

KUMARAGURU COLLEGE OF TECHNOLOGY,

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE - 641 049.

B.Tech., BIOTECHNOLOGY REGULATION 2024



CURRICULUM AND SYLLABI

I to VIII Semesters

Department of Biotechnology

DEPARTMENT VISION

Strong teaching and research foundation in the area of biotechnology and allied fields through knowledge dissemination to students and to scale new heights in the frontier areas of health, food, and environment and ethics for welfare of humankind.

DEPARTMENT MISSION

- M1** : Develop dynamic curriculum and syllabus to promote innovative
- M2** : Encourage students for innovation and setting start-ups and equip
- M3** : Train students on issues related to social welfare.
- M4** : Groom students to uphold professional and leadership qualities

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The program educational objective of B Tech Biotechnology program are:

- PEO1** : Graduates will build successful careers in biotechnology and related fields, working in diverse and multidisciplinary teams.
- PEO2** : Graduates will pursue higher studies and research by combining biological and engineering knowledge.
- PEO3** : Graduates will follow ethical practices and contribute to the well-being of mankind and environment.

PROGRAM OUTCOMES (POs)

Graduates of the Biotechnology undergraduate Program in B. Tech Biotechnology should have the ability to:

- PO1** : **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals, and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- PO2** : **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- PO3** : **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to

- meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- PO4** : **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- PO5** : **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- PO6** : **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- PO7** : **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- PO8** : **Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- PO9** : **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
- PO10** : **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- PO11** : **Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM SPECIFIC OUTCOMES (PSOs)

The Program Specific Outcomes of Biotechnology Undergraduate Program in B Tech Biotechnology is to prepare the graduates

- PSO1** : Apply fundamental biological principles to provide sustainable solutions for broad biotechnology sectors.
- PSO2** : Apply bioprocess principles and biological data-driven approaches to develop the processes and products for health, agriculture, food, and environmental systems.

**BIOTECHNOLOGY
REGULATION 2024
B.Tech., Biotechnology
CURRICULUM**

SEMESTER I

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24HST101	Heritage of Tamil	Theory	HS	1	0	0	0	1
2	24MAI112	Computational Linear Algebra and Calculus	Embedded	BS	3	0	2	0	4
3	24CYI103	Foundations of Chemistry for Biotechnology	Embedded	BS	3	0	2	0	4
4	24BTT101	Concepts of Biology	Theory	BS	2	0	0	0	2
5	24ADP001	Basics of AI	Practical	ES	0	0	2	0	1
6	24BTT102	Bioprocess Calculations	Theory	ES	3	0	0	0	3
7	24INP102	Innovation Practicum - 1	Practical	ES	0	0	2	0	1
8	24MEI103	Computer-Aided Engineering Graphics	Embedded	ES	2	0	2	0	3
9	24HSP111	Holistic Wellness- I	Practical	HS	0	0	2	0	1
10	24INP101	Design Thinking	Practical	HS	0	0	2	0	1
11	24INO--	FCLF-General Stack - 1	Practical	OE	0	0	2	0	1
Total Credits									22
Total Contact Hours/week									30

SEMESTER II

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24HST102	Tamils and Technology	Theory	HS	1	0	0	0	1
2	24HST103	Effective Communication	Theory	HS	2	0	0	0	2
	24HST104	Professional Communication	Theory	HS	2	0	0	0	
	24HSJ102	Fluency through Practice	Project	HS	0	0	0	4	
3	24MAI122	Advanced Computational Calculus	Embedded	BS	3	0	2	0	4
4	24PHI105	Foundational Physics for Biotechnology	Embedded	BS	3	0	2	0	4
5	24BTI103	Biochemistry and Cellular Energetics	Embedded	BS	3	0	2	0	4
6	24BTT104	Cell Biology	Theory	PC	3	0	0	0	3
7	24INP103	Innovation Practicum - 2	Practical	ES	0	0	2	0	1

8	24CSII01	Logical thinking and Problem Solving	Embedded	ES	3	0	2	0	4
9	24HSP112	Holistic Wellness- II	Practical	HS	0	0	2	0	1
10	24INO--	FCLF-General Stack - 2	Practical	OE	0	0	2	0	1
Total Credits									25
Total Contact Hours/week									32

SEMESTER III

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24HSP005	Mastering Conversations	Practical	HS	0	0	2	0	1
2	24MAI232	Applied Statistics for Engineers	Embedded	BS	3	0	2	0	4
3	24BTI201	Fundamentals of Microbiology and Immunology	Embedded	PC	3	0	2	0	4
4	24BTT202	Molecular Biology	Theory	PC	3	0	0	0	3
5	24BTT203	Bioanalytical Techniques and Instrumentation	Theory	PC	3	0	0	0	3
6	24BTP204	Cell and Molecular Biology Laboratory	Practical	PC	0	0	4	0	2
7	24INP201	Innovation Practicum - 3	Practical	ES	0	0	2	0	1
8	24BTJ205	Internship - I	Project*	PRJ	0	0	0	2	1
9	24INM201	Universal Human Values II: Understanding Harmony	Theory	HS	1	0	0	0	1
10	24INO---	FCLF General stack – 3	Practical	OE	0	0	2	0	1
Total Credits									21
Total Contact Hours/week									29

* Student can carry out an approved mini project instead of Internship -I

SEMESTER IV									
S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24HSP006	Mastering Group Discussion and Presentation Skills	Practical	HS	0	0	2	0	1
2	24BTI206	Cell Culture Techniques	Embedded	PC	2	0	4	0	4
3	24BTI207	Genetic Engineering	Embedded	PC	2	0	4	0	4
4	24BTI208	Protein Science and Enzyme Technology	Embedded	PC	2	0	2	0	3
5	24BTI209	Bioprocess Engineering Principles	Embedded	PC	3	0	2	0	4
6	24BTI210	Environmental Biotechnology and Sustainability	Embedded	PC	1	0	0	2	2
7	24INO--	FCLF Technical Stack - 1	Practical	OE	0	0	2	0	1

8	24INO--	FCLF Emerging Technology Stack - 1	Practical	OE	0	0	2	0	1
9	24INP202	Innovation Practicum - 4	Practical	ES	0	0	2	0	1
10	24INM102	Indian Knowledge Systems in Science and Engineering	Mandatory	HS	1	0	0	0	1
Total Credits									22
Total Contact Hours/week									33

SEMESTER V

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24HSP013	Mastering Career Readiness	Practical	HS	0	0	2	0	1
2	24BTI301	Upstream Bioprocessing	Embedded	PC	3	0	2	0	4
3	24BTI302	Bioinformatics	Embedded	PC	3	0	2	0	4
4	24BTI303	Immunotechnology	Embedded	PC	2	0	2	0	3
5	24BTE--	Professional Elective – I	Theory	PE	3	0	0	0	3
6	24BTE--	Professional Elective - II	Theory	PE	3	0	0	0	3
7	24BTJ304	Internship-II	Project*	PRJ	0	0	0	4	2
8	24BTT305	Core Competencies in Biotechnology	Mandatory	PC	0	1	0	0	0
9	24INO--	FCLF Technical Stack - 2	Practical	OE	0	0	2	0	1
10	24INO--	FCLF Emerging Technology Stack - 2	Practical	OE	0	0	2	0	1
Total Credits									22
Total Contact Hours/week									31

* Student can carry out an approved mini-project instead of Internship -II

SEMESTER VI

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24BTI306	Downstream Processing	Embedded	PC	3	0	2	0	4
2	24BTI307	Biostatistics and Experimental Design	Embedded	PC	1	0	2	0	2
3	24BTT308	Integrative Human Physiology	Theory	PC	3	0	0	0	3
4	24BTE--	Professional Elective -III	Theory	PE	3	0	0	0	3
5	24BTE--	Professional Elective -IV	Theory	PE	3	0	0	0	3
6		Language Elective	Embedded	HS	1	0	2	0	2

7	24INO--	FCLF Technical Stack - 3	Practical	OE	0	0	2	0	1
8	24INO--	FCLF Emerging Technology stack - 3	Practical	OE	0	0	2	0	1
9		Indian Constitution	Mandatory	MC	1	0	0	0	0
10	24BTJ309	Scientific Communication and Technical Writing	Project	PRJ	0	0	0	2	1
Total Credits									23
Total Contact Hours/week									30

SEMESTER VII

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24BTT401	Drug Development and Regulatory Affairs	Theory	PC	3	0	0	0	3
2	24BTT402	Bio-Entrepreneurship and Innovation	Theory	HS	3	0	0	0	3
3	24BTE	Professional Elective -V	Theory	PE	3	0	0	0	3
4	24BTE	Professional Elective -VI	Theory	PE	3	0	0	0	3
5	24BTE	Professional Elective -VII	Theory	PE	3	0	0	0	3
6	24BTJ403	Project Phase-I	Project	PRJ	0	0	0	6	3
Total Credits									18
Total Contact Hours/week									21

SEMESTER VIII

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24BTJ404	Project Phase - II	Project	PRJ	0	0	0	24	12
Total Credits									12
Total Contact Hours/week									24

PROFESSIONAL ELECTIVES

Professional Electives 1 & 3

SEMESTER - 5 & 6

Biomolecular and Cellular Biotechnology (Vertical -I)

(Course Code from 24BTE001 to 24BTE019)

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24BTE001	Nanobiotechnology	Theory	PE	3	0	0	0	3
2	24BTE002	Vaccine Technology	Theory	PE	3	0	0	0	3
3	24BTE003	Biomolecular Simulations	Theory	PE	3	0	0	0	3
4	24BTE004	Molecular Microbial Pathogenesis	Theory	PE	3	0	0	0	3
5	24BTE005	Stem Cell Technology	Theory	PE	3	0	0	0	3
6	24BTE006	Neurobiology and Cognitive Sciences	Theory	PE	3	0	0	0	3
7	24BTE007	Systems Biology	Theory	PE	3	0	0	0	3
8	24BTE008	Structural Biology	Theory	PE	3	0	0	0	3
9	24BTE009	Cancer Biology	Theory	PE	3	0	0	0	3

Professional Electives 2 & 4

SEMESTER - 5 & 6

Bioprocessing & Scaleup Engineering (Vertical -II)

(Course Code from 24BTE020 to 24BTE039)

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24BTE020	Industrial Biosafety and Bioethics	Theory	PE	3	0	0	0	3
2	24BTE021	Food Processing and Preservation Technology	Theory	PE	3	0	0	0	3
3	24BTE023	Industrial Biomanufacturing and Process Economics	Theory	PE	3	0	0	0	3
4	24BTE024	Biomass Valorization and Techno-economic Assessment	Theory	PE	3	0	0	0	3
5	24BTE025	Bioprocess Instrumentation and Control	Theory	PE	3	0	0	0	3
6	24BTE026	Bioreactor Design and Scale up	Theory	PE	3	0	0	0	3

Professional Electives 5

SEMESTER - 7**Healthcare Biotechnology (Vertical -III)**

(Course Code from 24BTE040 to 24BTE059)

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24BTE040	Immunoinformatic & Vaccine Design	Theory	PE	3	0	0	0	3
2	24BTE041	Recombinant DNA Technology in Medicine	Theory	PE	3	0	0	0	3
3	24BTE042	Gene Therapy	Theory	PE	3	0	0	0	3
4	24BTE043	Infectious Diseases and Diagnosis	Theory	PE	3	0	0	0	3
5	24BTE044	Host Microbe Interaction	Theory	PE	3	0	0	0	3

Professional Electives 6**SEMESTER - 7****Environmental & Sustainable Biotechnology (Vertical -IV)**

(Course Code from 24BTE060 to 24BTE079)

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24BTE060	Biological Process design for Wastewater Treatment	Theory	PE	3	0	0	0	3
2	24BTE061	Waste Management & Environmental Impact	Theory	PE	3	0	0	0	3
3	24BTE062	Bioenergy and Biofuels Technology	Theory	PE	3	0	0	0	3
4	24BTE063	Biorefineries	Theory	PE	3	0	0	0	3
5	24BTE064	Biofertilizers and Biopesticides	Theory	PE	3	0	0	0	3

Professional Electives 7**SEMESTER - 7****Food Biotechnology & Nutritional Sciences (Vertical -V)**

(Course Code from 24BTE080 to Course Code from 24BTE099)

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
1	24BTE080	Functional Foods and Nutraceuticals	Theory	PE	3	0	0	0	3
2	24BTE081	Nanomaterials in Food Applications	Theory	PE	3	0	0	0	3
3	24BTE082	Probiotics & Fermented Foods	Theory	PE	3	0	0	0	3

4	24BTE083	Nutritional Biochemistry	Theory	PE	3	0	0	0	3
5	24BTE084	Food Omics and Personalized Nutrition	Theory	PE	3	0	0	0	3
6	24BTE085	Public Health and Nutrition	Theory	PE	3	0	0	0	3

The following NPTEL 12-week 3 credit courses are eligible in respective verticals (with prior DCC Approval)

NPTEL COURSES

S.No	Course code	Course Title	Course Mode	Course Type	L	T	P	J	C
	24BTE	Developmental Biology	Theory*	PE	3	0	0	0	3
	24BTE	Advanced Fluorescence Microscopy and Image Processing	Theory*	PE	3	0	0	0	3
	24BTE	Structural Biology	Theory*	PE	3	0	0	0	3
	24BTE	Neurobiology	Theory*	PE	3	0	0	0	3
	24BTE	Systems Biology	Theory*	PE	3	0	0	0	3
	24BTE	Polymeric Biomaterials	Theory*	PE	3	0	0	0	3
	24BTE	Experimental Nanobiotechnology	Theory*	PE	3	0	0	0	3
	24BTE	Biomolecular Spectroscopy	Theory*	PE	3	0	0	0	3
	24BTE	Human Genetics and Genomics	Theory*	PE	3	0	0	0	3
	24BTE	RNA Biology	Theory*	PE	3	0	0	0	3
	24BTE	Microbial Biotechnology	Theory*	PE	3	0	0	0	3
	24BTE	Computer Aided Drug Design	Theory*	PE	3	0	0	0	3
	24BTE	Bioreactor Design and Analysis	Theory*	PE	3	0	0	0	3
	24BTE	Transport Phenomena in Biological Systems	Theory*	PE	3	0	0	0	3
	24BTE	Cell Culture Engineering	Theory*	PE	3	0	0	0	3
	24BTE	Vaccine Manufacturing and Scale-Up	Theory*	PE	3	0	0	0	3
	24BTE	Chromatography Techniques	Theory*	PE	3	0	0	0	3
	24BTE	Process Control & Instrumentation	Theory*	PE	3	0	0	0	3
	24BTE	Biochemical Reaction Engineering	Theory*	PE	3	0	0	0	3
	24BTE	Metabolic Engineering	Theory*	PE	3	0	0	0	3
	24BTE	Membrane Technology	Theory	PE	3	0	0	0	3

SEMESTER I

*** Course Outcomes should be clear, measurable, aligned with broader educational objectives, and focused on developing essential engineering skills while preparing students for future challenges in the field

COs: Embedded (3 to 4 credits): -6., Theory only - 5, Micro-credentials - 3, lab only - 3, project - 4

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

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge							3	2	2		2			
Problem Analysis							3	3	2		2			
Design/Development of Solutions							3	2	2		2			
Conduct Investigations of Complex Problems							3	2	3		1			
Engineering Tool Usage							3	2	2		2			
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														

Course Content

UNIT I: Language Families in India - Dravidian Languages

Language Families in India - Dravidian Languages - Tamil as a Classical Language - Classical Literature in Tamil - Secular Nature of Sangam Literature - Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

3 Hours

UNIT II: Language Families in India - Dravidian Languages

Language Families in India - Dravidian Languages - Tamil as a Classical Language - Classical Literature in Tamil - Secular Nature of Sangam Literature - Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

3 Hours

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam,

9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL)

Assessment	
Formative	Summative
Assignments & Quiz	CAT – II and End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)

Approved by: BoS Chairman	<i>B. S. S.</i> 16-08-2024
BoS Approval date:	16-08-2024

24MAI112	COMPUTATIONAL LINEAR ALGEBRA AND CALCULUS	L	T	P	J	C
		3	0	2	0	4
BS	(Common to BT, FT, TT)	SDG		4, 7, 9		
Pre-requisite courses	-	Data Book / Code book (If any)			-	

Course Objectives:

The purpose of taking this course is to:

1	develop and understanding of the solution techniques for systems of linear equations and their applications in engineering problems.
2	familiarize students with the concept of eigenvalues and eigenvectors, and their significance in transforming real-world systems.
3	apply differential calculus to solve real-life optimization problems involving rate changes and extrema.
4	enhance proficiency in evaluating integrals using analytical and numerical methods for solving area and volume problems in engineering.
5	introduce ordinary differential equations and their numerical solutions for modelling dynamic systems in various engineering disciplines.

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	apply matrix operations (Gauss Jordan, Gauss Seidel) to solve systems of linear equations in textile manufacturing and material composition problems.	Ap
CO2	apply eigenvalues and eigenvectors to simplify textile stress-strain matrices and design systems in fashion technology.	Ap
CO3	apply differential calculus to optimize garment fitting, fabric draping, and bio- responses in biotechnological textiles by analysing changes in variables.	Ap
CO4	analyse and estimate changes in textile production processes and biological systems with variable data points by utilizing numerical differentiation techniques (Newton's, Lagrange's methods).	An

CO5	solve integration problems using analytical and numerical methods (Trapezoidal, Simpson's rule) for calculating fabric area or volume in garment design and textile engineering.	Ap
CO6	apply numerical methods (Euler's method, Taylor series, Runge Kuta) to solve first-order ordinary differential equations in dynamic biotechnological processes such as enzyme kinetics or fluid flow in textile materials.	Ap

	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11			
Course Outcomes (CO)	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2	PSO-3
1	3	3	2		3	2		2	1	2				
2	3	3	2		3	2		2	1					
3	3	2	3		3	2		2	1					
4	3	3	2		3	2		2	1					

5	3	2	2		3	2		2	2	2				
6	3	3	2		3	2		2	1					

Course Content:

SYSTEM OF LINEAR EQUATIONS

Rank of a matrix – Consistency of a system of linear equations - Rouche's theorem - Linearly dependent and independent vectors – Solution of a system of linear equations - Row Echelon form method

9 Hours

Numerical Method - Solution of a system of linear equations by Gauss Jordan and Gauss Seidel Method.

