4	0	3
PC		SDG	3			
Pre-requisite courses	**Nil**	**Data Book / Codes / Standards (If any)**	Nil			

Course Objectives**:	The purpose of taking this course is to:
1	Gain hands-on training on the methods of sterilization and media preparation for cell culture.
2	Attain hands on training for establishment of cell culture techniques
3	Develop skills in working with cells of animals, plants, and microbes for application studies.

Course Outcomes*:**	**After successful completion of this course, the students shall be able to**	**Bloom's Taxonomy Level (BTL)**
CO 1	Apply aseptic techniques to prepare media, sterilize equipment, and maintain in-vitro cell cultures effectively.	R
CO 2	Perform cell counting, assess viability using microscopy, and analyze cell health parameters for culture maintenance.	R
CO 3	Induce and culture callus from medicinal plants to produce bioactive metabolites in scalable systems such as photobioreactors.	Ap
CO 4	Optimize culture conditions for industrially important microbes to enhance metabolite production and industrial applications.	An
CO 5	Analyze 16S and 18S RNA sequencing data to characterize industrially significant microbial strains.	E

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental issues**	**Modern engineering tools, interdisciplinary implementation6**
1.	3					
2.	3					
3.					3	3
4.		3	3			
5.	3		3		3	3

Course Content	
MAMMALIAN CELL CULTURE TECHNIQUES Media Preparation, Sterilization, and Subculturing mammalian cells; Cell Counting and Trypan Blue Cell Viability Assay. **Practical Component** Cell Proliferation and MTT Assay; Detection of Apoptosis – Acridine Orange Ethidium Bromide Double Staining and Fluorescent Microscopy	**5 Hours** **10 Hours**
PLANT TISSUE CULTURE TECHNIQUES MS Media and Stock Solution Preparation and Sterilization; Selection of Explants and Induction of Callus from Leaf Explants of Medicinal Plants; **Practical Component**	**5 Hours** **10**

Production of Secondary Metabolites from Callus of Medicinal Plants by Photobioreactor; Regeneration of Plants from Induced Callus/Explants by Direct or Indirect Organogenesis.	**Hours**
MICROBIAL CULTURE TECHNIQUES Isolation, Screening, and Purification of Microbial Bacteria/Yeast/Fungi/Actinomycetes) Species and Strains for Industrial Application. Culture Inoculum Preparation and Fixing the CFU for Fermentation/Assays. **Practical Component** Media Preparation and Optimization for Industrially Important Microbial Cultures, Cultivation, and Metabolite Production Using Bioreactor. Microbial (16S & 18S RNA) Sequencing and Analysis (Genus & Species Identification) and Preservation of Industrially Important Microbes.	**5 Hours** **10 Hours**

Theory Hours:15	**Tutorial Hours: 0**	**Practical Hours: 30**	**Project Hours:0**	**Total Hours:45**

Learning Resources
Textbooks
1. Masters, J.R.W (2007). *Animal Cell Culture: Practical Approach*. Oxford University Press, UK. 2. Sant Saran Bhojwani and M. K. Razdan (1996). *Plant Tissue Culture: Theory and Practice*. Elsevier Science.
Reference books/ Web Links
1. Ian R Freshney (2011). *Animal Cell Culture: A Manual of Basic Technique and Specialized Applications*. Wiley and Sons. 2. Vinci, V. A., & Parekh, S. R. (Eds.). (2002). *Handbook of industrial cell culture: mammalian, microbial, and plant cells*. Springer Science & Business Media.
Online Resources
1. A Beginner's Guide to Cell Culture: Practical Advice for Preventing Needless Problems - PMC (nih.gov)
2. An Introduction to Plant Tissue Culture: Advances and Perspectives - PubMed (nih.gov)
3. Microbial techniques and methods: basic techniques and microscopy - ScienceDirect.

Assessment (Embedded course)
CAT, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr. Lipin Dev, Scientific Director , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. Dr Ananthasubramanian Muthusamy, Professor, PSG College of Technology, Coimbatore		Dr. K. Kumaresan Associate Professor Dr. P. Muthukumaran Assistant Professor II
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

24MBT504	**BIOPRODUCT SEPARATION AND PURIFICATION ENGINEERING**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**
PC		**SDG**	**9, 12**			

Pre-requisite courses	**Nil**	**Data Book / Codes / Standards (If any)**	**Nil**

Course Objectives:**	**The purpose of taking this course is to:**
1	To understand and apply various cell lysis techniques (physical, chemical, enzymatic, and osmotic) to optimize the release of intracellular products in bioprocesses, ensuring efficient bioproduct recovery.
2	To evaluate and optimize primary bioseparation methods (membrane filtration, centrifugation, and emerging hybrid technologies) for enhancing the efficiency of separation processes in biomanufacturing.
3	To design and analyze bioprocessing systems that incorporate integrated strategies for continuous processing, scale-up, and techno-economic evaluations, ensuring cost-effectiveness and scalability in bioproduct recovery.

**Min requirements- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed

Course Outcomes:	**After successful completion of this course, the students shall be able to**	**Bloom's Taxonomy Level (BTL)**
CO 1	Apply advanced physical, chemical, enzymatic, and osmotic cell lysis techniques to optimize the recovery of intracellular bioproducts from various cell types.	Ap
CO 2	Analyze primary bioseparation techniques such as membrane filtration, centrifugation, and emerging hybrid technologies for	An

	effective separation of biomolecules in biomanufacturing.	
CO 3	Evaluate precipitation strategies andchromatographic methods for the efficient isolation and purification of bioproducts, incorporating simulation-based design and optimization.	E
CO 4	Develop process flow diagrams and conduct techno-economic evaluations to assess the cost-effectiveness and scalability of bioproduct recovery processes.	E
CO 5	Design integrated and scalable bioprocessing workflows, leveraging continuous processing strategies and Process Analytical Technology (PAT) for real-time monitoring and automation.	C