Practical Component

Solve a system of linear equations using Gauss Jordan and Gauss Seidel methods and interpret the results for a circuit analysis problem.

6 Hours

Use MATLAB to find the rank of a matrix and check the consistency of a system of

linear equations, applying the results to a mechanical structure problem.

EIGENVALUES AND EIGENVECTORS

Eigenvalues and Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors –Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

9 Hours

Numerical Method - Dominant Eigen value by Power Method.

Practical Component

Implement the Power Method in MATLAB to find the dominant eigenvalue of a matrix representing a dynamic system (e.g., vibration analysis of a mechanical structure).

6 Hours

Use MATLAB to perform orthogonal transformations and diagonalize a symmetric matrix in a physical system (e.g., stress-strain analysis).

DIFFERENTIAL CALCULUS

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable -

9 Hours

Numerical Method - Numerical differentiation by Newton's Forward and Backward Method (Equal intervals), Lagrange's Method (Unequal Intervals).

Practical Component

Use MATLAB to compute numerical differentiation using Newton's Forward and Backward methods for a data set representing temperature changes over time.

6 Hours

Apply Lagrange's method for numerical differentiation to an unequal interval data set,

such as population growth data.

Implement the Runge Kutta method of the 4th order in MATLAB to solve a dynamic system, such as the motion of a pendulum or a mass-spring system.					
Theory Hours :	45	Tutorial Hours :	0	Practical Hours :	30
				Project Hours :	0
					Total Hours: 75

Learning Resources	
Textbooks	
<ol style="list-style-type: none"> 1. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 9th Edition, New Delhi, 2023. 2. Grewal B.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 2013. 	
Reference books	
<ol style="list-style-type: none"> 1. Kreyzig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley and sons, 2011. 2. Weir, MD, Hass J, Giordano FR, "Thomas' Calculus", Pearson education 15th Edition, 2023. 3. Steven.C.Chapra, "Applied Numerical Methods with Matlab for Engineers and Scientists", 4th Edition, Tata McGraw Hill Co. Ltd, 2017. 4. Dennis G. Zill and Michael R Cullen, "Differential equations with boundary value problems", 7th Edition, Brooks/Cole Cengage Learning.2009. 5. Ron Larson and Bruce H. Edwards, "Calculus", 12th Edition Brooks/Cole Cengage Learning.2022. 6. James W. Demmel Applied Numerical Linear Algebra" 9th Edition, SIAM, 1997 	
Online Resources (Web Links)	
<ol style="list-style-type: none"> 1. MIT Open Courseware: Linear Algebra (Free) https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/ 2. Coursera: Numerical Methods for Engineers https://www.coursera.org/learn/numerical-methods-engineers 3. Khan Academy: Differential Calculus (Free) https://www.khanacademy.org/math/calculus-1 4. MIT OpenCourseWare: Differential Equations (Free) https://ocw.mit.edu/courses/mathematics/18-03sc-differential-equations-fall-2011/ 	

Assessment (Embedded course)
CAT, 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	Dr.T.Govindan, Government College of	Dr. R.Marudhachalam Dr. Vijitha Iyer

Private Limited, Coimbatore.	Engineering, Srirangam, Trichy.	Dr. A.Ezhilarasi,
Mr.Jayakumar Venkatesan,	Dr.C.Porkodi,	Department of Maths
Valles Marineris International	PSG College of Technology,	
Private Limited- Chennai.	Coimbatore.	
Mr. Imran Khan,	Dr.P.Paramanathan,	
GE Transportation Company,	Amrita Vishwa Vidyapeetham,	
Bangalore.	Coimbatore.	
Recommended by BoS on	16.08.2024	
Academic Council Approval No.	27	Date 24.08.2024



(Signature of BoS Chairperson)

24CYI103	FOUNDATIONS OF CHEMISTRY FOR BIOTECHNOLOGY	L	T	P	J	C
		3	0	2	0	4
BS		SDG	3, 6, 12			
Pre-requisite courses	-	Data Book / Code book (If any)		-		

Course Objectives:	
The purpose of taking this course is to:	
1	acquire foundational knowledge of solution chemistry, chemical kinetics, organic chemistry, and stereochemistry to understand their significance in biochemical processes.
2	develop analytical skills to evaluate reaction rates, enzyme behaviour, and organic reaction mechanisms under varying conditions.
3	build competency in applying organic chemistry principles and bonding theories to identify and synthesize organic molecules crucial to living cells and biochemical processes.
4	analyze the role of stereochemistry in biological systems to assess the efficacy and safety of pharmaceutical compounds.
5	enhance problem-solving abilities through hands-on laboratory experiments, integrating theoretical knowledge with practical applications in biotechnology.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	apply knowledge of solution chemistry to prepare and standardize chemical solutions for biochemical processes.	Ap
CO2	analyse the factors affecting reaction rates to evaluate enzyme behaviour under different conditions.	An
CO3	apply the reactivity of major organic molecules to identify functional groups and bonds in living cells.	Ap
CO4	apply various organic reactions and mechanisms to select appropriate pathways for biochemical synthesis.	Ap

CO5	analyse the role of stereochemistry in drug efficacy to assess the biological significance of isomers.	An
CO6	evaluate and apply fundamental principles of solution chemistry, chemical kinetics, organic reactions, and stereochemistry in biochemical processes and pharmaceutical production.	E

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1	3	2									3			
2	2	2		3	2						2			
3	1	1			1						1			
4	3			2							3			
5	2	3					2				2			
6	2	2		2						2	2			

Course Content	
<p>SOLUTION CHEMISTRY Types of solutions (gaseous, liquid, solid) - Solubility and factors affecting solubility - Concentration units (Molarity, Molality, Mass percentage and Parts per million (ppm), calculating concentration, dilution factors and percent yield - Colligative properties (Vapor pressure lowering, Boiling point elevation, Freezing point depression, osmotic pressure, Buffer solutions and their importance in biological systems)</p> <p>Practical Component:</p> <ul style="list-style-type: none"> Preparation of standard solutions and Standardisation of the prepared solutions Preparation of standard solutions-Buffer solutions 	<p>9 Hours</p> <p>6 Hours</p>
<p>CHEMICAL KINETICS Chemical Kinetics: Reaction rates and rate laws - Order of reaction and molecularity - Factors affecting reaction rates (Concentration, Temperature, Catalysts and Surface area) - Activation energy and the Arrhenius equation - Collision theory and transition state theory –Enzyme and their functions in cells, Enzyme kinetics and catalysis (Michaelis-Menten kinetics, Allosteric regulation)</p> <p>Practical Component:</p> <ul style="list-style-type: none"> Determination of the Rate Law for the Iodine Clock Reaction Using a Spectrophotometer Determination of Michaelis-Menten Parameters for the enzyme 	<p>9 Hours</p> <p>6 Hours</p>
<p>FUNDAMENTALS OF ORGANIC CHEMISTRY AND BONDING Chemical Bonding: Ionic bonds - covalent bonds - Hydrogen bonding - molecular geometry – polarity Introduction to organic compounds: IUPAC naming conventions – Structure of Functional groups (alcohols, aldehydes, ketones, carboxylic acids, esters, amines and amides) – Inductivity effects - hyper conjugative - resonance effects- Reaction species (carbocations, carbanions, free radicals, carbenes) - Major classes of organic molecules in living cells – Carbohydrates, lipids, proteins, nucleic acids.</p> <p>Practical Component:</p>	<p>9 Hours</p>

<ul style="list-style-type: none"> Determine the sensitivity of proteins to environmental conditions (heat, acid, and alcohol) Identification of functional groups in Glucose Detection of the presence of free amino acids and proteins containing free amino groups influenced by the amino acid's side chain structure - by the Ninhydrin test 	9 Hours										
<p>ORGANIC REACTIONS Classification of organic reactions: addition, substitution, elimination, oxidation and reduction processes) - Introduction of Redox, Hydrolysis, Condensation, Carboxylation, Decarboxylation, Phosphorylation, Dehydration reactions (in the context of biochemical reactions) and Reaction mechanisms - Free radical, Nucleophilic (SN1 & SN2 mechanism), Electrophilic (E1 & E2 mechanism) – Biological significance of functional groups - Assessing the Environmental Impact of Chemical Reactions.</p> <p>Practical Component:</p> <ul style="list-style-type: none"> To compare the rates of SN1 and SN2 reactions using alkyl halides and nucleophiles under controlled conditions. Hydrolysis of the triglycerides / Esters Synthesis of methyl orange compound. 	9 Hours 6 Hours										
<p>STEREOCHEMISTRY Isomerism Concepts: Structural isomers (Chain isomers, Position isomers, Functional group isomers) - Stereoisomers (Geometric isomers, Optical isomers (enantiomers), Diastereomers) - Importance of isomerism in biological systems (Drug efficacy and toxicity and Enzyme-substrate interactions) Case study: Thalidomide toxicity tragedy, L-DOPA in Parkinson Treatment.</p> <p>Practical Component: Identification of isomers – Polarimeter / Simulation experiments</p>	9 Hours 3 Hours										
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">Theory</td> <td style="width: 15%;">Tutorial</td> <td style="width: 15%;">Practical</td> <td style="width: 15%;">Project</td> <td style="width: 15%;">Total</td> </tr> <tr> <td>Hours: 45</td> <td>Hours: 0</td> <td>Hours: 30</td> <td>Hours: 0</td> <td>Hours: 75</td> </tr> </table>	Theory	Tutorial	Practical	Project	Total	Hours: 45	Hours: 0	Hours: 30	Hours: 0	Hours: 75	
Theory	Tutorial	Practical	Project	Total							
Hours: 45	Hours: 0	Hours: 30	Hours: 0	Hours: 75							

Learning Resources
References:
<ol style="list-style-type: none"> Jeffery, G. H., Bassett, J., Mendham, J., & Denny, R. C. (2012). Vogel's textbook of quantitative chemical analysis. Oxford University Press. Laidler, K. J. (1987). Chemical kinetics (3rd ed.). Harper & Row. Jain, P. C., & Jain, M. (2018). Engineering chemistry (17th ed.). Dhanpat Rai and Sons Purcell, K. F., & Kotz, J. C. (2005). Chemistry: Concepts and applications. Atkins, P. & de Paula, J. (2006). Physical chemistry (8th ed.). Oxford University Press. Stryer, L., Berg, J. M., & Tymoczko, J. L. (2002). Biochemistry (5th ed.). W. H. Freeman and Company. Fisher, J., & Arnold, J. R. P. (2002). Chemistry for biologists. Viva Books Private Limited. Morrison, R. T., & Boyd, R. N. (2002). Organic chemistry. Pearson Education Private Limited. Bahl, B. S., & Bahl, A. (2000). Advanced organic chemistry. S. Chand. Eliel, E. L., & Wilen, S. H. (1994). Stereochemistry of organic compounds. Wiley-Interscience. Sobti, R. C., & Khatri, P. K. (2011). Biotechnology for sustainable development. Narosa Publishing House. Brown, T. E., LeMay, H. E., & Bursten, B. E. (2006). Chemistry: The central science (10th ed.). Pearson Education. Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (7th ed.). W. H. Freeman and Company.
Online Resources (Weblinks)
<ol style="list-style-type: none"> NPTEL online course on Basics of organic chemistry NPTEL online course on Chemical kinetics

Assessment (Embedded course)
CAT, Activity and Learning Task(s) (Concept Map, Think-Pair-Share, Jigsaw), MCQ, End Semester Examination (ESE), Lab Workbook, Model Exam, Viva-Voce.

Course Curated by			
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)	
Dr. Muthuraja Perumal General Manager - Research & Development Rohith Industries, APIIC Industrial Park, Andhra Pradesh	Dr. Venkatakrishnan Professor, School of Chemical Sciences Indian Institute of Technology (Mandi) Himachal Pradesh India	Dr Shoba US, Dr. D Jalajaa, Department of Chemistry	
Recommended by BoS on	16.08.2024		
Academic Council Approval	No.27	Date	24.08.2024

24BTT101	CONCEPTS OF BIOLOGY				L	T	P	J	C
BS					2	0	0	0	2
					SDG		3, 14, 15		
Pre-requisite courses	-		Data Book / Code book (If any)		-				

Course Objectives	
The purpose of taking this course is to	
1	Levels of foundations that influence the diversified activities of life
2	Structural features and functions of different biomolecules
3	Modified Mendelian genetics and sex-linked genetics
4	Various postulates that endorse the phenomenon of the origin of life

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Apply the principles of carbon bonding, energy transformations between biomolecules and salient features of water to investigate the various domains of life	Ap
CO 2	Analyse the structural features and functions of carbohydrates and lipids	An
CO 3	Analyse the structural features and functions of amino acids and proteins	An
CO 4	Demonstrate the structural features and functions of nucleic acids	An
CO 5	Apply the fundamental concepts of genetics to explore the modified Mendelian patterns	Ap
CO 6	Apply different postulates to understand the origin of life	Ap

	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11		
Course Outcomes (CO)	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2
1	3	2										2	2
2	3	2									3	3	3
3	3	2									3	3	3
4	3	2									3	3	3
5	3	2									3	3	3
6	3	2									3	2	2

Course Content	
<p>FOUNDATIONS OF LIFE Chemical foundation – versatility of carbon bonding, common functional groups of biomolecules, difference between configuration (maleic acid and fumaric acid) and conformation; Physical foundation – overview of energy transformations in living organisms; significance of entropy in a biological system; Cellular foundation – overview of three distinct domains of life (tree of life); Characteristics of living organisms – metabolic process, generative process and control process; Water and life – structural features of water molecule, properties of water.</p>	9 Hours
<p>MOLECULES OF LIFE Carbohydrates – classification, structural features (Fischer’s linear and Haworth’s ring forms of glucose, Haworth’s ring form of sucrose, starch and cellulose), functions; Lipids – classification, overview of structure of triacyl glycerol and functions; Fatty acids – classification, numbering of carbon atoms in a fatty acid, influence of saturated and unsaturated fatty acids in the maintenance of biomembrane integrity; Amino acids – structure of standard amino acids, classification and functions; Proteins – nature of peptide bond, structural features of secondary (α – helix and β – pleated) and tertiary (myoglobin) protein, functions; Nucleic acids – structure of nucleotides and deoxynucleotides, Salient structural features of Watson and Crick model of DNA, functions of DNA and RNA.</p>	10 Hours
<p>GENETICS AND HEREDITARY Definitions – allele, genotypes, phenotype; Modified Mendelian Patterns – Codominance and Incomplete Dominance; Sex-Linked Traits and Chromosomal Disorders.</p>	5 Hours
<p>EVOLUTIONARY BIOLOGY Early thoughts about the origin of life – experimental proof of Francesco Redi, Spallanzani and Louis Pasteur; Formation of the first organic molecules – overview, Urey and Miller experiment; Development of membranes; Development of metabolic pathways - Autotroph Hypothesis; RNA World hypothesis; Endosymbiotic theory.</p>	6 Hours

Theory Hours:	30	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours:	30
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Learning Resources	
Textbooks	
1. Enger, Eldon, Ross, Frederick, and Bailey, David. <i>Concepts in Biology</i> . McGraw-Hill Science/Engineering/Math, (2009). 2. Satyanarayana, U., and U. Chakrapani. <i>Biochemistry</i> . 4/e. Elsevier India, (2013).	
Reference books	
1. Verma, P. S., and Agarwal, V. K. <i>Cell Biology, Genetics, Molecular Biology, Evolution and Ecology</i> . Library Edition. S. Chand Publishing, 2022. 2. Nelson, D L. <i>Lehninger Principles of Biochemistry</i> . W. H. Freeman and company, (2013). 3. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. <i>Fundamentals of Biochemistry</i> . John Wiley & Sons, (2016).	
Online Resources (Web Links)	
1. https://ocw.mit.edu/courses/7-01sc-fundamentals-of-biology-fall-2011/resources/macromolecules-lipids-carbohydrates-nucleic-acid-excerpt-1/ 2. https://ocw.mit.edu/courses/7-01sc-fundamentals-of-biology-fall-2011/resources/mendels-laws-excerpt-1/ 3. https://www.youtube.com/watch?v=P-vFwzpIXf0 4. https://www.youtube.com/watch?v=3ijinTO4TGs	
Assessment (Theory course)	
SA I, SAI, 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, Vee Tee Eco Green PVt Ltd, Angamaly, Kerala	Dr. Venkat Kumar, Dept of Biotechnology, School of Biological science, VIT Vellore	Dr. T. Sathish Kumar, Department of Biotechnology	
Recommended by BoS on	14.08.2024		
Academic Council Approval	27	Date	24.08.2024

24ADP001	BASICS OF ARTIFICIAL INTELLIGENCE	L	T	P	J	C
		0	0	2	0	1
ES	(Common to all Departments except CS, IT, AD)	SDG	8, 9, 16			
Pre-requisite courses	-	Data Book / Code book (If any)	-			

Course Objectives:	
The purpose of taking this course is to:	
1	introduce students to the fundamentals of Artificial Intelligence (AI) and Generative AI, and its key concepts
2	enable students to explore and experiment with common generative AI models and tools for generating text, images, audio, video, and code
3	equip students with the techniques and best practices for crafting effective prompts for AI models

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	understand the fundamentals of AI and generative AI, including its potential impact, issues, limitations, and ethical concerns and its practical use cases in real-world scenarios.	U
CO 2	explore common generative AI models and tools for text, code, image, audio, and video generation.	E
CO 3	apply common prompt engineering techniques and approaches for writing effective prompts.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1	2						2							
2	2		2											
3					2					2				

Course Content	
Introduction to Artificial Intelligence (AI) Practical Component Introduction to Artificial Intelligence (AI) - Generative AI Overview and Use Cases - Impact and Examples of AI - Application Domains for AI - Generative AI Applications. AI Concepts, Terminology - Cognitive Computing (Perception, Learning, Reasoning) - Terminology and Related Concepts of AI- Machine Learning Techniques and Training - Deep Learning - Neural Networks - Natural Language Processing, Speech, Computer Vision - Self Driving Cars. AI: Issues, Concerns and Ethical Considerations - AI Ethics, Regulations, Governance, and ESG. The evolution and future of AI - The AI Ladder - The Journey for Adopting AI Successfully - Hotbeds of AI Innovation.	8 Hours
Generative AI: Introduction and Applications Practical Component Introduction and Capabilities of Generative AI - Applications of Generative AI - Tools for Text Generation - Tools for Image Generation - Tools for Audio and Video Generation - Tools for Code Generation	6 Hours
Generative AI: Prompt Engineering Basics Practical Component Introduction to Prompt and Prompt Engineering - Best Practices for Prompt Creation - Common Prompt Engineering Tools - Hands on Lab: Getting to Know Our AI Prompting - Experimenting with Prompts - Naive Prompting and Persona Pattern. Prompt Engineering Techniques and Approaches - Text-to-Text Prompt Techniques - Interview Pattern Approach - Chain-of-Thought Approach - Tree-of-Thought Approach - Future of Human-Crafted Prompts - Text-to-Image Prompt Techniques - Hands-on Lab: Effective Text Prompts for Image Generation.	7 Hours
Project and Wrap Up Practical Component Graded Quiz Final Project: Generating Text, Images, and Code.	9 Hours

Theory Hours:	0	Tutorial Hours:	0	Practical Hours:	30	Project Hours:	0	Total Hours:	30
Learning Resources									
Textbooks:									
<ol style="list-style-type: none"> George F. Luger “Artificial Intelligence: Structures and Strategies for Complex Problem Solving” (6th Edition), Pearson, 2021. Anna Jordan, Robert S. Menzies, Kristine P. Schwab, “AI-Powered Creativity: Generative AI and the Future of Content Creation” Routledge, 2023. 									
References:									
<ol style="list-style-type: none"> https://platform.openai.com/docs/overview https://towardsdatascience.com/ https://gemini.google.com/ 									
Online Resource (Weblinks)									
<ol style="list-style-type: none"> Introduction to Artificial Intelligence (AI) Coursera Generative AI: Introduction and Applications Coursera Generative AI: Prompt Engineering Basics Coursera 									

Assessment (Practical course)			
MCQ, Mini project and viva-voce			
Course Curated by			
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)	
-	-	Dr. S. Sangeetha, Associate Professor Department of AI&DS	
Recommended by BoS on	16.08.2024		
Academic Council Approval	No: 27	Date	24.08.2024

24BTT102	BIOPROCESS CALCULATIONS	L	T	P	J	C
ES		3	0	0	0	3
		SDG	9, 12			
Pre-requisite courses	-	Data Book / Code book (If any)		-		

Course Objectives	
The purpose of taking this course is to	
1	Enable students to master unit conversions, flow diagrams, and gas laws.
2	Solve the material and energy balance problems for steady state operations.
3	Apply stoichiometry of growth and product formation.
4	Apply the unsteady state operations for material and energy balance.

Course Outcomes	
After successful completion of this course, the students shall be able to	Revised Bloom’s Taxonomy Levels (RBT)
CO 1	Explain the upstream and downstream processing steps involved in the industrial production of penicillin, aspartic acid, and Ap

	ethanol, and perform basic unit conversions and gas law calculations related to these processes	
CO 2	Apply material balance equations to solve steady-state problems in unit operations and simple reacting systems by calculating conversion, yield, selectivity, and limiting reactants.	Ap
CO 3	Apply fundamental energy balance equations to compute sensible heat, latent heat, and heat of reaction in non-reacting and simple reacting bioprocess systems.	Ap
CO 4	Apply stoichiometric relationships to calculate biomass yield, respiratory quotient, degree of reduction, and theoretical oxygen demand in microbial growth and product formation.	Ap
CO 5	Apply basic unsteady-state material and energy balance concepts to solve introductory problems involving recycle, bypass, and purge streams in bioprocess systems.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2
Engineering Knowledge													
Problem Analysis													
Design/Development of Solutions													
Conduct Investigations of Complex Problems													
Engineering Tool Usage													
The Engineer and The World													
Ethics													
Individual and Collaborative Team													
Communication													
Project Management and Finance													
Life-Long Learning													
1	3					3		2	2		3	3	3
2	3					3					3	3	3
3	3					3					3	3	3
4	3					3					3	3	3
5	3					3					3	3	3

Course Content	
BIOPROCESSING AND UNIT CONVERSIONS Overview of key processes used in pharmaceuticals, agriculture, and biofuels; Upstream and downstream processing steps in the industrial production of penicillin, amino acid (aspartic acid) and alcohol production by microbial fermentation; Unit conversions, Representation of units, Gas Laws.	9 Hours
MATERIAL BALANCE WITH AND WITHOUT CHEMICAL REACTION Material balances without chemical reactions: Material balances involved in distillation, extraction, drying, evaporation, and crystallization; Material balances with chemical reactions: Selectivity, conversion and yield, Limiting and excess reactant.	9 Hours
ENERGY BALANCE WITH AND WITHOUT CHEMICAL REACTION Thermophysics: Energy balance equation formulation, Components of energy balance, Heat capacity of solids, liquids and gases, Sensible and latent heat; Thermochemistry: Hess's law, Standard heat of reaction: formation and combustion, Enthalpy determination.	9 Hours
STOICHIOMETRY OF GROWTH AND PRODUCT FORMATION	9 Hours

Growth stoichiometry, Respiratory quotient, Degree of reduction, Electron balances, Biomass yield, Product Stoichiometry, Theoretical Oxygen Demand	
UNSTEADY STATE OPERATION Unsteady state operation- Material and Energy balances, Recycle, By-Pass and Purge Streams.	9 Hours

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45
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Learning Resources	
Textbooks	
<ol style="list-style-type: none"> Narayanan, K. V., & Lakshmikutty, B. <i>Stoichiometry and Process Calculations</i>. PHI Learning Pvt. Ltd. 2nd Edition (2016). Carlson, R., Morrissey, K., & Doran, P. M. <i>Bioprocess Engineering Principles</i>. Elsevier. 3rd Edition (2025). 	
Reference books	
<ol style="list-style-type: none"> Shuler, M. L., Kargi, F., & DeLisa, M. <i>Bioprocess Engineering: Basic Concepts</i>. Pearson Education India. 3rd Edition (2017). Himmelblau, D. M., & Riggs, J. B. <i>Basic Principles and Calculations in Chemical Engineering</i>. Pearson/FT Press. 8th Edition. Satyanarayana, U., & Chakrapani, U. <i>Biotechnology</i>. Books and Allied Pvt. Ltd. (2020). 	
Online Resources (Web Links)	
<ol style="list-style-type: none"> https://onlinecourses.nptel.ac.in/noc25_bt84 https://pdfroom.com/books/stoichiometry-and-process-calculations/1j5KLrx8dKr 	

Assessment (Theory course)
SA I, SA II, 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)	
Prakash Venkatachalapathi Deputy General Manager Theranyam Biologics Pvt. Ltd. Borapatla village, Hatboora Mandal, Borpatla,, Sangareddy, Telanga	Dr. Selvaraju Narayanasamy IIT Guwahati	Dr. D.R Manimaran Dr. N. Sivarajasekar Dr. M. Shanmugaparakash Department of Biotechnology	
Recommended by BoS on	14.08.2024		
Academic Council Approval	No: 27	Date	24.08.2024

24INP102	INNOVATION PRACTICUM – 1 (Common to all Departments)	L	T	P	J	C
		0	0	2	0	1
ES		SDG	9, 11, 12			

Pre-requisite courses	-	Data Book / Code book (If any)	-
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Course Objectives:

The purpose of taking this course is to:

1	analyse the effectiveness of systems thinking and problem-solving methodologies in applying data-driven insights for innovative solution design.
2	evaluate the impact of transdisciplinary collaboration on creating functional hardware prototypes through fabrication techniques.
3	understand the future trends and implications of technology in developing innovative products.

Course Outcomes:

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	recall the fundamental principles of custom hardware design.	R
CO2	understand the appropriate tools and their applications for solving hardware-related problems.	U
CO3	apply systems engineering concepts to real-world hardware design challenges.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1	2		1											
2	2				1									
3		2	2	1										

Course Content

Engineering Fundamentals and Innovation Why engineering? The concept of street fight engineering - Real-world design process and problem-solving methodology - Data-driven insights and concept generation - Case studies of successful engineering innovations.	3 Hours
Transdisciplinary Systems and Manu'Futuring Transdisciplinary systems to accelerate innovation - Manu'Futuring: Technology in hardware manufacturing and manufacturing of hardware technologies - Future scopes with product case studies.	6 Hours
Building Custom Hardware How to build a basic custom hardware - Electronics fundamentals and components - Software for hardware control - Fabrication techniques.	6 Hours
System Thinking and Engineering Introduction to system thinking - Real world as a system - Concept of system engineering and its application – iLenSys.	7 Hours
Creativity Time and Tech Teardown Creativity exercise: Apply system thinking to a real-world problem - Tech teardown: Analyse a product or system to understand its engineering principles - Presentation: Present your creative project and tech teardown with an engaging title	8 Hours

Theory Hours:	0	Tutorial Hours:	0	Practical Hours:	30	Project Hours:	0	Total Hours:	30
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Learning Resources	
Textbooks:	
1.	Sanjoy Mahajan - <u>Street Fighting Mathematics</u>
2.	Donald Knuth - <u>The Art of Computer Programming</u>
3.	Think like a programmer: <u>An introduction to creative problem solving</u>
4.	Thinking in Systems: <u>A Primer</u>
References:	
1.	Learning to code: <u>How to think like a programmer</u>
2.	How to find innovative ideas: <u>Ramesh Raskar's note</u>
3.	Case study: <u>How Tesla changed the auto industry</u>
4.	Ultimate Guide: <u>How to develop a new electronic hardware product</u>
Online Resources (Weblinks)	
1.	https://www.ifixit.com/Teardown?srsId=AfmBOorwzDG9RhJoL3L5tlZ_Dr4sVcey-vPC-pkKTj2E0mWJWtFYlikY
2.	https://www.symmetryelectronics.com/technology-teardowns/

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

Course Curated by			
Expert from Industry	Expert from Higher Education Institutions	Internal Expert	
Dr. Mahesh Veezhinathan Director - Innovation Practicum Associate VP - Forge. Innovation	-	Dr. Samuel Ratna Kumar P S Assistant Professor – III Department Mechanical Engineering	
Recommended by BoS on	17.08.2024		
Academic Council Approval	No: 27	Date	24.08.2024

24MEI103	COMPUTER AIDED – ENGINEERING GRAPHICS (Common to EE, EC, EI, BT)	L	T	P	J	C
		2	0	2	0	3
ES		SDG		9, 12		

Pre-requisite courses	-	Data Book / Code book (If any)	-
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Course Objectives:	
The purpose of taking this course is to:	
1	understand the fundamental principles of engineering graphics and their significance.
2	develop proficiency in freehand sketching, usage of drawing instruments, and lettering.
3	gain competency in using computer graphics technologies for graphical communication, including isometric views and various coordinate systems (absolute, relative, polar)

Course Outcomes	
After successful completion of this course, the students shall be able to	Revised Bloom's Taxonomy Levels (RBT)

CO1	apply the principles of engineering graphics to create accurate orthographic and isometric projections	Ap
CO2	design free-hand sketches of orthographic views from pictorial representations to improve spatial understanding and communication of engineering concepts	C
CO3	apply CAD software tools to create, edit, and annotate technical drawings and analyse them using ISO and ANSI standards	Ap
CO4	analyse the parametric and non-parametric CAD models, producing detailed two-dimensional documentation, including sectional views and annotations.	An
CO5	apply geometric and topological concepts to design 3D models for additive manufacturing.	Ap
CO6	apply the principles of engineering graphics to create accurate orthographic and isometric projections	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1	2	2		2							2			
2		1	2								1			
3	2	3	2	2							2			
4		1	1						2		1			
5				2	2			1			1			
6				2	2			1			1			

Course Content	
Introduction to Engineering Drawing Principles of Engineering Graphics and their significance, Freehand sketching, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute.	6 Hours
Orthographic and Isometric Projections Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes; Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.	6 Hours
Overview of Computer Graphics Listing the computer technologies that impact on graphical communication, Isometric Views of lines, Planes, Simple and compound Solids, Coordinates system - Absolute Coordinates, Relative Coordinates, Polar Coordinates.	6 Hours
Customization & CAD Drawing Setting up modules and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Isometric Projections and Solids.	6 Hours
Annotations, layering & other functions Layers to create drawings, create, edit and use customized layers; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and projecting the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Part editing	4 Hours

and two-dimensional documentation of models, Shape extractions (Freeform modelling). Planar projection theory includes sketching of perspective, isometric, Multiview, auxiliary, and section views. Spatial visualization exercises – Transformation, Rendering and Lighting. Geometry and topology of engineered components: Introduction to Additive manufacturing (AM); Exporting the 3D model.	8 Hours
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Theory	Tutorial	Practical	Project	Total
Hours: 30	Hours: 0	Hours: 30	Hours: 0	Hours: 60

Learning Resources

Textbooks

1. Dhawan, R. K. *A Textbook of Engineering Drawing*. S. Chand Publishing (2019).
2. Bhatt N.D., Panchal V.M. & Ingle P.R., *Engineering Drawing*, Charotar Publishing House (2014).
3. Shah, M.B. & Rana B.C. *Engineering Drawing and Computer Graphics*, Pearson Education (2008).

Reference books

1. Agrawal B. & Agrawal C. M. (2012), *Engineering Graphics*, TMH Publication
2. Narayana, K.L. & P Kanniah (2008), *Textbook on Engineering Drawing*, Scitech Publishers.

Online Resources (Weblinks)

1. <https://www.youtube.com/watch?v=8UKg928M4C0>
2. <https://www.youtube.com/watch?v=JvsJf1huMXQ>
3. <https://www.youtube.com/watch?v=8lHEizPf-wY>

Assessment (Embedded course)

CAT, 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. G. Vergin Vino Design Engineer TANCAM, Chennai	Dr. V. Prabhuraja Professor, Department of Mechanical Engineering PSG College of Technology, Coimbatore	Dr. Samuel Ratna Kumaar Assistant Professor – III Department of Mechanical Engineering
Recommended by BoS on	17.08.2024	
Academic Council Approval	No: 27	Date 24.08.2024

24HSP111	HOLISTIC WELLNESS-1	L	T	P	J	C
		0	0	2	0	1
HS	(Common to all Department)	SDG		2, 3		

Pre-requisite courses	-	Data Book / Code book (If any)	-
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Course Objectives:

The purpose of taking this course is to:

1	introduce first-year students to the foundational concepts of holistic wellness, emphasizing the integration of physical, mental, emotional, and Internal well-being.
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2	create a balanced lifestyle that promotes overall health and happiness through practical activities.
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Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	understand the basic principles of holistic wellness.	U
CO 2	apply strategies for maintaining physical health, including nutrition and exercise	Ap
CO 3	practice mindfulness techniques to enhance mental and emotional well-being.	Ap
CO 4	develop a personal wellness plan incorporating various aspects of holistic health.	C

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1						2		1						
2						2								
3						1					3			
4						2					3			

Course Content	
INTRODUCTION TO HOLISTIC WELLNESS: <ul style="list-style-type: none"> Overview of holistic wellness: physical, mental, emotional, and internal health. The importance of balance in overall well-being. Hands-on activity: Self-assessment of current wellness status. 	4 Hour
PHYSICAL WELLNESS: <ul style="list-style-type: none"> Importance of physical activity and exercise. Understanding nutrition and its role in health. Sleep hygiene and its impact on well-being. Hands-on activity: Designing a personalized fitness and nutrition plan. 	14 Hours
MENTAL AND EMOTIONAL WELLNESS: <ul style="list-style-type: none"> Stress management techniques. The role of Yoga, mindfulness and meditation in mental health. Emotional intelligence and its impact on relationships. Hands-on activity: Practicing Yoga, mindfulness and emotional regulation exercises. 	6 Hours
INTERNAL WELLNESS: <ul style="list-style-type: none"> Exploring the concept of Internal wellness. The role of purpose and meaning in life. Introduction to meditation and reflective practices. Hands-on activity: Developing a personal reflection, Yoga and meditation routine. 	4 Hours
INTEGRATING WELLNESS PRACTICES: <ul style="list-style-type: none"> Combining physical, mental, emotional, and Internal wellness practices into daily life. 	2 Hours

<ul style="list-style-type: none"> Developing a balanced wellness plan. Hands-on activity: Creating a comprehensive personal wellness plan. 					
Theory Hours:	0	Tutorial Hours:	0	Practical Hours:	30
				Project Hours:	0
					Total Hours: 30

Learning Resources

Textbooks:

- Jayanna, Krishnamurthy., Science & Practice of Integrative Health & Wellbeing Lifestyle., White Falcon Publishing (2020).
- Rosenberg, Marshall Bertram., Nonviolent Communication: A Language of Life., Puddle Dancer Press, Encinitas, CA (2015).