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental issues**	**Modern engineering tools, interdisciplinary implementation6**
1.	3		3	2	2	
2.	3	3	3	3	3	
3.	3	3	3	3	2	
4.	3	3	3	3	3	3
5.	3	2		2	3	3

Course Content	
CELL LYSIS TECHNQUIES Physical methods: High-pressure homogenization, impact of multiple passes, scale-up considerations. Bead milling: Optimization of bead size/composition, continuous vs. batch operation, energy efficiency. Ultra sonication: probe design, scalability challenges. Chemical Methods:Detergent-based lysis, Novel surfactants, optimization, selective permeabilization. Enzymatic lysis: Engineered lysozymes. Solvent extraction: Green solvents, switchable solvents, ionic liquids. Osmotic lysis: Pulsed osmotic treatments, osmolyte selection, combined approaches. Case study: Enhancing lysis efficiency in microbial, plant, and animal cell	**9 Hours**

bioprocesses	
PRIMARY BIOSEPARATION Membrane Filtration Technologies: Tangential flow filtration (TFF), high-performance TFF (HPTFF), vibrating membrane filtration. Centrifugation Techniques: Disc stack centrifugation, continuous tubular centrifugation, zonal centrifugation. Emerging Hybrid Technologies: Centrifugal membrane filtration, acoustic wave-enhanced filtration. AI and Machine Learning in Bioseparation Processes:Introduction to the role of AI and machine learning in optimizing the downstream processing	**9Hours**
ISOLATION AND PURIFICATION OF BIOPRODUCT Precipitation techniques. Liquid-liquid extraction: Aqueous Two-Phase Systems (ATPS). Adsorption. Chromatography: column selection, Packing material selection; Testing procedure for packed columns; Calculation for number of theoretical plates; Asymmetry and design aspects; Theory, practices and application of Affinity chromatography, Gel permeation chromatography, Ion exchange chromatography and Hydrophobic interaction chromatography. Case study: Simulation of chromatographic processes and precipitation reactions using simulation software.	**9 Hours**
FINAL POLISHING AND ECONOMIC EVALUATION Lyophilization, spray drying, crystallization. Introduction to Process Design and development of process flowsheets using super pro. Economical analysis: Capital Cost Estimation, Operating Cost, Estimation and Profitability Analysis. Case study: Techno economical analysis of high value and low volume bioproducts	**9 Hours**
PROCESS INTEGRATION AND SCALE-UP Continuous processing: Benefits, challenges, and scale-up considerations. Process intensification: Combining unit operations for enhanced productivity. Case studies: Successful integration of continuous bioprocessing strategies. Process Analytical Technology (PAT):Real-time monitoring, in-line sensors, automation in bioprocessing.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	**45**

Learning Resources*

Textbooks

1. Harrison, R. G., P. W. Todd, S. R. Rudge, and D. P. Petrides. *Bioseparations Science and Engineering*. 2nd ed. Oxford: Oxford University Press, 2015.
2. Scopes, R. K. *Protein Purification: Principles and Practice*. 2nd ed. New Delhi: Narosa Publications, 2005.
3. Li, Y., and S. K. Khanal. "Bioenergy: Principles and Applications." In *Bioenergy*, 505–520. John Wiley & Sons, 2016.

Reference books/ Web Links

1. Forciniti, D. *Industrial Bio-separation: Principles and Practice*. Oxford: Blackwell

Publishing, 2008.
2. Ghosh, R. *Principles of Bioseparations Engineering*. Singapore: World Scientific Publishing, 2006.
3. Janson, J. C., ed. *Protein Purification: Principles, High Resolution Methods, and Applications*. Vol. 149. Hoboken, NJ: John Wiley & Sons, 2011.
4. Sofer, G. K., and L. Hagel. *Handbook of Process Chromatography: A Guide to Optimization, Scale-Up, and Validation*. London: Academic Press, 2014.

Online Resources

1. https://archive.nptel.ac.in/courses/102/106/102106022/

Assessment (Theory course)
CAT, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**	
Dr. Lipin Dev, Scientific Director , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. N. Selvaraju, Associate Professor, IIT Guwahati, Assam	Dr. M. Shanmugaprakash Associate Professor Dr. Ram K Assistant Professor III	
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

24MBP505	**BIOPRODUCT DEVELOPMENT LAB I**	**L**	**T**	**P**	**J**	**C**
		0	**0**	**4**	**0**	**2**
PC		**SDG**	**9,12**			

Pre-requisite courses	**Nil**	**Data Book / Codes / Standards (If any)**	**Nil**

Course Objectives:**	**The purpose of taking this course is to:**
1	Equip students with hands-on experience in key bioproduct development processes, including gene expression, bioprocess engineering, process simulation, and bioproduct recovery and purification.
2	Enable students to design, optimize, and execute experiments, applying their theoretical understanding to address real-world bioproduct development challenges effectively.
3	Develop students' ability to critically analyze experimental results and foster innovative solutions for bioproduct development and commercialization in the biotechnology industry.

**Min requirements- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed

Course Outcomes* :**	**After successful completion of this course, the students shall be able to**	**Bloom's Taxonomy Level (BTL)**
CO 1	Apply advanced molecular techniques such as RT-PCR, qPCR, SOE PCR, and Nested PCR to optimize recombinant protein expression, confirm its presence using Western blotting, and diagnose pathogens or identify foreign genes in genetically modified crops.	Ap
CO 2	Design, simulate, and optimize bioprocesses using tools like SuperPro Designer and MATLAB for material and energy balance, unit operations, and fermentation kinetics to enhance industrial production of biomolecules such as monoclonal antibodies and biodiesel.	An
CO 3	Apply advanced techniques such as protein precipitation, affinity chromatography, ion exchange chromatography, gel filtration chromatography, and ultrafiltration to recover, purify, and concentrate biomolecules effectively for industrial and research applications.	Ap

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental issues**	**Modern engineering tools, interdisciplinary implementation6**
1.	3					
2.	3					
3.					3	3

Course Content

GENE EXPRESSION 1. Optimization of inducer concentration for recombinant protein expression. 2. Confirmation of recombinant protein using Western blotting. 3. Molecular diagnosis of pathogens using RT –PCR 4. QPCR for identification of foreign genes from genetically modified crops. 5. RAPD for DNA fingerprinting.	**10 Hours**
BIOPROCESS ENGINEERING 1. Batch Fermentation : Operation and Kinetic Parameter Estimation	**5 Hours**
PROCESS SIMULATION 1. Introduction to SuperPro Designer – Material and Energy balance 2. Simulation of Batch and continuous operations 3. Simulation of monoclonal antibodies production 4. Simulation of biodiesel from degummed oil production 5. Modelling batch,fed-batch & continuous fermentation kinetics using MATLAB	**5 Hours**
BIOPRODUCT RECOVERY AND PURIFICATION 1. Protein Precipitation Using Ammonium Sulfate 2. Affinity Chromatography for Protein Purification 3. Ion Exchange Chromatography for Protein Separation 4. Gel Filtration Chromatography (Size Exclusion Chromatography) 5. Ultrafiltration for Concentration and Desalting	**10 Hours**

Theory Hours:	**0**	**Tutorial Hours:**	**0**	**Practical Hours:**	**30**	**Project Hours:**	**0**	**Total Hours:**	30

Learning Resources*
Textbooks
1. Lewin, Benjamin. *Genes*. 12th ed. Jones & Bartlett Publishers, 2017. 2. Doran, Pauline M. *Bioprocess Engineering Principles*. 2nd ed. Academic Press, 2013. 3. Scopes, Robert K. *Protein Purification: Principles and Practice*. 2nd ed. Narosa Publications, 2005.
Reference books/ Web Links
1. Shuler, Michael L., and Fikret Kargi. *Bioprocess Engineering: Basic Concepts*. 2nd ed. Prentice Hall, 2002. 2. Ladisch, Michael R. Bioseparations Engineering: Principles, Practice, and Economics. 2nd ed. Wiley, 2018. 3. Walls, Daniel, and Ewa Toth. Protein Chromatography: Methods and Protocols. 2nd ed. Humana Press, 2017. 4. Koutinas, Michalis, ed. Computer Aided Applications in Biopharmaceutical Technology. Elsevier, 2020.

5. Sinclair, Craig, and Salvador García Munoz, eds. Process Systems Engineering for Biochemical Engineering: Advanced Modeling and Analysis Tools for Bioprocess Simulation. CRC Press, 2016.
6. Green, Michael R., and Joseph Sambrook. *Molecular Cloning: A Laboratory Manual*. 4th ed. Cold Spring Harbor Laboratory Press, 2019.

Online Resources

1. https://ocw.mit.edu MIT OpenCourseWare - Molecular Biology Techniques
2. https://www.intelligen.com/ - SuperPro Designer and MATLAB Tutorials by Intelligen, Inc.
3. https://www.cytivalifesciences.com - Protein Purification Guide by GE Healthcare

Assessment (Practical course)
Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**	
Dr. Lipin Dev, Scientific Officer , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. N. Selvaraju, Associate Professor, IIT Guwahati, Assam	Dr. M. Shanmugaprakash Associate Professor Dr. Ram K Assistant Professor III	
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

SEMESTER II

24MBI506	COMPUTATIONAL BIOLOGY	L	T	P	J	C
		3	0	2	0	4
PC		SDG	3,9			

Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	Nil

Course Objectives**:	The purpose of taking this course is to:
1	Develop expertise in biological sequence alignment, phylogenetic analysis, protein structure analysis, molecular docking for drug design, and machine learning techniques.
2	Gain hands-on experience in sequence alignment, protein modelling, drug design, and neural networks through practical exercises and case studies.
3	Apply acquired skills to real-world problems, enhancing understanding and capability in the areas of sequence analysis, structural modelling, and computational drug design.

**Min requirements- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed

Course Outcomes***:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO1	Apply sequence alignment techniques to evaluate the similarity between biological sequences using appropriate tools.	Ap
CO2	Analyze protein structures to compare their stability and folding patterns for accurate structural predictions.	An
CO3	Evaluate molecular docking approaches and post-processing techniques to optimize drug-target interaction predictions.	E
CO4	Analyze molecular dynamics simulations to interpret conformational changes and their impact on molecular behavior.	Ap
CO5	Create machine learning models for biological data analysis to enhance predictive accuracy in computational biology.	C
CO6	Compare and contrast various force field models and energy minimization techniques to assess their effectiveness in simulations.	E

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental**	**Modern engineering tools, interdisciplinary implementation**
1.	3					
2.	3					
3.					3	3
4.		3	3			
5.	3		3		3	3
6.	3			3	3	3

Course Content

SEQUENCE ALIGNMENT AND PHYLOGENETIC ANALYSIS Biological Databases: Classification and Functions, Sequence Alignment Basics - Dotplot, Measures of sequence similarity, Scoring schemes; Dynamic Programming Algorithm: Optimal pairwise alignment, Scoring Matrices: PAM and BLOSSUM, BLAST Programs: PSI-BLAST, PHI-BLAST. Multiple Sequence Alignment- Assessing the quality of an alignment, Profiles, Hidden Markov Models (HMMs): Introduction and application in MSA; Phylogenetic Analysis - Clustering methods, Cladistics methods, Addressing varying rates of evolution, Bootstrapping Techniques. **Case Study 1:** Optimizing substitution matrix choice and gap parameters for sequence alignment. **Practical Component** 1. Basics of Unix Operating System – commands and Scripts. 2. Pairwise , Multiple and Phylgenetic analysis of Biological Sequences	**12 Hours** **5 Hours**
PROTEIN STRUCTURE ANALYSIS Protein stability and folding, Superposition of structures and structural alignments – DALI and MUSTANG; Protein structure prediction and modeling – Apriori and Empirical methods; Secondary structure prediction, Homology modeling, fold recognition, Protein structure comparison; Solvent Accessibility - Naccess; residue-residue contacts – short, medium, and long-range contacts, Conformational energy calculation. **Practical Component** 1. Molecular visualization using Pymol and Chimera 2. Homology Modelling of Protein – Single, Multiple and Loop Refinement	**10 Hours** **5 Hours**