References:

- B.K.S Iyengar., Yoga: The Path to Holistic Health., Dorling Kindersley Limited, City of Publication (2001)
- Goleman Daniel., Emotional Intelligence., Bloomsbury India, India, (2021).
- James Allen., As a Man Thinketh., Maple Press, Noida, (2010)
- Swami Budhanandha., Will power and its development., Advaita Ashrama Mayavati, Pithoragarh, Himalayas from its Publication Department, Calcutta. (2001)
- Kalderdon Adizes Ichak., What Matters in Life: Lessons I Learned from Opening My Heart ., WS Press, Newtown, PA (2023)

Online Resources (Weblinks)

- [Learning Suryanamskar](#)
- [Yoga for well-being](#)
- [Nutritional Educational contents](#)
- [Introduction to Psychology](#)
- [Guided Meditation](#)
- [Simplified physical exercises instructions](#)
- [Simplified Physical Exercises](#)
- [Life skills and value education](#)
- [James Allen Library](#)

Assessment (Practical course)

Participation, Practical activities and assignments, personal wellness plan and reflection.

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. Ezhilarasi Principal- KCT
Recommended by BoS on	16.08.2024	
Academic Council Approval	No: 27	Date 24.08.2024

24INP101	DESIGN THINKING (Common to all Department)	L	T	P	J	C
		0	0	2	0	1
ES		SDG	9			
Pre-requisite courses	-	Data Book / Code book (If any)		-		

Course Objectives:	
The purpose of taking this course is to:	
1	introduces first-year engineering students to Design Thinking, focusing on practical, user-centered problem-solving techniques
2	empathize with users, generate ideas, and create models to test and refine their solutions
3	understand iteration, empathy, and critical reflection to cultivate a creative mindset

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	apply problem-solving techniques and the Design Thinking process to engineering problems using simple models	Ap
CO 2	understand user needs through various empathy techniques and develop/refine models iteratively based on user insights.	U
CO 3	reflect critically on their learning journeys and the emotional demands of problem-solving. Collaborate effectively in teams to develop innovative solutions	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11			
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2	PSO-3
1	1		2			2		2			1			
2	1							2			1			
3	1		2			2		1			1			

Course Content	
<p>Introduction to Problem Solving and Ground Rules Introduction to problem-solving strategies without mentioning Design Thinking-Emphasize problem-solving attitudes, mindsets, and behaviours necessary for iterative problem solving (e.g., openness to failure, patience, empathy)-Set ground rules for the course, including incentives for creative risk-taking and penalties for non-participation or lack of reflection-Overview of the Design Thinking process and its importance.</p>	6 Hours
<p>Empathy and Problem Definition Techniques for understanding user needs, including observation, interviews, surveys and focus groups-Importance of secondary research as a complement for the above-mentioned methods-Introduction to empathy cycles: involve students in two empathy cycles before and after problem definition-Finetuning problem definition based on user insights.</p>	6 Hours
<p>Ideation and Concept Modelling Brainstorming ideas and selecting feasible solution-Creating concept modelling to visualize ideas-Include an empathy cycle after students propose solutions, allowing them to revisit and reshape their solutions based on further insights from users.</p>	6 Hours
<p>Prototyping and Testing with Models Building basic prototypes using simple materials (e.g., cardboard, clay)- Introduction to different prototyping methods (e.g., low-fidelity vs high-fidelity models) for different contexts: product design, space design, policy, and digital/e-commerce solutions-Conduct</p>	6 Hours

an empathy cycle after the prototype is developed to gather user feedback and refine the prototype.	
Iteration and Final Modelling Project Students refine their prototypes based on feedback from the empathy cycle-Finalize prototypes for presentation based on consistent feedback loops.	6 Hours
Presentation, Reflection, and Learning Summaries Students present their final projects and reflect on their learning journeys, including how their understanding of problem-solving and empathy evolved during the course- Learning Summary Activity: Each student presents their individual journey and learning outcomes from the empathy cycles and iterations-Peer review and group discussions.	6 Hours

Theory Hours: 0	Tutorial Hours: 0	Practical Hours: 30	Project Hours: 0	Total Hours: 30
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Learning Resources

Textbooks:

1. Handbook of Design Thinking, Christian Muller – Roterberg, Kindly Direct Publishing
2. The Art of Innovation, Tom Kalley
3. **E Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna Book Publishing Company**

Online Resources (Weblinks)

1. [Survey and focus group design guides](#)
2. [Guidance on Designing, Administering and Analyzing Focus Groups and Interviews](#)
3. [Empathy mapping tools](#)
4. [How to Make a Concept Model](#)
5. [Brainstorming Techniques: 15 Creative Activities](#)
6. [10 Brainstorming Techniques for Developing New Ideas](#)
7. [Brainstorming templates](#)
8. [5 Common Low-Fidelity Prototypes and Their Best Practices](#)
9. [UX Prototypes: Low Fidelity vs. High Fidelity](#)
10. [Low-fidelity vs. High-fidelity Design Prototypes \(and when to use which\)](#)
[Case study 1: Iterative Design and Prototype Testing of the NN/g Homepage](#)
[Case study 2: Using iterative design to optimise the user flow of a product](#)
11. [Reflective practice toolkit](#)

Assessment

Formative: Assignments, Mini project

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)
		Dr. Padhmanand Sudhagar R Department of Bio-Tech Dr. Arul H Department of Physics
Recommended by BoS on	16.08.2024	
Academic Council Approval	No: 27	Date 24.08.2024

SEMESTER II

	To know agriculture and irrigation technology. Understanding Scientific Tamil and Computer Tamil.	
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*** Course Outcomes should be clear, measurable, aligned with broader educational objectives, and focused on developing essential engineering skills while preparing students for future challenges in the field

COs: Embedded (3 to 4 credits): -6., Theory only- 5, Micro-credentials - 3, lab only – 3, project – 4

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

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1	2		2				3	2	2		2			
2	2		2				3	2	2		2			
3	2		2				3	2	2		2			

Course Content	
<p>I: [Faded text]</p> <p>Weaving Industry during Sangam Age - Ceramic technology - Black and Red Ware Potteries (BRW)-Graffiti on Potteries.</p>	3Hours
<p>II: [Faded text]</p> <p>Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo-Saracenic architecture at Madras during British Period.</p>	3Hours
<p>III: [Faded text]</p>	

<p>ஊர்ப்புறம், கட்டிடக்கலை, கட்டிடக்கலை, கட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலைகட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலை.</p> <p>Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel-Copper and gold- Coins as source of history - Minting of Coins - Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.</p>	3Hours
<p>IV: கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலை:</p> <p>கட்டிடக்கலை, கட்டிடக்கலை, கட்டிடக்கலை, கட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை- கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை- கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலைகட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை.</p> <p>Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoempu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries - Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.</p>	3Hours
<p>V: கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை:</p> <p>கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை.</p> <p>Development of Scientific Tamil - Tamil computing-Digitalization of Tamil Books- Development of Tamil Software - Tamil Virtual Academy - Tamil Digital Library - Online Tamil Dictionaries - Sorkuvai Project.</p>	3Hours

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

Reference books/ Web Links
<p>TOTAL: 15 PERIODS</p> <p>TEXT-CUM-REFERENCE BOOKS</p> <ol style="list-style-type: none"> 1. கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை (கட்டிடக்கலை: கட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை). 2. கட்டிடக்கலை கட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலை. (கட்டிடக்கலை கட்டிடக்கலை). 3. கட்டிடக்கலை - கட்டிடக்கலை கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை கட்டிடக்கலை (கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை). 4. கட்டிடக்கலை - கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை. (கட்டிடக்கலைகட்டிடக்கலை கட்டிடக்கலை). 5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL- (in print) 6. Social Life of the Tamils The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies. 7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian> Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies). 8. The Contributions of the Tarnils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation> Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation> Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) - Reference Book.

Online Resources

- https://www.youtube.com/watch?v=Gp1ratX2sOE&list=PLtyn2o7hocf40PtPibRqJTf_dQL3eOtLI
- <https://www.youtube.com/watch?v=jteRvnNiD6w>

Assessment	
Formative	Summative
Assignments / Mini project), Quiz, Lab	CAT – II and End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)

Approved by: BoS Chairman	<i>B.ound</i> 16-08-2024
BoS Approval date:	16-08-2024

Course Code : 24HST103	Effective Communication	L	T	P	J	C
Course Category : Theory		2	0	0	0	2
		SDG	4 & 8			

Pre-requisite courses	NIL	Data Book / Codes / Standards (If any)	NIL
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Course Objectives**:	The purpose of taking this course is to:
1	To enhance students' abilities to communicate ideas effectively, both orally and in writing, by developing skills in organizing thoughts clearly and logically and expressing them through well-structured paragraphs and concise summaries.
2	To enable students to critically evaluate and synthesize information from multiple sources and utilize suitable writing techniques and formats to produce professional-quality content tailored to various contexts.
3	To foster active listening, critical reading, and reflective thinking, empowering students to create engaging, relevant, and informative content by applying effective communication strategies across diverse platforms.

Course Outcomes***:		Bloom's Taxonomy Level (BTL)
After successful completion of this course, the students shall be able to		
CO 1	Demonstrate proficiency in delivering ideas effectively, both in speaking and writing, with a deeper understanding of the content and the ability to convey complex ideas through well-structured paragraphs and summaries.	K3
CO 2	Create and present original content by evaluating information from multiple sources and employing appropriate formats and writing strategies across various professional contexts.	K6
CO 3	Produce engaging and informative content through active listening, reading, reflection, and effective communication skills.	K5

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11			
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
												PSO-1	PSO-2	PSO-3
1							2	2	3		3			
2							2	2	3		3			
3							2	2	3		3			

Course Content	
Text Analysis Composition of Coherent Paragraphs (Expository, Descriptive, Narrative, Evaluative) - Loud Reading (Reading Extracts will be given where students identify the main idea of paragraphs or sections and debrief)	6 Hours
Visual & Written Analysis Process writing (Drafting effective introduction, process and conclusion using appropriate transition words and phrases) - Describing Visuals (Line graph, Bar Chart, Flow Chart, Pie Chart, Table, Tree diagram) - Note Making & Summarizing	6 Hours
Professional Correspondence Crafting Professional Emails - Writing Instruction for Manuals - Reading technical documents (Reading extracts will be given to construct sentences from the new words found in the document)	6 Hours
Research and Documentation Library Reading (Identify at least three sources and extract information, Summarize the main ideas and key findings from each source, compile their findings into a brief report that includes the main points, sources, and relevance)	6 Hours

to the topic)- Report Writing (Title Page, Abstract, Introduction, Methodology, Results, Discussion, Conclusion and recommendation)	
Talk Analysis and Podcast Skills Listening to and analyzing TED talks – Preparing Podcast-PRISM (Professional Rhetoric Improvement and Speech Mastery) to share facts, opinions and experiences - Writing Reviews on products.	6 Hours

Theory Hours:30	Tutorial Hours:-	Practical Hours:-	Project Hours:-	Total Hours:30
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Learning Resources*
Textbooks
Reference books/ Web Links
<ol style="list-style-type: none"> Swamy, V. R. Narayana. Strengthen Your Writing. Orient Longman, 2003. Sasikumar, V., and P. V. Dhamija. Spoken English: A Self-Learning Guide to Conversation Practice. Tata McGraw Hill, New Delhi (1993). Maison, Margaret M. Examine Your English. Orient Longman, 1999. Rizwi, Ashraf. Effective Technical Communication. Tata McGraw Hill, 2005. Pickett, Nell Ann, and Ann A. Laster. Technical English: Writing, Reading, and Speaking. Harpercollins College Div, 1993.
Online Resources
<ol style="list-style-type: none"> https://owl.purdue.edu/owl/general_writing/academic_writing/paragraphs_and_paragraphing/index.html https://learnenglish.britishcouncil.org/skills/writing/upper-intermediate-b2/describing-trends https://hbr.org/2016/07/how-to-write-email-with-military-precision https://owl.purdue.edu/owl/subject_specific_writing/professional_technical_writing/reports_and_memos/index.html

Assessment	
Formative	Summative
Assignments	CAT- I, CAT – II and End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)
Mr.Vijayan Ramanathan , Project manager, Toppan Merrill. Technologies, Coimbatore	Dr. Aninditha Sahoo, IIT, Madras Dr.P.R.Sujatha Priyadharshini, Anna University Chennai Dr. E. Justin Ruben, CIT, Coimbatore	Faculty members of the Department of Languages and Communication

Approved by: BoS Chairman	<i>Bond</i>
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	16.08.2024
BoS Approval date:	16.08.2024

Course Code : 24HST104	Professional Communication	L	T	P	J	C
Course Category : Theory		2	0	0	0	2
		SDG		4 & 8		

Pre-requisite courses	NIL	Data Book / Codes / Standards (If any)	NIL
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Course Objectives**:	The purpose of taking this course is to:
1	To develop students' abilities to craft clear, concise, and well-structured technical content and professional communications
2	To enhance students' communication skills in team settings
3	To equip students with cross-cultural communication skills and effective listening techniques

Course Outcomes***:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Demonstrate proficiency in crafting clear, concise, and well-structured technical content and professional communications, including emails that meet industry standards.	K3
CO 2	Communicate effectively in team settings, showcasing collaboration, conflict resolution, and leadership skills, while employing creative writing techniques to convey complex ideas.	K4
CO 3	Apply principles of cross-cultural communication and effective listening techniques to engage successfully in diverse, globalized professional environments.	K3

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1							1	3	1		3			
2						2	3	3	2		3			

3						1	1	3	1		3			
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Course Content	
Mastering Professional Communication Industry-specific terminology (Business / Technical Register) - Crafting professional emails - Essential elements of an effective email (subject line, salutation, body, closing) - reading and responding to email communication – Networking Emails - Analyzing and interpreting technical texts (Loud Reading).	6 Hours
Navigating Digital Media Introduction to Digital media and online communication tools (instant messaging, video conferencing, social media, blogs, forums) - Listening and analyzing advanced audio materials - Creative & Blog Writing (General & Technical).	6 Hours
Technical Writing Techniques Writing Reflective Essays / Experience Sharing, Process writing, Transcoding graphics (interpreting technical texts), Writing Reviews (Research Articles & Books).	6 Hours
Building a Professional Digital Presence Creating Digital Profile - Overview of different digital platforms (LinkedIn, GitHub, personal websites) - Setting Up a LinkedIn Profile – Crafting a Video Resume – Digital Etiquette and Professionalism - Cross-cultural communication and diversity awareness.	6 Hours
Social Responsibility in Practice Environmental and social responsibilities - Case studies and real-world applications - Project Work - Writing Project reports.	6 Hours

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

Learning Resources*
Textbooks
Reference books/ Web Links
1. Baker, W., & Ishikawa, T. Transcultural Communication Through Global Englishes: An Advanced Textbook for Students. Routledge, 2021. 2. Bodnar, O., Fedak, S., Hinsirowska, I., Denysiuk, N., Perenchuk, O., Plavutska, I., ... & Shchur, N. English for Study and Work: A Coursebook In-class Activities. 2017. 3. Doff, A., Thaine, C., Puchta, H., Stranks, J., & Lewis-Jones, P. Cambridge English Empower Advanced Student's Book. Cambridge University Press, 2016. 4. Hewings, M., Thaine, C., & McCarthy, M. Cambridge Academic English C1 Advanced Student's Book: An Integrated Skills Course for EAP. Cambridge University Press, 2012. 5. Beer, D. F., & McMurrey, D. A. A Guide to Writing as an Engineer. John Wiley & Sons, 2019.
Online Resources
1. https://hbr.org/2016/07/how-to-write-email-with-military-precision 2. https://ocw.mit.edu/courses/comparative-media-studies-writing/21w-732-scientific-and-technical-communication-spring-2015/ 3. https://www.coursera.org/learn/digital-media 4. https://owl.purdue.edu/owl/subject_specific_writing/professional_technical_writing/reports_and_memos/index.html

Assessment	
Formative	Summative
Assignments	CAT- I, CAT – II and End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)
Mr.Vijayan Ramanathan , Project manager, Toppan Merrill. Technologies, Coimbatore	Dr. Aninditha Sahoo, IIT, Madras Dr.P.R.Sujatha Priyadharshini, Anna University Chennai Dr. E. Justin Ruben, CIT, Coimbatore	Faculty members of the Department of Languages and Communication

Approved by: BoS Chairman	<i>BOS</i>
	16.08.2024
BoS Approval date:	16.08.2024

Course Code : 24HSJ102	Fluency Through Practice	L	T	P	J	C
		0	0	0	4	2
Course Category:		SDG		4,9,12,17		

Pre-requisite courses	NIL	Data Book / Codes / Standards (If any)	
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Course Objectives**:	The purpose of taking this course is to: (3 to 5)
1	To develop professional communication skills, including technical writing, public speaking, and collaborative discourse.
2	To foster creativity and critical thinking by producing real-world academic and professional outputs such as book chapters, journal articles, and intellectual property.
3	To instill awareness of global and ethical communication practices, contributing to sustainability and social impact.
4	To enhance students' language fluency through project-based learning relevant to engineering

Course Outcomes***:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Analyze and apply effective communication techniques in professional contexts.	Analysis
CO 2	Collaborate in teams to design and execute language-based projects with real-world applications.	Apply
CO 3	Develop critical thinking and problem-solving skills through research, analysis, and presentation of technical content.	Analysis
CO 4	Produce publishable-quality written and spoken outputs, such as book chapters, journal articles, and copyrighted content.	Create

	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11			
Course Outcomes (CO)	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2	PSO-3
1		2	2	1			3	2	2	1	2			
2		3	2	1			3	2	2	1	2			
3		2	2	2			3	2	2	1	2			
4		3	1	1			3	2	2	1	1			

<u>Course Content</u>	
Introduction to Activity Based Learning Research and Initial Project Planning Technical Writing and Documentation Creative Writing Drafting and Editing Techniques Teamwork and Peer Collaboration	60

Public Speaking and Presentation Skills Common pitfalls and improvements Cross-Cultural Communication and Global Ethics Intellectual Property and Copyrighting Publication – English for research Writing Digital Communication & Social Responsibility	
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Theory Hours:	Tutorial Hours:	Practical Hours:	Project Hours: 60	Total Hours: 60
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Learning Resources*
Textbooks
3.
Reference books/ Web Links
<ol style="list-style-type: none"> 1. Mahesh Kumar, Dr.Soma. Soft Skills: Enhancing Personal and Professional Success, McGraw Hill, 2023. 2. Maxwell, John C. Developing the leader within you, HarperCollins, 2018. 3. Ansarian, Loghman, and Teoh, Mei Lin. Problem-based Language Learning and Teaching: An Innovative Approach to Learn a New Language. Singapore, Springer Nature Singapore, 2018. 4. Savin Baden, M., Major, C. H. (2004). Foundations of Problem Based Learning. United Kingdom: McGraw-Hill Companies, Incorporated.
Online Resources
https://www.sciencedirect.com/science/article/pii/S2590291123002735 https://www.cal.org/adultesl/pdfs/problem-based-learning-and-adult-english-language-learners.pdf https://www.apu.ac.jp/rcaps/uploads/fckeditor/publications/polyglossia/Polyglossia_V16_Ng.pdf

Assessment		
Assessment Component	Weightage (%)	Details
Project Proposal and Research Summary	10%	Initial research plan and summary of ideas.
Mid-Semester Progress Review (Presentation)	15%	Presentation on project progress, reviewed by peers and faculty.
Final Project Review (Presentation)	15%	Presentation on project progress, reviewed by peers and faculty.
Public Speaking Evaluation	15%	Evaluation based on public speaking workshops and final project presentation.
Technical Writing and Documentation	15%	Submission of book chapters or technical documents with focus on professional communication.
Final Project Submission (Book/Article/Podcast/ Videos Etc)	30%	Submission of final written project—book chapters, articles, or copyrighted material.