MOLECULAR DOCKING FOR COMPUTER-AIDED DRUG DESIGN Tools and Techniques in Computer-Aided Drug Design (CADD), Docking - Approaches, Post-Processing of Docking Results - Tools and Strategies; Best Practices for Docking-Based Virtual Screening; Virtual Libraries. Empirical Force Field Models - Molecular Mechanics - General Features of Molecular Mechanics Force Fields, Bond Stretching, Angle Bonding, Torsional Terms, Introduction to non-bonded interaction, Electrostatic Interactions, Van der Waals Interactions, Hydrogen Bonding in molecular mechanics. Introduction to Energy Minimization - Derivative and non-derivative, Applications of Energy Minimization. Molecular Dynamics using Simple Model - Setting up and running molecular Dynamics simulation - MD at constant temperature and pressure, Conformational changes from MD Simulation. **Practical Component :** 1. Structure-based drug design – Molecular docking using Autodock and Virtual screening using Autodock 2. Molecular Dynamics of protein only and protein-ligand complex	**12 Hours** **10 Hours**
MACHINE LEARNING TECHNIQUES Artificial Neural Network – Perceptron, Characteristics of neural networks, models of neuron, Single and multi-layer ANN perceptron, back propagation, learning, input – hidden and output layer computation, Application of ANN. **Practical Component:** 1. Construction of an ANN-based model for enzyme inhibition studies	**8 Hours** **10 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**30**	**Project Hours:**	**0**	**Total Hours:**	**75**

Learning Resources*

Textbooks

1. Pevsner, Jonathan. *Bioinformatics and Functional Genomics*. 3rd ed. Wiley-Blackwell, 2015.
2. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. *Deep Learning*. MIT Press, 2016.

Reference books/ Web Links

1. Jones, Neil C., and Pavel A. Pevzner. An Introduction to Bioinformatics Algorithms. MIT Press, 2004.
2. Baxevanis, Andreas D., and B. F. Francis Ouellette. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 43rd ed. John Wiley & Sons, 2004.
3. Gromiha, M. M. Protein Bioinformatics: From Sequence to Function. Academic Press, 2010.
4. Coumar, S. M., ed. Molecular Docking for Computer-Aided Drug Design: Fundamentals, Techniques, Resources and Applications. Academic Press, 2021.
5. Da Silva, I. N., D. H. Spatti, R. A. Flauzino, L. H. B. Liboni, and S. F. dos Reis Alves. Artificial Neural Networks. Springer International Publishing, 2017

Online Resources
1. https://onlinecourses.nptel.ac.in/noc21_bt06/preview 2. https://onlinecourses.nptel.ac.in/noc21_bt29/preview 3. https://onlinecourses.nptel.ac.in/noc23_cs18/preview *Refer to the attached information

Assessment
CAT, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By			
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**		**Internal Expert(s)**
Dr M. Harishankar Head- R&D Syngene Biocon Biologicals Pvt Ltd Bengaluru	Dr. Anantharaman Professor and Head Department of Biotechnology PSG College of Engineering, Coimbatore		Dr. Vinohar Stephen Rapheal Associate Professor & Head Dr. Ram K Assistant Professor III Department of Biotechnology
Recommended by BoS on	14-08-2024		
Academic Council Approval	No.27	**Date**	24-08-2024

24MBT507	REGULATORY AFFAIRS IN BIOMANUFACTURING PROCESSES	L	T	P	J	C
		3	0	0	0	3
PC		SDG	3,9			

Pre-requisite courses	Nil	Data Book / Code book(If any)	Nil

Course Objectives:	
The purpose of taking this course is to:	
1	Analyze the regulatory framework governing biomanufacturing and risk management strategies for assuring quality techniques in biomanufacturing processes
2	Examine the risk management strategies to ensure compliance and maintain product safety throughout the product lifecycle

Course Outcomes***:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO1	Apply the roles and responsibilities of key regulatory bodies such as the FDA and EMA in the biomanufacturing process	Ap
CO2	Analyse Good Manufacturing Practices (GMP) principles to identify compliance requirements in a given biomanufacturing scenario	An
CO3	Analyze the regulatory pathways for biologics to determine the	An

	appropriate approval process for a new biopharmaceutical product.	
CO4	Examine risk management strategies and evaluate their effectiveness in maintaining compliance within biomanufacturing processes	An
CO5	Evaluate post-market surveillance to identify adverse trends and recommend improvements for ongoing product safety and determine the best practices from successful and unsuccessful regulatory strategies.	An

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental issues**	**Modern engineering tools, interdisciplinary implementation**
1.			3	3		
2.			3	3		
3.			3	3		
4.			3	3		
5.			3	3		

Course Content	
INTRODUCTION TO REGULATORY AFFAIRS IN BIOMANUFACTURING Overview of Regulatory Bodies: Key regulatory agencies: FDA, EMA and international counterparts) and their roles and responsibilities; Regulatory Pathways and Processes: Regulatory pathways for biologics: IND and BLA and approval processes for new biologics and biosimilars; Regulatory Landscape and Frameworks: International regulations and harmonization (ICH guidelines).	**9 Hours**
GOOD MANUFACTURING PRACTICES (GMP) Principles of GMP: Overview of GMP requirements for biologics; key principles: hygiene, training and environmental monitoring; Quality Systems and Documentation: Importance of quality systems in GMP, types of documentation, and record-keeping practices; Process Validation and Equipment Qualification: Steps in process validation (installation, operational, and performance qualification), and the importance of equipment calibration and maintenance.	**9 Hours**

QUALITY ASSURANCE AND RISK MANAGEMENT QUALITY ASSURANCE (QA) AND QUALITY CONTROL (QC) Definitions and roles, techniques for ensuring product quality and consistency; Risk Management Strategies: Identifying and assessing risks in biomanufacturing, tools and techniques for risk mitigation : HACCP, FMEA; Compliance and Audit Processes: Maintaining compliance with regulations, preparing for, and conducting regulatory audits.	**9 Hours**
PRODUCT LIFECYCLE MANAGEMENT AND POST-MARKET SURVEILLANCE Stages of Product Lifecycle: Development, clinical trials, and commercialization stages, with regulatory considerations at each stage; Post-Market Surveillance: Importance of monitoring product safety and efficacy, adverse event reporting, and management; Pharmacovigilance: Role of pharmacovigilance in biomanufacturing, systems for ongoing safety monitoring, and risk assessment.	**9 Hours**
REGULATORY CHALLENGES, TRENDS, AND CASE STUDIES CURRENT CHALLENGES IN REGULATORY AFFAIRS Evolving regulations and technological advancements:impact of globalization on regulatory practices; Future Trends in Regulatory Science: Emerging trends such as personalized medicine and digital health, potential future directions and innovations in regulatory science; Case Studies and Real-World Examples: Analysis of successful and unsuccessful regulatory strategies, lessons learned from industry case studies.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**0**	**Total Hours:**	45

Learning Resources
Textbooks:
1. Desai, Mihir A., and Venkatesh Jorapur. Biopharmaceuticals: Biochemistry and Biotechnology. CRC Press, 2018.
References:
2. Nally, John D., ed. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control. CRC Press, 2016 3. Hockmeyer, William T., and Michael A. Palladino. Biomanufacturing: Principles and Applications. Springer, 2017. 4. Wang, Wei, and Sandeep K. Singh, eds. Formulation and Process Development Strategies for Manufacturing Biopharmaceuticals. John Wiley & Sons, 2018. 5. Poon, C., and Didier R. Thevenot, eds. Emerging Trends in Cell and Gene Therapy. Springer, 2015.
Online Educational Resources:
6. https://archive.nptel.ac.in/courses/127/106/127106137/

Assessment (Theory course)
CAT, Activity and Learning Task(s)*, MCQ, End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr M. Harishankar Head- R&D Syngene Biocon Biologicals Pvt Ltd Bengaluru	Dr. Jibu Thomas Professor and Head , Karunya University, Coimbatore		Dr.S.Nithya Priya Assistant Professor III Dr.K.Kumaresan Associate Professor
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

24MBP508	**BIOPRODUCT DEVELOPMENT LAB II**	**L**	**T**	**P**	**J**	**C**
PC		**0**	**0**	**2**	**0**	**1**
		SDG	**3,6 12**			

Pre-requisite courses	**NIL**	**Data Book / Codes / Standards (If any)**	

Course Objectives:**	**The purpose of taking this course is to:**
1	Develop hands-on expertise in applying advanced analytical techniques such as spectroscopy, chromatography, and thermal analysis for the characterization and evaluation of biological, pharmaceutical, and environmental bioproducts.
2	Enable students to design and perform experiments tailored to real-world scenarios, ensuring proficiency in quantification, purification, and profiling of various biomolecules using standard and modern instrumentation.
3	Interpret and validate experimental data with scientific rigor, fostering the ability to troubleshoot analytical procedures and relate experimental outcomes to product quality, regulatory standards, and sustainability goals.

**Min requirements- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed

Course Outcomes* :**	**After successful completion of this course, the students shall be able to**	**Bloom's Taxonomy Level (BTL)**
CO 1	Apply advanced analytical techniques (ATR-FTIR, AAS, Kjeldahl) for the quantification of biomolecules and contaminants in biological and environmental samples.	Ap
CO 2	Analyze and optimize bioproduct purification and profiling using chromatography-based methods such as FPLC, HPLC, HPTLC, and GC.	An
CO 3	Evaluate the stability, purity, and functional characteristics of bioproducts using integrated instrumental data to support product	E

	development and process decisions.	

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental issues**	**Modern engineering tools, interdisciplinary implementation**
1.	3	3	3	2	2	2
2.	3	3	3	2	2	3
3.	3	3	3	3	3	3

Course Content	
Biomolecular Characterization and Analysis: 1. ATR-FTIR Spectroscopy for Organic Contaminant Detection in Water Samples 2. AAS-Based Quantification of Heavy Metals in Acid-Digested Soil 3. Determination of Protein Concentration in Biological Samples Using the Kjeldahl Nitrogen Estimation Method 4. FPLC-Based Purification of Proteins Using Ion exchange chromatography 5. Quantitative Analysis of Active Pharmaceutical Ingredients (APIs) via HPLC 6. Phytochemical Profiling of Plant Bioactives Using HPTLC 7. Biogas Composition Analysis Using Gas Chromatography (GC) 8. Thermogravimetric Analysis (TGA) for Evaluating Thermal Stability of Bioproducts	**15 Hours**

Theory Hours:	**0**	**Tutorial Hours:**	**0**	**Practical Hours:**	**30**	**Project Hours:**	**0**	**Total Hours:**	**30**

Learning Resources*

Textbooks

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). *Principles of Instrumental Analysis* (7th ed.). Cengage Learning.

Reference books/ Web Links

1. Pavia, Donald L., Gary M. Lampman, George S. Kriz, and Randall G. Engel. *Introduction to Spectroscopy: A Guide for Students of Organic Chemistry*. 5th ed. Cengage Learning, 2014.

2. Crouch, S. R., and J. C. W. Morris. *Atomic Absorption Spectroscopy*. 2nd ed. Wiley, 2001
3. Burgess, J. A., and J. J. Murphy. *Enzyme Assays: Methods and Protocols*. Humana Press, 2016.
4. Svensson, Anders, and K. H. Meyer. *Fast Protein Liquid Chromatography (FPLC): Principles and Applications*. Academic Press, 2019.
5. Snyder, Lloyd R., Joseph J. Kirkland, and John W. Dolan. *Introduction to Modern Liquid Chromatography*. 3rd ed. Wiley, 2010.
6. Wilson, Ivor D., and John Walker. *Gas Chromatography and Mass Spectrometry: A Practical Guide*. 2nd ed. Academic Press, 2020.