Course Curated By		
Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)

Mr.Vijayan Ramanathan , Project manager, Toppan Merrill. Technologies, Coimbatore	Dr. Aninditha Sahoo, IIT, Madras Dr.P.R.Sujatha Priyadarshini, Anna University Chennai Dr. E. Justin Ruben, CIT, Coimbatore	Faculty members of the Department of Languages and Communication
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Approved by: BoS Chairman	<i>Bond</i>
	16.08.2024
BoS Approval date:	16.08.2024

24MAI122	ADVANCED COMPUTATIONAL CALCULUS (Common to BT, FT, TT)	L	T	P	J	C
		3	0	2	0	4
BS		SDG		3, 9, 12		
Pre-requisite courses	-	Data Book / Codes books (If any)			-	

Course Objectives:	
The purpose of taking this course is to:	
1	apply Taylor's series expansion to approximate functions of two variables and use Lagrange's method of undetermined multipliers for optimizing such functions.
2	develop proficiency in solving higher-order linear differential equations with constant coefficients using numerical techniques such as Taylor's series and Runge-Kutta methods.
3	set up and evaluate double and triple integrals in cartesian coordinates for calculating areas and volumes of various two- and three-dimensionl regions.
4	attain expertise in using numerical methods such as Trapezoidal and Simpson's rules to evaluate double and triple integrals for areas and volumes when analytical solutions are difficult.
5	examine and apply Laplace transforms to solve differential Equations to represent dynamic systems across different engineering fields.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	apply Taylor's series expansion to approximate stress distribution in textile materials under varying load conditions.	Ap
CO 2	use Lagrange's method to optimize dyeing processes in fashion industry to minimize cost while meeting color consistency constraints.	Ap
CO 3	apply Runge-Kutta methods to model and predict the growth rates of microbial populations in biotechnology applications.	Ap
CO 4	use Euler's method to solve heat conduction problems in textile manufacturing processes for better thermal management.	Ap
CO 5	evaluate the volume of fabric needed for complex garment patterns using triple integrals to ensure accurate material estimation.	E
CO 6	solve differential equations for the response of biosensors to varying stimuli using Laplace transforms to improve sensor design.	Ap

Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)
1	2	3	4	5	6	7	8	9	10	11	

Course Outcomes (CO)	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2	PSO-3
1	3	3	2	1	2	1	1	2						
2	2	3	3	1	2	2	1	2						
3	2	3	2	3	2	1	1	2						
4	2	3	2	2	2	1	1	2						
5	2	2	3	1	2	1	1	2						
6	2	3	2	3	3	2	1	2						

Course Content	
<p>FUNCTIONS OF SEVERAL VARIABLES Total derivatives – Differentiation of composite functions – Taylor’s series expansion – Maxima and minima of functions of two variables – Lagrange’s method of undetermined multipliers</p> <p>Practical Component</p> <ul style="list-style-type: none"> Taylor’s series expansion of function of two variables. Maxima and Minima of a function of two variables. 	<p>9 Hours</p> <p>6 Hours</p>
<p>HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS Linear equations of second and higher order with constant coefficients – Rules and Problems for finding the particular integral – Initial value problems - Single step methods: Taylor’s series method – Truncation error – Euler and Improved Euler methods – Fourth order Runge–Kutta method</p> <p>Practical Component</p> <ul style="list-style-type: none"> Solution of second order ordinary differential equations by Euler and improved Euler method. Solution of second order ordinary differential equations by Runge Kutta method of 4th order. 	<p>9 Hours</p> <p>6 Hours</p>
<p>MULTIPLE INTEGRALS Double integration in Cartesian coordinates – Area as double integrals-Triple integration in Cartesian coordinates – Volume as triple integrals – Numerical double integration – Trapezoidal rule – Simpson’s rule.</p> <p>Practical Component</p> <ul style="list-style-type: none"> Area and volume using multiple integrals. Numerical double integration by Trapezoidal and Simpson’s rule 	<p>9 Hours</p> <p>6 Hours</p>
<p>LAPLACE TRANSFORMS Definition - Properties: Superposition, Shift in t or Time Delay, Shift in s, Time Derivatives, Time Integral- Initial Value Theorem - Final Value Theorem.</p> <p>Practical Component</p> <ul style="list-style-type: none"> Solution of transcendental functions using Laplace transforms. Heaviside functions 	<p>9 Hours</p> <p>6 Hours</p>
<p>INVERSE LAPLACE TRANSFORMS Definition - Properties -Inverse transforms using convolution method and partial fractions method -Solution of linear ordinary differential equations of second order with constant coefficients.</p> <p>Practical Component</p> <ul style="list-style-type: none"> Inverse Laplace Transforms. Solution of differential equations using inverse Laplace transform. 	<p>9 Hours</p> <p>6 Hours</p>

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 30	Project Hours: 0	Total Hours: 75
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Learning Resources

Textbooks

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2014.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Sastry S.S., "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.
4. Grewal B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science, Khanna Publishers, 10th Edition, New Delhi, 2015.

Reference books

1. Veerarajan T., "Engineering Mathematics (for First Year)", Tata McGraw Hill Pub. Co. Ltd., New Delhi, Third Edition, 2011.
2. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics", S. Chand & Co., New Delhi, (Reprint) 2014.
3. Kandasamy P., Thilagavathy K. and Gunavathy K., "Numerical Methods", S. Chand Co. Ltd., New Delhi, 2007.

Online Resources (Weblinks)

1. <https://www.khanacademy.org/math/integral-calculus>

Assessment

CAT, 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. Mr. Jayakumar Venkatesan, Valles Marineris International Private Limited- Chennai. Mr. Imran Khan, GE Transportation Company, Bangalore.	Dr. T. Govindan, Government College of Engineering, Srirangam, Trichy. Dr. C. Porkodi, PSG College of Technology, Coimbatore. Dr. P. Paramanathan, Amrita Vishwa Vidyapeetham, Coimbatore.	Dr. R.Maruthachalam Dr.S.Sathiyapriya Ms. S.Arunadevi Department of Mathematics	
Recommended by BoS on	16.08.2024		
Academic Council Approval No.	27	Date	24.08.2024



(Signature of BoS Chairperson)

24PHI105	FOUNDATIONAL PHYSICS FOR BIO-TECHNOLOGY	L	T	P	J	C
		3	0	2	0	4
Embedded		SDG		9		

Pre-requisite courses	High School Education	Data Book / Codes / Standards (If any)	
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Course Objectives:	The purpose of taking this course is to:
1	provide students with a comprehensive understanding of fundamental concepts in crystallography, applied optics, quantum physics, green energy, and heat transfer, and their applications in solving engineering problems.
2	develop students' practical skills through hands-on experiments, enabling them to effectively conduct measurements, analyse data, and apply theoretical knowledge to real-world scenarios.
3	integrate theoretical knowledge with practical laboratory skills, preparing students to tackle complex challenges and advance in fields related to physics and engineering.


Course Outcomes***:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Apply crystallography principles to analyze material structures and solve engineering problems.	Ap
CO 2	Apply optics and spectroscopy techniques to conduct experiments and analyze data for biotechnology and medical diagnostics.	Ap
CO 3	Apply quantum concepts in experiments to determine Planck's constant and particle size	Ap
CO 4	Evaluate green energy systems' efficiency through theory and practical experiments, like measuring solar cells.	E
CO 5	Analyze heat transfer and fluid properties, and apply this in lab experiments to determine thermal conductivity.	An
CO 6	Apply optics, quantum physics, green energy, and physics methods to design practical solutions in experimental setups	Ap

	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)	Program
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<ol style="list-style-type: none"> 1. DiMarzio, Charles A., Optics for Engineers., CRC Press, Boca Raton (2024). 2. Shih, Yanhua., An Introduction to Quantum Optics: Photon and Biphoton Physics., CRC Press, Boca Raton (2021). 3. Gerry, Christopher C., and Knight, Peter L., Introductory Quantum Optics., Cambridge University Press, Cambridge (2023).
Online Resources
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/113106106 2. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2013/ 3. https://www.coursera.org/learn/renewable-energy

Assessment	
Formative	Summative
Assignments / Mini project), Quiz, Lab	CAT- I, CAT – II and End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)
		[Dr.E.Shobhana & Dr.S.Inbakumar, Physics]

Approved by: BoS Chairman	
BoS Approval date:	16-08-2024

24BTI103	BIOCHEMISTRY AND CELLULAR ENERGETICS	L	T	P	J	C
		3	0	2	0	4

Course Outcomes (CO)	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team	Communication	Project Management and Finance	Life-Long Learning	PSO1	PSO2
1	3	3									3	2	2
2	3	3									3	3	3
3	3	3									3	3	3
4	3	3									3	3	3
5	3	3									3	3	3
6	3	3			3			3	3		3	3	3

Course Content	
<p>METABOLISM OF CARBOHYDRATES Glycolysis; Homolactate fermentation in skeletal muscle; Alcohol fermentation in yeast; Pyruvate oxidation; Citric acid cycle (TCA cycle); HMP shunt; Glycogenolysis; Feeder pathways for glycolysis; Calculation of energetics of glucose (aerobic and anerobic conditions); Regulation of glycolysis (overview); Regulation of glycogenolysis (overview); Regulation of citric acid cycle (overview). Entner – Doudoroff (ED) pathway, Phosphoketolase (PK) pathway. Glycogenesis; Gluconeogenesis; Regulation of glycogenesis (overview); Regulation of gluconeogenesis (overview).</p> <p>Practical Component (Any three experiments, excluding DEMO)</p> <ol style="list-style-type: none"> 1. Handling of pipettes (glass and micro), calculation and preparation of working standard solutions, and laboratory safety protocol (DEMO) 2. Qualitative analysis of sugars (glucose, fructose, maltose, sucrose and starch) 3. Quantification of free reducing sugars by 3,5 – DNS assay 4. Determination of glucose level using a kit-based assay 5. Determination of hexokinase activity (manual or kit-based assay) 	<p>13 Hours</p> <p>9 Hours</p>
<p>CATABOLISM OF FATTY ACID β – oxidation of fatty acid (even chain) – activation, transport into mitochondrial membrane via carnitine, oxidation; Oxidation of odd chain fatty acid (propionyl CoA to succinyl CoA); Highlights of peroxisomal β – oxidation (structures NOT needed); Calculation of energetics of fatty acid (even chain); Regulation of fatty acid oxidation (overview).</p> <p>Practical Component</p> <ol style="list-style-type: none"> 1. Determination of triglycerides by kit-based assay 	<p>6 Hours</p> <p>3 Hours</p>
<p>ANABOLISM OF FATTY ACID, LIPID AND CHOLESTEROL Ketogenesis - formation of acetoacetate and β -hydroxybutyrate; Biosynthesis - Fatty acid, triacylglycerol and cholesterol; Regulation of syntheses - fatty acid, triacylglycerol and cholesterol (overview).</p>	<p>7 Hours</p>

Practical Component (Any ONE experiment) <ol style="list-style-type: none"> 1. Estimation of free cholesterol by kit-based assay 2. Quantification of sterols by Libermann – Burchard method 	3 Hours
METABOLISM OF AMINO ACIDS AND NUCLEOTIDES Amino acid catabolism -Transamination, oxidative deamination and urea cycle; Interconnection between urea and citric acid cycles (structures NOT needed , a circuit diagram is sufficient); Summary of amino acid catabolism (structures NOT needed , a circuit diagram is sufficient); Regulation of urea cycle; Biosynthesis of purines (De novo pathway for AMP & GMP) and pyrimidines (CTP); Conversion of ribonucleotides to deoxyribonucleotides (structures NOT needed , a circuit diagram is sufficient); Regulation of purine synthesis	10 Hours
Practical Component (Any FOUR experiments) <ol style="list-style-type: none"> 1. Estimation of total protein content by Lowry’s method 2. Quantification of total protein content by Biuret method 3. Quantification of urea by Berthlot method (Kit-based assay) 4. Quantification of DNA using the UV spectroscopy method 5. Estimation of DNA by the diphenylamine method 6. Estimation of RNA by the orcinol method 7. Determination of uric acid content by kit-based assay 	12 Hours
CELLULAR RESPIRATION Definitions – Gibbs free energy (G), enthalpy, entropy and standard free energy change (ΔG°); Example for conversion of a thermodynamically unfavorable to a favorable reaction; Chemical basis/ rationale for the large free energy change associated with ATP hydrolysis; List of high energy compounds; Electron transfer reactions in mitochondria; Chemiosmotic model for the synthesis of ATP; Highlights of binding change model of ATP synthase in the synthesis of ATP. Photophosphorylation.	9 Hours
Practical Component <ol style="list-style-type: none"> 1. Determination of ED₅₀ using an <i>in vitro</i> antioxidant assay 	3 Hours
Theory Hours: 45	Tutorial Hours: 0
Practical Hours: 30	Project Hours: 0
Total Hours: 75	

Learning Resources
Textbooks
<ol style="list-style-type: none"> 1. Satyanarayana, U., and U. Chakrapani. <i>Biochemistry</i>. 7/e. Elsevier India (2025). 2. Nelson, D. L., Michael M. Cox, and Aaron A. Hoskins. <i>Lehninger Principles of Biochemistry</i>. 8/e. W. H. Freeman and Company / Macmillan Learning (2021).
Reference books
<ol style="list-style-type: none"> 1. Heilman, D., Woski, S., Voet, D., Voet, J. G., & Pratt, C. W. <i>Fundamentals of Biochemistry</i>. 6th ed. John Wiley & Sons (2025). 2. Rodwell, V. W., Kennelly, P. J., Botham, K. M., & Weil, P. A. <i>Harper’s Illustrated Biochemistry</i>. 32nd ed. McGraw-Hill Education (2022). 3. Sadasivam, S., & Manickam, A. <i>Biochemical Methods</i>. 4th ed. New Age International Publishers (2022). 4. Shanmugam, S., Sathish Kumar, T., & Panneer Selvam, K. <i>Laboratory Handbook on Biochemistry</i>. 2nd ed. PHI Learning Pvt. Ltd. (2020).
Online Resources (Weblinks)
<ol style="list-style-type: none"> 1. https://ocw.mit.edu/courses/7-05-general-biochemistry-spring-2020/video_galleries/video-lectures/ 2. https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation

Assessment (Embedded course)
SA-I and SA-II, 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. M. Kannan Manager, Healthium Medtech Ltd Bengaluru, Karnataka, India.	Dr. J. Hema Associate Professor Department of Biotechnology PSG College of Technology Coimbatore.	Dr. T. Sathish Kumar, Department of Biotechnology
Recommended by BoS on	14.08.2024	
Academic Council Approval	No:27	Date 24.08.2024

24BTT104	CELL BIOLOGY				
	L	T	P	J	C
	3	0	0	0	3
PC	SDG		3,4		
Pre-requisite courses	24BBT101 Concepts of Biology	Data Book / Code book (If any)		-	

Course Objectives	
The purpose of taking this course is to	
1	Provide students with a comprehensive understanding of cellular structure and function.
2	Equip students with analytical skills to investigate cell proliferation, regulation through the cell cycle, apoptosis, and signalling pathways, enabling them to understand the molecular mechanisms governing cellular growth and homeostasis.
3	Educate students on subcellular components and cell signalling pathways.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Explain the chemical, physical, cellular foundations of life by relating carbon chemistry energy transformations entropy water properties and defining characteristics of living systems across the three domains of life	Ap
CO 2	Interpret the structural organization of major biomolecules-carbohydrates, lipids, proteins and nucleic acids and related their molecule futures to their biological functions in living systems	An

CO 3	Apply fundamental genetic principles to analyse inheritance patterns involving modified mendelian traits is sex-linked inheritance, and chromosomal disorders.	Ap
CO 4	Analyse major hypotheses and experimental evidence related to the origin and evolution of life, including prebiotic chemistry metabolic evolution RNA world and Endosymbiosis	An
CO 5	Integrate concepts from Molecular Biology, genetics and evolutionary biology to explain the continuity, diversity and adaptation of life forms at the cellular and organismal and levels.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Teamwork	Communication	Project Management and Finance	Life-Long Learning		
1	3	2											3
2	3	2					1						3
3	3	2		2									3
4	3	2		2									3
5	3	-			2						2	3	3
6													