Online Resources

1. https://archive.nptel.ac.in/courses/104/106/104106122/

Assessment (Practical course)
Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**	**Internal Expert(s)**	
Dr. Lipin Dev, Scientific Director , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. N. Selvaraju, Associate Professor, IIT Guwahati, Assam	Dr. M. Shanmugaprakash Associate Professor Dr. Ram K Assistant Professor III	
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

24MBP509	BIOTECHNOLOGY PROFESSIONAL PRACTICES LAB	L	T	P	J	C
		0	0	2	0	1
PC		SDG	9, 6, 13			

Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	Nil

Course Objectives:	The purpose of taking this course is to:
1.	Equip students with hands-on experience in R&D, Quality Control (QC), and Quality Assurance (QA) practices, along with exposure to Good Manufacturing Practices (GMP) in biotech industries.
2.	Develop competencies in biotechnology process optimization, regulatory compliance, and data analysis through practical exercises and industry interactions.
3.	Enhance students' professional communication and career readiness for roles in research, manufacturing, and allied biotech sectors through industry-oriented training.

**Min requirements- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed

Course Outcomes:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO1	Demonstrate the ability to analyze, interpret, and document biological product quality parameters by applying R&D, QC, and QA practices in biotechnology.	Ap
CO2	Analyze the implementation of Good Manufacturing Practices (GMP) and Good in biopharma and food industries by assessing compliance and identifying key process improvements.	An
CO3	Develop professional competencies for the biotech industry by crafting industry-specific resumes, cover letters, and participating in mock interviews.	C

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental issues**	**Modern engineering tools, interdisciplinary implementation**
1.	3	3	3	3	3	3
2.	3	3	3	3		3
3.	3	3	3	3	3	3

Course Content	
Research & Development: Optimization and scale-up of secondary metabolite production Study the impact of media composition and environmental factors on secondary metabolite yield, transform small-scale batch and fed-batch culture experiments, study growth kinetics and metabolite accumulation, and sssess purity using spectroscopic and chromatographic methods. **QC/QA and GLP/GMP in Biotech Manufacturing**: Study sterility, endotoxin, and potency tests on biologics, studies as per regulatory guidelines, GMP Compliance in Biopharma Manufacturing, simulate aseptic processing and contamination control strategies, maintain batch records and standard operating procedures (SOPs), GMP Standards in Food Biotechnology, perform HACCP (Hazard Analysis and Critical Control Points) evaluation, conduct microbial and physicochemical testing of food biotech products. **Industry Career Preparedness** Workshops on creating effective resumes and cover letters tailored to the biotech industry, mock interviews with feedback from industry professionals.	**15 Hours**

Theory Hours:	**0**	**Tutorial Hours:**	**0**	**Practical Hours:**	**15**	**Project Hours:**	**0**	**Total Hours:**	**15**

Learning Resources*
Textbooks
1. Fermentation Microbiology and Biotechnology – E.M.T. El-Mansi, C.F.A. Bryce, A.L. Demain & A.R. Allman, CRC Press 4th Edition (2018) 2. Good Manufacturing Practices for Pharmaceuticals – Joseph D. Nally, CRC Press, 7th

Edition (2016) 3. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies – Craig Shimasaki, Academic Press, 2nd Edition (2020)
Reference books/ Web Links
1. Secondary Metabolism in Microorganisms, Plants and Animals – Michael Wink, CRC Press, 1st Edition (2010) 2. ICH Quality Guidelines: An Implementation Guide – Andrew Teasdale, David Elder & Raymond W. Nims, Wiley, 1st Edition (2017) 3. Building a Successful Career in Scientific Research – Phil Dee, 1st Edition (2006), Cambridge University Press
Online Resources
1. MIT OpenCourseWare – Principles of Chemical Science 2. U.S. FDA – Good Manufacturing Practices (GMP) Regulations 3. Biotechnology Industry Organization (BIO) Career Center

Assessment (Laboratory course)
Report preparation, Continuous Assessment, Journal paper discussion

*Activity and Learning Task(s): assessed through Active Learning Strategies (ALS) Eg: One-minute paper, exit tickets/exit slips, Think-pair-share, Socratic seminar, reflective journal, Low-stakes quizzes, Diagnostic questions, Open-ended questions, Concept map, Homework tasks. Delete Assessment tables that do not apply to this course.

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr. Lipin Dev, Scientific Director , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. N. Selvaraju, Associate Professor, IIT Guwahati, Assam		Dr. N. Sivarajasekar, AP III, Biotechnology, KCT
Recommended by BoS on	14.08.2024		
Academic Council Approval	No.27	**Date**	24.08.2024

24MBJ510	TECHNICAL SEMINAR	L	T	P	J	C
		0	0	0	2	1
PC		SDG	2			

Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	Nil

Course Objectives**:	The purpose of taking this course is to:
1	Enhance the ability of self-study
2	To Improve presentation and communication skills
3	To Increase the breadth of knowledge.

**Min requirements- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed

Course Outcomes***:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Identify and choose appropriate topic of relevance.	An
CO 2	Assimilate literature on technical articles of specified topic and develop comprehension	Ap
CO 3	Prepare technical report.	E
CO 4	Design, develop and deliver presentation on specified technical topic	

BTL: R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	Independent Research and Development	Technical Report and documentation	Mastery over domain specialization	Bio-based techniques, health, professional ethics	Sustainable technology, environmental	Modern engineering tools, interdisciplinary implementation
1.	3					
2.	3					
3.					3	3
4.		3	3			
5.	3		3		3	3

Guidelines	
• The student is expected to present a seminar in one of the current topics in the field of Thermal Engineering related issues / technology.	