Course Content	
CELL STRUCTURE AND ORGANIZATION Hierarchy of cells, tissues, organs, systems and organisms. Overview of cell theory: Distinction between prokaryotic and eukaryotic cells, Cell diversity in shape, size, and function; Cytoplasm: composition and functions. Structure and functions of cell organelles: Nucleus, Mitochondria, Golgi apparatus, ER, Ribosomes, chloroplast, peroxisomes, lysosome. Organelle biogenesis;	9 Hours
MEMBRANE DYNAMICS AND TRANSPORT MECHANISMS	9 Hours

Structure of Biological Membranes: Fluid mosaic model: Membrane asymmetry and fluidity: factors affecting fluidity, lipid rafts; Membrane proteins: integral, peripheral, and lipid-anchored proteins, Membrane Transport Mechanisms- Passive transport: diffusion, facilitated diffusion, osmosis; Active transport: primary and secondary active transport, Bulk transport: endocytosis (phagocytosis, pinocytosis, receptor-mediated) and exocytosis, Membrane.	
CELL CYCLE AND CELL DIVISION Overview of the Cell Cycle: Phases of the cell cycle: G1, S, G2, M phases. Regulation of cell cycle. Cell division – Binary fission, Mitosis and Meiosis and their differences: Apoptosis and cell differentiation	6 Hours
CELL COMMUNICATION AND SIGNAL TRANSDUCTION Types of cell signalling: autocrine, paracrine, endocrine, juxtacrine; Receptors: cell-surface receptors (GPCRs, RTKs) and intracellular receptors; Signalling molecules: ligands, second messengers (cAMP, Ca ²⁺ , IP ₃); Signal Transduction Pathways : G-protein-coupled receptor (GPCR) signalling: mechanism, examples, and regulation; GPCR based signal transduction – epinephrine, glucagon; Receptor tyrosine kinase (RTK) signal transduction – EGF, PDGF	12 Hours
TECHNIQUES IN CELL BIOLOGY & THERAPEUTIC APPLICATIONS Cell culture (Microbial, Plant, Animal) and maintenance, Enumeration of cells - flow cytometry; CRISPR-Cas9 and gene editing techniques; Single-cell RNA sequencing. Types of stem cells: Embryonic, adult, and induced pluripotent stem cells, Applications of stem cells in regenerative medicine; Stem cell banking and storage, Ethical considerations in stem cell research; Cell lines and their applications	9 Hours
Theory Hours: 45	Tutorial Hours: 0
Practical Hours: 0	Project Hours: 0
Total Hours: 45	

Learning Resources
Textbooks
<ol style="list-style-type: none"> 1. Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. <i>Molecular Biology of the Cell</i>, 7th ed. New York: W.W. Norton & Company, 2022. 2. Lodish, Harvey, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. <i>Molecular Cell Biology</i>, 9th ed. New York: W.H. Freeman, 2021/2022. 3. Karp, Gerald, Janet Iwasa, Wallace Marshall. <i>Cell and Molecular Biology: Concepts and Experiments</i>, 9th ed. Hoboken, NJ: Wiley, 2020. 4. Channarayappa. <i>Cell Biology</i>. Hyderabad: Universities Press (India) Pvt. Ltd., 2010
Reference books
<ol style="list-style-type: none"> 1. Cooper, Geoffrey M., and Robert E. Hausman. <i>The Cell: A Molecular Approach</i>. 8th ed. Sunderland, MA: Sinauer Associates/Oxford University Press, 2023 2. Pollard, Thomas D., William C. Earnshaw, Jennifer Lippincott-Schwartz, and Graham Johnson. <i>Cell Biology</i>. 4th ed. Philadelphia: Elsevier, 2023.
Online Resources (Weblinks)
<ol style="list-style-type: none"> 1. https://www.ncbi.nlm.nih.gov/books/NBK21054/ 2. https://www.nature.com/nrm/ 3. https://www.ascb.org/ 4. https://www.biointeractive.org/
Assessment (Theory Course)
SA-I, SA-II, 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. Harishankar MK Syngene International Limited.	Dr. Mukesh Doble, IIT Madras	Dr.K.Kumaravel Dr.T.Sathish Kumar Dr. Vinohar Stephen Rapheal	
Recommended by BoS on	14.08.2024		
Academic Council Approval	No:27	Date	24.08.2024

24INP103	INNOVATION PRACTICUM – II (Common to All branches)	L	T	P	J	C
		0	0	2	0	1
ES		SDG	9, 11, 12			
Pre-requisite courses	-	Data Book / Code book (If any)	-			

Course Objectives:	
The purpose of taking this course is to:	
1	equip students with essential tools and techniques for leveraging open-source technologies to develop proof-of-concepts and prototypes
2	provide hands-on experience and participants will gain a comprehensive understanding of the entire product development process
3	final prototyping, empowering them to transform their ideas into tangible outcomes

Course Outcomes		Revised Bloom's Taxonomy Levels (RBT)
After successful completion of this course, the students shall be able to		
CO 1	analyse the effectiveness of various electronic tools and techniques in product development processes	An
CO 2	develop and implement functional software prototypes using open-source tools	Ap
CO 3	design and fabricate 3D models using digital fabrication techniques	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)			
	1	2	3	4	5	6	7	8	9	10	11				
Engineering Knowledge															
Problem Analysis															
Design/Development of Solutions															
Conduct Investigations of Complex Problems															
Engineering Tool Usage															
The Engineer and The World															
Ethics															
Individual and Collaborative Team work															
Communication															
Project Management and Finance															
Life-Long Learning															
												PSO-1			
													PSO-2		
														PSO-3	

1	3	2	2	2	2									
2	2	2	2		2									
3	2	2	3	2	2									

Course Content

INTRODUCTION TO OPEN-SOURCE TOOLS AND TECHNIQUES

Explore the concept of open-source, its underlying principles and its contrast with proprietary software, Discuss the advantages of using open-source tools, such as lower costs, increased innovation, educational value, and community support, walk through to the commonly used open-source tools for electronics design (KiCad, FreeCAD), software development (Python, Eclipse), and fabrication (Cura, LinuxCNC).

3 Hours

ELECTRONICS FUNDAMENTALS AND TOOLS

Introduction to basic electronic components (resistors, capacitors, transistors, etc.), Understanding of electronic circuits and their functions, Hands-on practice with CircuitJS and Falstad, Simulating and analysing electronic circuits, Introduction to Arduino and Raspberry Pi, exploring their capabilities and applications, Designing PCBs using KiCad and EasyEDA, Understanding PCB fabrication processes

6 Hours

SOFTWARE PROTOTYPING AND TOOLS

Benefits of rapid prototyping in product development, Iterative design and testing, Wireframing tools (Balsamiq, Figma), UI design tools (Sketch, Figma), Programming languages (Python, JavaScript), Testing frameworks (Selenium), No-code platforms (Bubble, Adalo, Wix, AppGyver), Building functional prototypes without extensive coding

6 Hours

FABRICATION AND PROTOTYPING

Overview of fabrication techniques (3D printing, laser cutting, CNC machining), Prototyping methods for physical products, using tools like Blender, TinkerCAD, or Fusion 360, Creating 3D models for physical prototypes, Hands-on experience with laser cutting and engraving, Understanding their applications and limitations

7 Hours

SIMULATION & DEMONSTRATION

Integrated project demonstration, explaining the design process, technical choices, and outcomes, simulation showcase to demonstrate their understanding of various technical tools and prototyping techniques

8 Hours

Theory Hours:	0	Tutorial Hours:	0	Practical Hours:	30	Project Hours:	0	Total Hours:	30
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Learning Resources

Textbooks:

4. [Damir Godec, Joamin Gonzalez-Gutierrez, Axel Nordin, Eujin Pei, Julia Ureña Alcázar, A guide to additive manufacturing, Springer – 2022. https://doi.org/10.1007/978-3-031-05863-9](https://doi.org/10.1007/978-3-031-05863-9)
5. [Introducing SolidWorks, Dassault Systems.](#)

References:

19. [Insight into Electronics](#)
20. [Microcontroller Programming with Arduino and Python](#)
21. [Fundamentals of 3D modelling](#)

Online Resources (Weblinks)

3. Google Play store apps:
 - a. <https://play.google.com/store/apps/details?id=com.electronicslab>
 - b. <https://play.google.com/store/apps/details?id=it.android.demi.elettronica>
2. <https://engservices-ece.sites.olt.ubc.ca/files/2020/01/SolidWorks-3D-Printing-Tutorial-R2.pdf>

Assessment (Practical course)

Lab Workbook, Experimental Cycle tests, viva-voce

Course Curated by			
Expert from Industry	Expert(s) from Higher Education Institution	Internal Expert	
Dr. Mahesh Veezhinathan Director - Innovation Practicum Associate VP - Forge. Innovation	-	Dr. Samuel Ratna Kumar P S Assistant Professor – III Department Mechanical Engineering	
Recommended by BoS on	17.08.2024		
Academic Council Approval	No: 27	Date	24.08.2024

24CSI101	LOGICAL THINKING AND PROBLEM SOLVING (Common to all Programmes)	L	T	P	J	C
		3	0	2	0	4
ES		SDG	8, 9			
Pre-requisite courses	-	Data Book / Code book (If any)	-			

Course Objectives:	
The purpose of taking this course is to:	
1	gain a comprehensive understanding of computing systems, including their classification, processing units, memory structures, storage hierarchies, and the essential functions and types of operating systems
2	develop strong logical and analytical thinking skills, enabling the systematic analysis and solution of computational problems using reasoning techniques, algorithms, and flowcharts.
3	acquire a solid foundation in C programming, mastering the use of data types, operators, control structures, and input/output operations to create efficient and effective programs.
4	apply advanced programming techniques, including the use of arrays, structures, pointers, and functions, to solve complex real-world problems with a focus on modular and efficient coding practices.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	understand the basic concepts of hardware, software, Operating systems, and the logic behind the functioning of the Computing systems.	U
CO2	apply logical thinking and reasoning to solve computing problems using tools like algorithms and flowcharts.	Ap
CO3	understand the structured programming paradigms, memory organization and how the language can be used as a tool to solve problems.	U
CO4	develop simple programs using data types, operators, control structures, pointers, and functions as appropriate in real world applications.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11			
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2	
1	2													
2	3	2	1									3		
3		1										2		
4	3	2	1									3		

Course Content

FUNDAMENTALS OF COMPUTERS AND COMPUTING

Generations of computers, and classification of computers (supercomputers, mainframes, minicomputers, microcomputers). Processing Units (CPU, GPU, TPU), memory (RAM, ROM), storage devices and hierarchy, input / output and peripheral devices. System software, application software. Operating Systems - Functions (process management, memory management, file system management, device management, security), types of operating systems (desktop, mobile, networking, distributed, real-time, embedded). **Number Systems:** Introduction to different number systems (binary, octal, decimal, hexadecimal), conversions between number systems, and binary arithmetic (addition, subtraction, multiplication, division).

6 Hours

Practical Component

Exploring hardware and software components

4 Hours

LOGICAL THINKING, REASONING AND TOOLS

Problem Analysis – Logical Thinking vs Critical Thinking vs Design Thinking - Inference – Inductive Reasoning – Deductive Reasoning – **Logical Thinking Tools: Algorithms:** Definition and importance, characteristics of algorithms (finite, clear and unambiguous, well-defined inputs and outputs, feasible). Algorithm representation Techniques: Pseudocode, stepwise refinement, and top-down design. **Flowcharts:** Symbols used in flowcharts, creating flowcharts, and examples of flowchart-based problem-solving.

8 Hours

Practical Component

Algorithm writing and Flowcharts,

4 Hours

PROGRAMMING PARADIGMS AND INTRODUCTION TO C PROGRAMMING

Programming Paradigms: Structured programming - functional programming - object-oriented programming. **Introduction to C Programming:** History of C - features of C - structure of a C program – input / output statements. **Data Types:** Primitive data types (int, char, float, double) - derived data types, typecast. **Operators:** Arithmetic operators - relational operators - logical operators - bitwise operators - assignment operators - operator precedence. **Conditional Statements:** If - if-else - nested if - switch-case. **Looping Statements:** For loop - while loop - do-while loop. Pre-processor Directives and Command line arguments, Storage Classes.

11 Hours

Practical Component

Programs on Operator precedence, Decision Making, Iterations

10 Hours

ARRAYS AND STRUCTURES		
Collections: Arrays – 2D Arrays – String Manipulation. Structures and Unions: Definition - declaration - accessing members - differences between structures and unions - applications.		10 Hours
Practical Component Programs on Arrays, Structures, Union,		6 Hours
POINTERS AND FUNCTIONS		
Pointers: Definition - declaration - pointer arithmetic - pointers and arrays. Functions: Definition - declaration - types of functions (user-defined, library functions) - parameter passing (by value, by reference) pointers and functions, recursion.		10 Hours
Practical Component Pointers and Functions. Additional programs on Files to be discussed.		6 Hours
Theory Hours:	Tutorial Hours:	Practical Hours:
45	0	30
Project Hours:	Total Hours:	75
0	75	

Learning Resources	
Textbooks:	
<ol style="list-style-type: none"> 1. Kanetkar, Yashavant. Let Us C. BPB Publications, New Delhi (2023). 2. Rajaraman, V. Fundamentals of Computers. PHI Learning, New Delhi (2020). 3. Dromey, R.G. How to Solve it by Computer. Prentice Hall International, New York (2008). 	
Reference	
<ol style="list-style-type: none"> 1. Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to Algorithms. MIT Press, Cambridge (2022). 2. Balagurusamy, E. Programming in ANSI C. McGraw Hill Education, New York (2021). 3. Kernighan, Brian W., and Dennis M. Ritchie. The C Programming Language. Prentice Hall, New York (2017). 4. Patterson, David A., and John L. Hennessy. Computer Organization and Design: The Hardware/Software Interface. Morgan Kaufmann, San Francisco (2017). 	
Online Resources (Weblinks)	
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/106105214 2. https://www.coursera.org/learn/computer-fundamentals 3. https://www.khanacademy.org/computing/computer-science/algorithms 4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-006-introduction-to-algorithms-fall-2011/ 5. https://www.geeksforgeeks.org/c-programming-language/ 	

Assessment (Embedded course)
CAT, 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)
-	-	Dr. S. Kavitha, Department of Information Technology
Recommended by BoS on	16.08.2024	
Academic Council Approval	No: 27	Date 24.08.2024

24HSP112	HOLISTIC WELLNESS-II (Common to all Department)	L	T	P	J	C
		0	0	2	0	1
HS		SDG	3, 4			
Pre-requisite courses	Holistic Wellness-I	Data Book / Code book (If any)			-	

Course Objectives:

The purpose of taking this course is to:

1	build on the foundation laid in Holistic Wellness -I and deepening into the practices and principles of holistic wellness.
2	explore advanced techniques in mental, emotional, and spiritual well-being, with an emphasis on creating sustainable wellness habits.

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	apply advanced techniques in mindfulness, meditation, and stress management.	Ap
CO 2	understand the role of community and social connections in wellness.	U
CO 3	develop resilience and adaptability in maintaining wellness.	E
CO 4	refine and sustain a personalized holistic wellness plan.	E

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World						2		2						
Ethics						2								
Individual and Collaborative Team work						2								
Communication														
Project Management and Finance														
Life-Long Learning											3			
											3			

Course Content

ADVANCED MINDFULNESS AND MEDITATION: <ul style="list-style-type: none"> Deepening mindfulness practices for enhanced mental clarity. Exploring different forms of meditation (e.g., guided, transcendental, movement-based). Hands-on activity: Daily meditation practice and journaling reflections. 	6 Hours
EMOTIONAL RESILIENCE AND MENTAL HEALTH: <ul style="list-style-type: none"> Building emotional resilience through positive psychology practices. Cognitive-behavioural strategies for managing stress and anxiety. 	6 Hours

<ul style="list-style-type: none"> Hands-on activity: Developing and practicing a resilience toolkit. 	
SOCIAL AND ENVIRONMENTAL WELLNESS: <ul style="list-style-type: none"> The impact of social connections and community on wellness. Creating a supportive environment for personal growth. Hands-on activity: Building a community wellness project or group activity. 	6 Hours
INTERNAL GROWTH AND PURPOSE: <ul style="list-style-type: none"> Exploring the deeper aspects of internal wellness and self-actualization. Reflective practices for discovering life purpose and meaning. Hands-on activity: Creating a vision board or personal mission statement. 	6 Hours
SUSTAINING WELLNESS PRACTICES: <ul style="list-style-type: none"> Strategies for maintaining wellness habits over the long term. Adapting wellness plans to life changes and challenges. Hands-on activity: Revising and finalizing a long-term personal wellness plan. 	6 Hours
Theory Hours: 0	Tutorial Hours: 0
Practical Hours: 30	Project Hours: 0
Total Hours: 30	

Learning Resources	
Textbooks:	
<ol style="list-style-type: none"> Hanh, Thich Nhat. <i>The Miracle of Mindfulness: An Introduction to the Practice of Meditation</i>. Beacon Press, Boston (1975). Tolle, Eckhart. <i>The Power of Now: A Guide to Spiritual Enlightenment</i>. New World Library, Novato (1997). Patel, Kamlesh. <i>Heartfulness Way: Heart-Based Meditations for Spiritual Transformation</i>, Kamlesh Patel, 2018. 	
References:	
<ol style="list-style-type: none"> Goleman Daniel., <i>Emotional Intelligence.</i>, Bloomsbury India, India, (2021). James Allen., <i>As a Man Thinketh.</i>, Maple Press, Noida, (2010) Swami Budhanandha., <i>Will power and its development.</i>, Advaita Ashrama Mayavati, Pithoragarh, Himalayas from its Publication Department, Calcutta. (2001) Rosenberg, Marshall Bertram., <i>Nonviolent Communication: A Language of Life.</i>, Puddle Dancer Press, Encinitas, CA (2015). Jayanna, Krishnamurthy., <i>Science & Practice of Integrative Health & Wellbeing Lifestyle.</i>, White Falcon Publishing (2020). Lipton, Bruce., <i>The Biology of Belief 10th Anniversary Edition: Unleashing the Power of Consciousness, Matter & Miracles</i>, Hay House, Carlsbad (2015). Kalderdon Adizes Ichak., <i>What Matters in Life: Lessons I Learned from Opening My Heart</i> ., WS Press, Newtown, PA(2023). Murphy, Joseph., <i>The Power of Your Subconscious Mind [Original Edition (Complete)]</i>, Prentice-Hall, Englewood Cliffs (1963). Kamlesh D. Patel., <i>Designing Destiny: The Heartfulness Way</i>, Heartfulness Institute, Chennai (2021) 	
Online Resources (Weblinks)	
<ul style="list-style-type: none"> Introduction to Psychology Guided Meditation Life skills and value education James Allen Library 	

Assessment (Practical course)	
Participation, Practical activities and assignments, personal wellness plan and reflection.	

Course Curated by		
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. Ezhilarasi Principal- KCT
Recommended by BoS on		
Academic Council Approval	No: 27	Date 24.08.2024

SEMESTER III

Course Code: 24HSP005	24HSP005-Mastering Conversations	L	T	P	J	C
Course Category: Practical		0	0	2	0	1
		SDG	4 & 8			

Pre-requisite courses - Nil	NIL	Data Book / Codes / Standards (If any)	Nil
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Course Objectives:	The purpose of taking this course is to: (3 to 5)
1	Demonstrate understanding of different perspectives by analyzing complex personal and professional situations.
2	Engage in thoughtful dialogue and discussions about complex, real-world issues, utilizing critical thinking to assess different viewpoints.
3	Apply role-playing as a tool to enhance understanding of workplace dynamics, conflict resolution, and team collaboration.

Course Outcomes:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Empathize with and understand people in both professional and personal contexts, reflecting on situations from multiple perspectives and participating in activities that mirror career-related scenarios	Ap
CO 2	Analyze and converse critically on complex subjects, demonstrating the ability to approach and deal with various social contexts effectively	An
CO 3	Exhibit skills in role-playing and enacting given situations to navigate diverse social interactions and career-related contexts.	C

Course Outcomes should be clear, measurable, aligned with broader educational objectives, and focused on developing essential engineering skills while preparing students for future challenges in the field

COs: Embedded (3 to 4 credits): –6,, Theory only- 5, Micro-credentials - 3, lab only – 3, project – 4

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

	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11			
Course Outcomes (CO)	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2	PSO-3


1						3			3	2	3			
2									1	2				
3									3	2				

Course Content				
Practical Component / Roleplays Dynamics				6 Hours
Introduction to Role play - Benefits of role plays - Importance of gesture, tone and modulation-Skill development through role play activities - Types of role plays -Conversation Building through communicative functions-Initiating a dialogue- Framing questions- Receiving feedback				
Practical Component /Roleplays on Social Skill				6 Hours
Social Interactions: - (Ordering food at a restaurant- Making a reservation at a hotel-- Shopping at a store-- Attending a party or social gathering) Travel and Tourism:(Asking for directions- Booking a flight or hotel-- Exploring a new city- Interacting with local people) Community and Volunteering:(Participating in a charity event- Volunteering at a local organization- Discussing community issues- Organizing a community project)				
Practical Component / Roleplays on Education and Technology				6 Hours
Education and Personal Growth:(Setting goals-(Short term & Long term)- Creating a study plan- Participating in a workshop- Reflecting on personal growth) Technology and Online Interactions:(Participating in an online meeting- Creating a social media post- Writing an email or text message- Making an online purchase) Technology and Science:(Explaining a scientific concept- Discussing emerging technologies- participating in Hackathons- Presenting a research paper)				
Practical Component / Roleplays on Strategic Insights				6 Hours
Critical Thinking :(Evaluating a news article-solving a moral dilemma-Decision with incomplete information-Assessing a historical event) Problem-Solving:(Resolving a conflict- Negotiating a deal - Making a complaint- Apologizing for a mistake) Business and Entrepreneurship:(Pitching an idea- Negotiating a contract- Conducting a market Research- Presenting a product launch)				
Practical Component / Roleplays on Cultural Exchange				6 Hours
Cultural Exchange:(Sharing customs and traditions- Discussing cultural differences- Exploring historical events- Participating in a cultural festival) Media and Entertainment:(Event planning- Creating an advertisement-Digital Marketing-Conducting interviews- Creating news broadcast- Writing and Performing a script- Enacting one act plays) Arts and Culture:(Visiting an art gallery - Attending/ organizing a concert or play - Discussing literature- Creating a piece of art)				
Theory Hours:	Tutorial Hours:	Practical Hours:	Project Hours:	Total Hours:
		30		30

Learning Resources*	
Textbooks	
Reference books/ Web Links	
1. Bonwell, C. C., & Eison, J. A. (1991). Active learning: Creating excitement in the classroom. Washington, DC: The George Washington University. 2. Harbour, E., & Connick, J. (2005). Role playing games and activities rules and tips. Retrieved from https://www.businessballs.com/roleplayinggames.htm 3. Lebaron, J., & Miller, D. (2005). The potential of jigsaw role playing to promote the social construction of knowledge in an online graduate education course. Retrieved from http://paws.wcu.edu/jlebaron/Jigsaw-FnlTCRpdf_050812.pdf 4. Davies, A. (2018). Teaching and learning through role-play: A practical guide. Maidenhead, UK: McGraw-Hill Education. 5. Young, K. C. (2016). The art of role play: Developing realistic scenarios for skill development. Boston, MA: Pearson. 6. Yardley-Matwiejczuk, K. M. (1997). Role play: Theory and practice. London, UK: SAGE Publications Ltd.	
Online Resources	
https://www.niu.edu/citl/resources/guides/instructional-guide https://positivepsychology.com/role-playing-scripts/	

Assessment	
Formative	Summative
Assignments / Mini project), Quiz, Lab	Quizzes and written assignments, Participation in group activities

Course Curated By		
Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)
Mr. Vijayan Ramanathan , Project manager, Toppan Merrill. Technologies, Coimbatore	Dr. Aninditha Sahoo, IIT, Madras Dr. P.R. Sujatha Priyadharshini, Anna University Chennai Dr. E. Justin Ruben, CIT, Coimbatore	Dr. Arokia Lawrence Vijay Dr. Tissaa Tony

Approved by: BoS Chairman	
BoS Approval date:	16-8-2024

24MAI232		L	T	P	J	C
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	APPLIED STATISTICS FOR ENGINEERS (Common to BT, FT, TT)	3	0	2	0	4
BS		SDG		3,8		

Pre-requisite courses	Frequency distribution, Sample and Population	Data Book / Codes / Standards (If any)	Statistical Tables
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Course Objectives:	The purpose of taking this course is to:
1	introduce the concept of random variables and their probability distributions.
2	explore two-dimensional random variables, correlation, and regression analysis
3	provide knowledge of hypothesis testing using small and large sample tests.
4	explain the principles of experimental design and analysis of variance
5	familiarize students with statistical quality control techniques

Course Outcomes:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	describe different types of random variables and their probability distributions.	Ap
CO 2	analyse joint distributions and measure relationships using correlation and regression techniques	An
CO 3	conduct hypothesis tests using Z-tests and Chi-square for large samples	Ap
CO 4	perform small sample hypothesis tests using t-tests and F-tests.	Ap
CO 5	apply ANOVA and experimental design methods for data analysis.	An
CO 6	construct and interpret control charts for process monitoring.	Ap

	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Course Outcomes (CO)	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communication	Project Management and Finance	Life-Long Learning			
1	3	2			2									
2	3	3			2									
3	3	3		2	1				2					
4	3	3		2	1				2					
5	3	3		1	3				2					
6	3	3		1	3				2					

Course Content	
RANDOM VARIABLES Axioms of probability - Conditional probability – Total probability – Baye’s theorem - Random variable – Properties – Probability mass function – Probability density function – Distribution function - Binomial, Poisson and Normal distributions.	9 Hours
Practical Component	6 Hours

<ul style="list-style-type: none"> • Generate a Binomial distribution, plot its PMF and CDF, find the probability of a given range, and compute its mean and variance. • Simulate Poisson and Normal distributions, visualize them using PMF and histograms, and calculate probabilities for given ranges. 	
<p>TWO DIMENSIONAL RANDOM VARIABLES AND CORRELATION AND REGRESSION</p> <p>Two dimensional random variables – Joint Density and Distribution Functions –Marginal distributions- Correlation – Karl Pearson’s Correlation coefficient ((Discrete Data) – Regression lines. (Discrete Data). central limit theorem-Simple problems.</p> <p>Practical Component</p> <ul style="list-style-type: none"> • Generate a two-dimensional discrete random variable, compute its joint probability distribution, and plot the joint probability mass function (PMF). • Compute Karl Pearson’s and Spearman’s Rank Correlation coefficients for a given discrete dataset, fit regression lines, and interpret the results. 	<p>9 Hours</p> <p>6 Hours</p>
<p>TESTING OF HYPOTHESIS</p> <p>Testing of hypothesis for large samples: single mean, difference of means- Small samples tests based on t and F distributions: single mean, difference of means, paired t- test and variance ratio test – Chi-square test for independence of attributes and goodness of fit.</p> <p>Practical Component</p> <ul style="list-style-type: none"> • Perform hypothesis testing for large samples by conducting Z-tests for a single mean and difference of means and interpret the results. • Conduct t-tests (single mean, difference of means, and paired t-test), F-test for variance ratio, and Chi-square tests for independence of attributes and goodness of fit using given datasets. 	<p>9 Hours</p> <p>6 Hours</p>
<p>DESIGN OF EXPERIMENTS</p> <p>Analysis of Variance (ANOVA) – Completely Randomized Design (CRD) – Randomized Block Design (RBD) -Latin Square Design</p> <p>Practical Component</p> <ul style="list-style-type: none"> • Conduct an ANOVA using a Completely Randomized Design (CRD) and a Randomized Block Design (RBD) on a given dataset and compare the treatment effects. • Perform a Latin Square Design ANOVA on provided data, analyze the treatment differences, and interpret the outcomes. 	<p>9 Hours</p> <p>6 Hours</p>
<p>STATISTICAL QUALITY CONTROL</p> <p>Concept of process control - Control charts for variables: Mean and Range charts – Control charts for attributes: p, np, c – charts.</p> <p>Practical Component</p> <ul style="list-style-type: none"> • Construct and analyze Mean and Range (\bar{X} and R) control charts for a given dataset to monitor process stability. • Develop p, np, and c control charts for attribute data, interpret the control limits, and determine if the process is in control. 	<p>9 Hours</p> <p>6 Hours</p>

Theory Hours:	45	Tutorial Hours:		Practical Hours:	30	Project Hours:		Total Hours:	75
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Learning Resources	
Textbooks	
1. Walpole R. E., Myers S.L. & Keying Ye, “Probability and Statistics for Engineers and Scientists”, Pearson Education Inc, 10 th edition, 2020. 2. Charles Henry Brase and Corrinne Pellillo Brase “Understandable Statistics”, Cengage Learning Company, Toronto, 12 th edition, 2016. 3. Andy Field, Jeremy Miles, and Zoë Field, “Discovering Statistics Using R”, Sage Publications, 1 st edition, 2012.	
Reference books	
1. Johnson R. A., Miller & Freund’s “Probability and Statistics for Engineers”, 9 th Edition, Pearson Education, Delhi, 2017. 2. Gupta S.C, and Kapur V.K “Fundamentals of Applied Statistics”, Sultan Chand, New Delhi, 4 th Edition, 2014. 3. Michael J. Crawley, “The R Book”, Wiley, 3 rd Edition, 2020.	
Online Resources// Web Links	
Introduction to Probability and Statistics Using R: https://www.atmos.albany.edu/facstaff/timm/ATM315spring14/R/IPSUR.pdf	

Assessment	
Formative	Summative
Assignments / PBA, SBA, Worksheet, Quiz, Lab	CAT- I, CAT – II and End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)
1. Dr. R VASU Business Excellence and Management Systems Consultant Specialisation in Process Excellence, Six Sigma Quality, Health Safety & Environment Systems Vice President (Retired) Brakes India.	1. Dr. M. Sivakumar Assistant Professor Sr. Grade Vellore Institute of Technology, Vellore 2. Dr. Ramesh Babu Assistant Professor (SG) Amrita University Coimbatore, Tamil Nadu.	1. Dr. R. Marudhachalam Associate Professor, Department of Mathematics, KCT
Recommended by BoS on	25.4.2025	
Academic Council Approval		Date

24BTI201	FUNDAMENTALS OF MICROBIOLOGY AND IMMUNOLOGY	L	T	P	J	C
		3	0	2	0	4
PC		SDG	3, 6			

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team	Communication	Project Management and Finance	Life-Long Learning		
1	3	enable accurate identification and characterization of microorganisms.										3	3
2	3	Acquire fundamental knowledge on microbial morphology and structure.										3	3
3	3	Gain practical competence in aseptic techniques, enumeration, and preservation methods.										3	3
4	3	Develop analytical and technical skills in microbial cultivation and application in industrial research settings.										3	3
5	3											3	3
Course Outcomes			3					3	3			3	3

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Apply the mechanism of different sterilization, staining techniques for the preparation and identification of pure cultures.	Ap
CO 2	Investigate the ultra-structure, functions and multiplications of bacteria, virus and fungi.	U
CO 3	Analyse the environmental and nutritional factors influencing microbial growth and inhibition.	An
CO 4	Analyse strategies for different strain improvement and preservation and applications of industrial important microorganisms.	An
CO 5	Understand host immune responses and mechanisms of antimicrobial agents in relation to microbial pathogenesis and drug resistance.	U
CO 6	Interpret the sterilization, isolation, staining, growth kinetics and AMR of microorganism.	E

Pre-requisite courses	-	Data Book / Code book (If any)	-
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Course Content	
INTRODUCTION TO MICROBIOLOGY AND MICROSCOPY	07 Hours

<p>Introduction to microbiology and scope; Classification and nomenclature of microorganisms (overview of Bergey's Manual); Physical and chemical controlling methods of sterilization; Types of microbial growth media and culture techniques; Principles and applications of light and electron microscopy; Principles of microbial staining (simple, differential, and special stains)</p> <p>Practical Component:</p> <p>Introduction to microbiology lab safety, SOPs, and microbial air monitoring system, good laboratory practices and biosafety levels (BSL-1, BSL-2); SOP training</p> <ol style="list-style-type: none"> 1. Microbial culture media preparation and sterilization 2. Aseptic inoculation techniques (bacteria and fungi) 	<p>06 Hours</p>
<p>MICROBIAL MORPHOLOGY, STRUCTURE, FUNCTION, AND MULTIPLICATION</p> <p>Morphology and classification of bacteria: shape, size, and arrangements. Colony morphology; Ultrastructure of prokaryotic cells: cell wall (Gram-positive and Gram-negative), plasma membrane, capsule, pili, flagella, cytoplasm, endospores, and nucleoid. Structure of archaea and differences from bacteria. Morphology of fungi (yeast, molds, spores) and protozoa. Viral morphology; bacteriophage structure. Microbial multiplication: Binary fission, endospore, asexual and sexual reproduction in fungi and protozoa (<i>Plasmodium</i> life cycle) and viral replication cycles (lytic and lysogenic).</p> <p>Practical Component:</p> <ol style="list-style-type: none"> 3. Staining techniques: Simple stain, Gram stain, Negative stain, Endospore stain, Lacto-phenol cotton blue (parallel sessions) 4. Pure Culture Isolation techniques: Serial dilution, pour plate, streak plate, spread plate 	<p>10 Hours</p> <p>06 Hours</p>
<p>MICROBIAL NUTRITION AND GROWTH</p> <p>Nutritional types of microorganisms (autotrophs, heterotrophs, etc.); synchronous vs asynchronous growth; Batch culture and microbial growth curve; Batch and Continuous culture; Methods to measure microbial growth; generation time, growth rate constant; Factors affecting microbial growth.</p> <p>Practical Component:</p> <ol style="list-style-type: none"> 5. Preservation of microbial cultures by short- and long-term storage 6. Measurement of turbidity using McFarland standards and nephelometry (preparation of Inoculum) 	<p>05 Hours</p> <p>06 Hours</p>

STRAIN IMPROVEMENT, PRESERVATION AND INDUSTRIAL APPLICATIONS	08 Hours
<p>Mutation, selection, and adaptive evolution for strain improvement; Recombinant strains: plasmids, transposons, transformation techniques; Screening for auxotroph and overproducers; Industrially important traits: high-yielding strains for enzyme (Protease), antibiotic (Streptomycin), and organic acid production (Citric acid); Preservation techniques: Short and long term, cryopreservation, lyophilization, serial transfer.</p> <p>Practical Component:</p> <ol style="list-style-type: none"> 7. Enumeration of microorganisms: Viable count and direct microscopic methods. 8. Determination of bacterial growth curve – Generation Time 9. Anaerobic Cultivation: Techniques using anaerobic jars and thioglycolate medium. 	06 Hours
HOST IMMUNE RESPONSE AND ANTIMICROBIAL AGENTS	15 Hours
<p>Introduction to the Immune System : Innate and adaptive immunity; Physical and chemical barriers; Innate Immune Response: Phagocytes, NK cells, complement system, Inflammation and cytokines; Adaptive Immune Response: B-cells and T-cells; Antigen presentation, MHC, humoral and cell-mediated immunity; Antimicrobial Agents: Types: antibiotics, antifungals, antivirals, antiparasitic, Mechanisms of action (cell wall, protein, nucleic acid synthesis), Broad-spectrum vs. narrow-spectrum agents; Antimicrobial Resistance (AMR) : Resistance mechanisms: enzyme production, target modification, efflux pumps.</p> <p>Practical Component:</p> <ol style="list-style-type: none"> 10. Preparation and Staining of Peripheral Blood Smear for Microscopic Identification of Blood Cells 11. Antibiotic Sensitivity Testing: Disc diffusion method and determination of MIC and MBC 12. Immunoelectrophoresis 	06 Hours
	75 hours

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	30	Project Hours:	0	Total Hours:	75
Learning Resources									
Textbooks:									
<ol style="list-style-type: none"> 9. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2024). <i>Pelczar's Microbiology</i> (6th ed.). Medtech Science Press. 10. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). <i>Principles of fermentation technology</i>. Elsevier. 11. El-Mansi, E. M. T., Nielsen, J., Mousdale, D., & Carlson, R. P. (2018). <i>Fermentation Microbiology and Biotechnology</i> (4th ed.). CRC Press. 									
References:									
<ol style="list-style-type: none"> 1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). <i>Principles of Fermentation Technology</i> (3rd ed.). Butterworth-Heinemann, Elsevier. 2. Casida Jr, L. E. (2019). <i>Industrial microbiology</i>. 									