• The seminar shall be of 30 minutes duration and give presentation to the Seminar Assessment Committee (SAC). • A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. • In a session of three periods per week, 4 students are expected to present the seminar. • Students are encouraged to use various teaching aids such as power point presentation and demonstrative models. • Students are required to prepare a seminar report in the prescribed format given by the Department.	

Theory Hours:	**0**	**Tutorial Hours:**	**0**	**Practical Hours:**	**0**	**Project Hours:**	**20**	**Total Hours:**	**20**

Learning Resources*
Textbooks
1. Zeiger, M. (2000). Essentials of Writing Biomedical Research Papers. McGraw-Hill Education. 2. Alley, M. (1996). The Craft of Scientific Presentations. Springer.
Reference books/ Web Links
1. Day, R. A., & Gastel, B. (2012). How to Write and Publish a Scientific Paper. Cambridge University Press.
Online Resources 1. NPTEL Course: Effective Writing – https://nptel.ac.in/courses/109/104/109104032/ 2. Coursera: Writing in the Sciences – https://www.coursera.org/learn/sciwrite 3. Elsevier Researcher Academy – https://researcheracademy.elsevier.com/

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
Dr. M.K. Harishankar Principal Scientist Syngene International Ltd	Dr.Jibu Thomas Associate Professor Karyunya University	Dr.N.Saraswathy Dr.K.Kumaravel Dr.P.Muthukumaran

SEMESTER III

24MBJ601	SOCIAL IMMERSION PROJECT	L	T	P	J	C
		0	0	0	4	2
PW		SDG	SDG 3, 6, 13, 15			

Pre-requisite courses	Nil	Data Book / Code book(If any)	Nil

Course Objectives:	
The purpose of taking this course is to:	
1	Sensitize students to real-world societal challenges, especially in underserved communities.
2	Foster empathy, problem-solving, and innovation using biotechnology.
3	Integrate field engagement with sustainable, ethical, and impactful interventions.
4	Align student work with relevant Sustainable Development Goals (SDGs).

Note: Course Objectives:- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed. Number of Course objectives must range from 3 to 5

Course Outcomes***:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	After successful completion of this course, the students shall be able to	An
CO 2	Identify and analyze real-time societal and environmental issues through direct field engagement, considering relevant social, economic, and ecological contexts.	Ap
CO 3	Collect, interpret, and evaluate field data to design appropriate biotechnological or awareness-based interventions addressing identified community problems.	E
CO4	Collaborate effectively with local communities, NGOs, and institutional bodies to implement context-sensitive and sustainable project solutions.	Ap

RBT levels: Write the abbreviated levels - R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental**	**Modern engineering tools, interdisciplinary implementation**
1.	3	3	3	3	3	3
2.	3	3	3	3	3	3
3.	3	3	3	3	3	3
4.	3	3	3	3	3	3

SIP Activities – Structured Guidelines	

A. Preparation & Orientation
• Understand the scope, objectives, and relevance of SIP.
• Study successful biotech-based social innovations.
• Learn about SDGs and how biotechnology aligns with social progress.
• Identify target community/region (rural or urban underserved).
• Plan field visit logistics with mentor approval.
• Map stakeholders relevant to the target community/problem.
B. Field Engagement
• Conduct field visits to selected sites.
• Carry out:
  o Household/community surveys
  o Interviews with key stakeholders
  o Observational studies and informal interactions
• Document findings through:
  o Written field notes
  o Photo/video logs
  o Recorded interviews (with consent)
C. Problem Identification & Analysis
• Analyze collected data (quantitative and qualitative).
• Identify gaps, pain points, and unmet needs of the community.
• Perform SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis.
• Formulate a clear, concise problem statement.
• Validate problem relevance with stakeholders and mentor.
D. Solution & Proposal Development
• Brainstorm possible biotech/awareness-based interventions.
• Design a prototype or educational/awareness tool.
• Develop implementation plan, budget, and impact strategy.
• Consult with subject experts and community partners.
• Pilot test intervention in a small sample/group if feasible.
E. Implementation & Feedback
• Implement the proposed solution through:
  o Workshops, demonstrations, health/awareness campaigns
  o Prototype deployment or trial interventions
	30 Hours

• Monitor community participation, feedback, and reaction.
• Modify or adapt the solution based on real-time response.
F. Reporting & Reflection
• Prepare a comprehensive project report including:
  ○ Background, objectives, methods, outcomes, and challenges
  ○ Visual documentation (photos, videos, charts)
  ○ Ethical, social, and environmental impact analysis
• Submit a **reflective journal** (individual) summarizing personal learning.
• Present the project via **poster and/or oral presentation**.
• Participate in **peer review** and group feedback sessions**.**	

Theory Hours:	**Tutorial Hours:**	**Practical Hours:**	**Project Hours:**	**30**	**Total Hours:30**

Learning Resources

Textbooks:

1. Chambers, R. *Participatory Rural Appraisal: Principles and Practice*, Earthscan Publications (1994).
2. Gupta, Anil K. *Grassroots Innovation: Minds on the Margin Are Not Marginal Minds*, Penguin Books India (2016).

References:

1. Pretty, Jules N. "Participatory Learning for Sustainable Agriculture." World Development, Vol. 23, No. 8 (1995): pp. 1247–1263.
2. Leach, Melissa, Ian Scoones, and Andy Stirling. "Dynamic Sustainabilities: Technology, Environment, Social Justice." STEPS Centre Working Paper, Institute of Development Studies, University of Sussex (2010).
3. Sachs, Jeffrey D. "From Millennium Development Goals to Sustainable Development Goals." The Lancet, Vol. 379, No. 9832 (2012): pp. 2206–2211.
4. Desai, Vandana, and Robert B. Potter (Eds.) The Companion to Development Studies, Routledge (2014).

Online Educational Resources:

1. https://swayam.gov.in
2. https://nptel.ac.in/courses/121106007 – NPTEL course on Sustainable Development
3. https://www.un.org/sustainabledevelopment/

Assessment (Practical course)

1. Activity and Learning Tasks (Reflective journal, problem scoping report, field report)
2. Mini Project Proposal and Implementation Report
3. Final Presentation (Poster + Oral defense)
4. Peer and Mentor Feedback

*Activity and Learning Task(s): assessed through Active Learning Strategies (ALS) Eg: One-minute paper, exit tickets/exit slips, Think-pair-share, Socratic seminar, reflective journal, Low-stakes quizzes, Diagnostic questions, Open-ended questions, Concept map, Homework tasks. Delete Assessment tables that do not apply to this course.

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr. Lipin Dev, Scientific Director , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. Jibu Thomas Professor and Head Karunya University Coimbatore		Dr Kumaresan K, BT Dr. Ram K Dr Vinohar Stephen Rapheal
Recommended by BoS on	07.05.2025		
Academic Council Approval	No.	**Date**	26.06.2025

24MBJ602	**PROJECT PHASE I / INDUSTRY PROJECT**	**L**	**T**	**P**	**J**	**C**
		0	**0**	**0**	**20**	**10**
EEC		**SDG**	**SDG 1-17**			

Pre-requisite courses	Nil	**Data Book / Code book(If any)**	Nil

Course Objectives:	
The purpose of taking this course is to:	
1	Identify important social needs and problems for research
2	To formulate a research component for solve the problem and collect relevant literature survey
3	Carry out standardization and foundational work

Note: Course Objectives:- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed. Number of Course objectives must range from 3 to 5

Course Outcomes* :**	**After successful completion of this course, the students shall be able to**	**Bloom's Taxonomy Level (BTL)**
CO 1	Formulate a suitable experimental design by identifying and defining biotechnological problems through comprehensive literature surveys.	An
CO 2	Demonstrate the ability to critically review scientific literature and synthesize relevant information to support project planning.	E
CO 3	Apply appropriate technical skills to carry out standardization and foundational experimental work.	Ap
CO4	Interpret experimental results effectively and communicate	An

	project progress through scientific presentations and reports.	

RBT levels: Write the abbreviated levels - R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental**	**Modern engineering tools, interdisciplinary implementation**
1.	3	3	3	3	3	3
2.	3	3	3	3	3	3
3.	3	3	3	3	3	3
4.	3	3	3	3	3	3

Theory Hours:		**Tutorial Hours:**		**Practical Hours:**		**Project Hours:**	**20**	**Total Hours:**	**20**

Assessment (Practical course)
Rubrics based Evaluation , Faculty and Panel review, Viva voce, Report Submission

*Activity and Learning Task(s): assessed through Active Learning Strategies (ALS) Eg: One-minute paper, exit tickets/exit slips, Think-pair-share, Socratic seminar, reflective journal, Low-stakes quizzes, Diagnostic questions, Open-ended questions, Concept map, Homework tasks. Delete Assessment tables that do not apply to this course.

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr. Lipin Dev, Scientific Director , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. Jibu Thomas Professor and Head Karunya University Coimbatore		Dr Kumaresan K, BT Dr. Ram K Dr Vinohar Stephen Rapheal
Recommended by BoS on	07.05.2025		
Academic Council Approval	No.	**Date**	26.06.2025

SEMESTER IV

24MBJ603	PROJECT PHASE II / INDUSTRY PROJECT	L	T	P	J	C
		0	0	0	40	20
EEC		SDG	SDG 1-17			

Pre-requisite courses	Nil	Data Book / Code book(If any)	Nil

Course Objectives:	
The purpose of taking this course is to:	
1	Identify important social needs and problems for research
2	To formulate a research component for solve the problem and collect relevant literature survey
3	Carry out standardization and foundational work

Note: Course Objectives:- should cover Knowledge to be Acquired, Skills to be gained, and Competency to be Developed. Number of Course objectives must range from 3 to 5

Course Outcomes*** :	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Formulate a suitable experimental design by identifying and defining biotechnological problems through comprehensive literature surveys.	An
CO 2	Demonstrate the ability to critically review scientific literature and synthesize relevant information to support project planning.	E
CO 3	Apply appropriate technical skills to carry out standardization and foundational experimental work.	Ap
CO4	Interpret experimental results effectively and communicate project progress through scientific presentations and reports.	An

RBT levels: Write the abbreviated levels - R, U, Ap, An, E, C (Remember, Understand, Apply, Analysis, Evaluate, Create)

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
Course Outcomes (CO)	**Independent Research and Development**	**Technical Report and documentation**	**Mastery over domain specialization**	**Bio-based techniques, health, professional ethics**	**Sustainable technology, environmental**	**Modern engineering tools, interdisciplinary implementation**
1.	3	3	3	3	3	3
2.	3	3	3	3	3	3
3.	3	3	3	3	3	3
4.	3	3	3	3	3	3

Theory Hours:		**Tutorial Hours:**		**Practical Hours:**		**Project Hours:**	**40**	**Total Hours:**	**40**

Assessment (Practical course)
Rubrics based Evaluation , Faculty and Panel review, Viva voce, Report Submission

*Activity and Learning Task(s): assessed through Active Learning Strategies (ALS) Eg: One-minute paper, exit tickets/exit slips, Think-pair-share, Socratic seminar, reflective journal, Low-stakes quizzes, Diagnostic questions, Open-ended questions, Concept map, Homework tasks. Delete Assessment tables that do not apply to this course.

Course Curated by			
Expert(s) from Industry	**Expert(s) from Higher Education Institution**		**Internal Expert(s)**
Dr. Lipin Dev, Scientific Director , Vee Tee Ecogreen Pvt Ltd, Angamaly, Kerala	Dr. Jibu Thomas Professor and Head Karunya University Coimbatore		Dr Kumaresan K, BT Dr. Ram K Dr Vinohar Stephen Rapheal
Recommended by BoS on	07.05.2025		
Academic Council Approval	No.	**Date**	26.06.2025