3. Waites, M. J., Morgan, N. L., Rockey, J. S., & Highton, G. (2019). *Industrial Microbiology: An Introduction* (2nd ed.). Wiley-Blackwell.
4. Tortora, G. J., Funke, B. R., & Case, C. L. (2021). *Microbiology: An Introduction* (13th ed.). Pearson Education.
5. Cappuccino, J. G., & Welsh, C. T. (2023). *Microbiology: A Laboratory Manual* (13th ed.). Pearson.

Online Educational Resources:

4. <https://openstax.org/details/books/microbiology>
5. <https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation>
6. <https://bio.libretexts.org/Bookshelves/Microbiology>

Assessment (Embedded course)

SA I and SA II 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)
Dr.K.C. Sivanandappa, SRO, Pasteur Institute of India, Coonoor, Ooty	Dr.Hema J, Associate Professor, Department of Biotechnology, PSG College of Technology, Coimbatore. Dr.Jibu Thomas, Professor and Head, Department of Biotechnology, Karunya Institute of Technology, Coimbatore	Dr.K. Kumaresan, Dr.K. Kumaravel Dr.T. Sathishkumar, Dr.P. Muthukumaran Biotechnology, KCT
Recommended by BoS on	07/05/2025	
Academic Council Approval	28 th Meeting	Date 26/06/2025

24BTT202	MOLECULAR BIOLOGY	L	T	P	J	C
		3	0	0	0	3
PC		SDG	3, 12			
Pre-requisite courses	-	Data Book / Code book (If any)		-		

Course Objectives:

The purpose of taking this course is to:

1	Introduce the molecular architecture of genomes and their role in cellular processes.
2	Explain the mechanisms and regulation of the central dogma: DNA replication, transcription, and translation
3	Understand the types, causes, and molecular repair mechanisms of DNA damage in living cells.

Course Outcomes:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Compare the genome organization, complexity, and regulatory elements between prokaryotes and eukaryotes.	U
CO 2	Explain the mechanisms of DNA replication in prokaryotes and eukaryotes	U
CO 3	Describe the mechanisms of transcription and Translation in prokaryotes and eukaryotes	An
CO 4	Analyze mechanisms of gene regulation and the role of epigenetic modifications in gene expression.	An
CO 5	Illustrate different types of mutations and DNA repair mechanisms.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team														
Communication														
Project Management and Finance														
Life-Long Learning														
1	3								2		2	3		
2	3	2	2						2			3		
3	3						3		2		2	3		
4	3							3	2		3	3		
5	3							3	2			3		

Course Content

<p>GENE AND GENOME ORGANIZATION Difference between prokaryotic and eukaryotic genomes, Functional and non-functional genome regions, Organelle genomes (mitochondrial and chloroplast DNA), Plasmids, Compact genome: absence of introns and minimal regulatory elements, Chromatin structure and nucleosome organization, Pseudogenes, Orthologs, paralogs, and gene family evolution, Tandem repeats (satellites, minisatellites, microsatellites), Transposable elements (Class I and Class II)</p>	9 Hours
<p>DNA REPLICATION Semiconservative model: Meselson-Stahl experiment, Origin of replication (OriC in prokaryotes, multiple origins in eukaryotes), Replication fork structure, Leading and lagging strand synthesis, enzymes and protein involved in replication (helicase, gyrase, topoisomerase, SSBP), DNA Polymerases: Prokaryotic (Pol I, II, III), Eukaryotic (Pol α, δ, ϵ, γ), Prokaryotic termination: Ter</p>	8 Hours

sites and Tus protein, Eukaryotic termination: telomeres and end replication problem, proof reading and replication errors.	
<p>TRANSCRIPTION</p> <p>RNA polymerase structure and function (core enzyme and sigma factor), Promoter structure: -10 and -35 regions, Initiation, elongation, and termination steps, Rho-dependent and Rho-independent termination, Types of RNA polymerases (Pol I, II, III) and their targets, Eukaryotic promoter elements: TATA box, CAAT box, GC box, General transcription factors (TFIID, TFIIB, etc.), Enhancers, silencers, and mediator complex, Post Transcriptional modifications: Capping at 5' end, Splicing of introns (spliceosome mechanism), Polyadenylation at 3' end, Alternative splicing and mRNA diversity</p>	8Hours
<p>TRANSLATION</p> <p>Introduction to translation: Role in gene expression, components (mRNA, tRNA, ribosomes, amino acids). Translation in prokaryotes: Shine-Dalgarno sequence, 70S ribosome, Translation steps: initiation, elongation, termination. Translation in eukaryotes: Kozak sequence, 80S ribosome, involvement of initiation factors, post-translational modifications. Comparison and regulation of translation in prokaryotic vs. eukaryotic systems.</p>	8Hours
<p>GENE REGULATION AND DNA MUTATION AND REPAIR MECHANISMS</p> <p>Constitutive vs. regulated gene expression, Operon concept : Structure and components: promoter, operator, structural genes, regulator gene, Types of operons: inducible (lac operon), repressible (trp operon), Role of activators and repressors, Riboswitch-mediated regulation of mRNA, Alternative sigma factors and stress response, Regulation by small RNAs (siRNA, miRNA),</p> <p>Types of mutations(insertion, deletion, substitution, transversion, transition), mutagens (physical, chemical and biological), Silent, missense, and nonsense mutations, Mutations affecting regulatory regions (promoters, enhancers, splice sites), Replication errors, DNA breaks (SSB, DSB), DNA repair mechanism(photo reactivation, BER, NER, MMR).</p> <p>Case study: Check point proteins in bacteria and DNA repair mechanism</p>	12 Hours

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours:	45
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Learning Resources
Textbooks:
<ol style="list-style-type: none"> Freifelder, D. (1987). <i>Molecular biology</i> (2nd ed.). Narosa Publishing House. Verma, P. S., & Agarwal, V. K. (2004). <i>Principles of molecular biology</i> (1st ed.). S. Chand & Company Ltd.
Reference Books:

32. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's genes XII* (12th ed.). Jones & Bartlett Learning.

33. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). *Molecular cell biology* (9th ed.). W. H. Freeman and Company.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc24_bt07/preview

Assessment (Theory course)

CAT - I, CAT – II, 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.Lipin Dev, VeeTee Ecogreen Pvt Ltd	Dr.Jibu Thomas, Karunya University, Coimbatore	Dr.N.Saraswathy/BT Dr.K.Kumaravel/BT Dr.P.Muthukumaran/BT
Recommended by BoS on	07.05.2025	
Academic Council Approval	28 th Meeting	Date 26.06.2025

24BTT203	BIOANALYTICAL TECHNIQUES AND INSTRUMENTATION	L	T	P	J	C
		3	0	0	0	3
PC		SDG	3, 12			
Pre-requisite courses	-	Data Book / Code book (If any)			-	

Course Objectives	
The purpose of taking this course is to	
1	Apply the statistic principles to validate an experimental data
2	Analyse and interpret the data obtained from various spectroscopy techniques
3	Analyse and interpret the data obtained from different chromatography and electrophoretic techniques

Course Outcomes:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Apply the statistic variables to validate the experimental methods	Ap
CO 2	Apply the principle of various components of spectroscopy to understand the instrumentation related phenomenon	Ap
CO 3	Analyse the instrumentation related phenomenon to interpret the data obtained through different spectroscopy methods	An
CO 4	Examine the technique related phenomenon to evaluate the data obtained by various chromatography methods	An
CO 5	Analyse the technique related phenomenon to evaluate the data obtained from different electrophoretic techniques	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2
Engineering Knowledge													
Problem Analysis													
Design/Development of Solutions													
Conduct Investigations of Complex Problems													
Engineering Tool Usage													
The Engineer and The World													
Ethics													
Individual and Collaborative Team work													
Communication													
Project Management and Finance													
Life-Long Learning													
1	3					3					3	3	3
2	3					3					3	3	3
3	3	3				3					3	3	3
4	3					3					3	3	3
5	3					3					3	3	3

Course Content	
FUNDAMENTALS OF MEASUREMENTS AND VALIDATION METHODS	5 Hours

Classification of instrumental methods; Fundamentals of accuracy, precision and limits of detection (LOD) and limits of quantification (LOQ); Quality control/assurance – definition, standard operating procedure, calibration, validation; Validation of air handling systems and water handling systems in pharmaceutical industries.	
PRINCIPLE AND COMPONENTS OF SPECTROSCOPY Properties of electromagnetic radiation; Beer – Lambert’s law – relationship and deviations; Relationship between transmittance and absorbance; general principle of absorption; Components of general spectrophotometer – sources of radiation, wavelength selectors/ isolators (filters, prisms and gratings), sample holders, detectors (photovoltaic cells, photomultiplier tubes (PMT) and pyroelectric material).	6 Hours
INSTRUMENTATION OF MOLECULAR AND ATOMIC SPECTROSCOPY Principle, instrumentation and applications of spectroscopy – UV, Visible, Fourier transform infrared (FT IR), Raman, nuclear magnetic resonance (NMR), molecular mass (MS) and circular dichroism (CD); Principle, instrumentation and applications of atomic absorption spectroscopy; Principle, instrumentation and applications of fluorometry; Assay of pharmaceutical drugs (specific applications) – assay of amoxicillin trihydrate and folic acid (UV spectroscopy), assay of aspirin and its fingerprint interpretation (FTIR spectroscopy).	12 Hours
CHROMATOGRAPHY Factors affecting the resolution of chromatography; Application of VanDeemter equation; Principle, technique and applications - Thin layer chromatography (TLC), High Performance thin layer Chromatography (HPTLC), Supercritical fluid chromatography, gel filtration, ion exchange chromatography, high performance liquid chromatography (HPLC), Ultraperformance liquid chromatography (UPLC) and gas chromatography (GC); Identification of specific substances as impurities in drugs (TLC assay) – morphine in apomorphine hydrochloride; Quantification of human insulin using HPLC	11 Hours
ELECTROPHORESIS Electrophoresis – introduction & troubleshooting parameters; Principle, instrumentation and applications - paper, agarose gel, polyacrylamide gel (PAGE), SDS-PAGE, microchip, denaturing gradient gel electrophoresis (DGGE) or temperature gradient gel electrophoresis (TGGE), capillary electrophoresis, and isoelectric focusing.	11 Hours

Theory	Tutorial	Practical	Project	Total
Hours: 45	Hours:0	Hours:0	Hours:0	Hours: 45
Learning Resources				
Textbooks:				

- Skoog, D., Holler, F., & Crouch, S. (2014). Principles of Instrumental analysis (6th ed.). USA: Brooks Cole Publishing Company.
- Wilson, K., & Walker, J. (2006). Principles and techniques of biochemistry and molecular biology (7th ed.). Cambridge: Cambridge University Press.

Reference Books:

- Sharma, B. (2014). Instrumental methods of chemical analysis (analytical chemistry) (24th ed.). India: GOEL Publishing House.
- Gurdeep R. Chatwal and Sham K. Anand, G. (2012). Instrumental Methods of Chemical Analysis (5th ed.). India: Himalaya Publishing House.
- Costa, B. M. D. C., Griveau, S., d'Orlye, F., Bedioui, F., da Silva, J. A. F., & Varenne, A. (2021). Microchip electrophoresis and electrochemical detection: A review on a growing synergistic implementation. *Electrochimica Acta*, 391, 138928. <https://doi.org/10.1016/j.electacta.2021.138928>
- Ashutosh Kar. (2005). Pharmaceutical Drug Analysis (revised 2nd edition). New Age International Pvt. Ltd..

Online Resources:

- <https://nptel.ac.in/courses/103108100>
- <https://alison.com/course/introduction-to-chromatography-system>
- <https://alison.com/course/understanding-the-basics-of-electrophoresis>

Assessment (Theory course)

SA - I, SA- II, 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)
Mr. M. Kannan Manager, Healthium Medtech Ltd Bengaluru, Karnataka, India.	Dr. J. Hema Associate Professor Department of Biotechnology PSG College of Technology Coimbatore.	Dr. T. Sathish Kumar Dr. M. Shanmugaprakash Dr. A. Thirumurugan
Recommended by BoS on	07.05.2025	
Academic Council Approval	28 th Meeting	Date 26.06.2025

24BTP204	CELL AND MOLECULAR BIOLOGY LABORATORY	L	T	P	J	C
		0	0	4	0	2
PC		SDG	3			

Pre-requisite courses	-	Data Book / Code book (If any)	-
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Course Objectives:

The purpose of taking this course is to:

1	To introduce fundamental techniques in cell and molecular biology through hands-on experiments involving model organisms and cultured cells.
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2	To study cellular processes such as cell division in anther and onion root tip to understand mitosis and meiosis
3	To investigate the various method, employ to extract Genomic DNA from bacteria, yeast and from plants

Course outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Interpret experimental data and apply biological principles to real-world cellular systems.	An
CO2	Utilize microscopy, staining, and cell viability assays to assess cellular health and behaviour.	U
CO3	Develop proficiency in genomic DNA extraction and electrophoresis for molecular analysis.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team	Communication	Project Management and Finance	Life-Long Learning		
1	3	3		3	3				2		2	3	
2	3	2	2	3					2			3	
3	3	3		3					2		2	3	

Course Content

- | | |
|---|----------|
| <ol style="list-style-type: none"> 1. Study of Cell Division – Meiosis (Anther stain) Mitosis (Onion root tips) 2. Karyotyping and Barr bodies 3. Effect of Environmental Stress on Cell Membrane Integrity - Osmosis on bacterial cells. 4. Trypan Blue Exclusion for Cell Viability 5. Polymerase chain reaction for amplification of prokaryotic gene 6. DNA analysis using agarose gel electrophoresis 7. Visualization of live and dead cells using fluorescent dyes 8. Nucleic acid extraction from plants and quantification using nanodrop 9. Genomic DNA extraction from bacteria and yeast 10. Assessment of bacteria cell viability using Colony forming units | 30 Hours |
|---|----------|

Theory Hours:	0	Tutorial Hours:	0	Practical Hours:	30	Project Hours:	0	Total Hours:	30
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Learning Resources**Textbooks:**

5. Alberts, B., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2015). *Molecular Biology of the Cell* (6th ed.). Garland Science.
6. Cappuccino, J. G., & Welsh, C. T. (2017). *Microbiology: A Laboratory Manual* (11th ed.). Pearson.
7. Alberts, B., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular Biology of the Cell* (7th ed.). W. W. Norton & Company.

Reference Books:

1. Pawley, J. B. (Ed.). (2016). *Handbook of Biological Confocal Microscopy* (4th ed.). Springer.
2. Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock Biology of Microorganisms* (15th ed.). Pearson.

Online Resources:

2. [Molecular Biology Laboratory Manual Summer 2016](#)
3. <https://www.ncbi.nlm.nih.gov/books/NBK9941/>
4. <https://molecular-biology.coe.hawaii.edu/protocols/>

Assessment (Laboratory course)

Workbook, Viva-Voce, Model-Lab exams, End Semester Examination (ESE)

Recommended by BoS on Dr.Lipin Dev, Vee Fee	07.05.2025	Dr.Jibu Thomas,	Dr.N.Saraswathy/BT
Ecological Council Approval	28 th Meeting	Maruthi University, Coimbatore	Dr.K.K.Manoj/BT Dr.P.Muthukumaran/BT

24INM201	Universal Human Values II: Understanding Harmony (Common to All Branches)	L	T	P	J	C
		1	0	0	0	1
HS		SDG	3,4,5,10,12, 1 3,14,15,16,1 7			
Pre-requisite courses	-	Data Book / Code book (If any)	-			

Course Objectives:

The purpose of taking this course is to:

1	Introduce the concept and significance of value education in shaping a meaningful and fulfilling life.
2	Enable students to understand the human being as a co-existence of self and body and the harmony within.
3	Develop an understanding of harmony in relationships, family, and society.
4	Help students appreciate the interconnectedness and harmony in nature and existence.
5	Instill the importance of ethical behaviour in personal, professional, and social contexts.

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonom y Levels (RBT)
CO1	Understand the foundational concepts of value education and human aspirations.	U

CO2	Analyze the human being as a holistic entity comprising self and body.											An		
CO3	Evaluate and cultivate harmonious relationships within the family and society.											E		
CO4	Interpret the interconnectedness in nature and recognize harmony in existence.											U		
CO5	Apply holistic understanding to professional ethics and sustainable living.											Ap		
Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11			
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2	PSO-3
	1					3	3	3	3		3			
	2					3	3	3	3		3			
	3					3	3	3	3		3			
	4					3	3	3	3		3			
	5					3	3	3	3		3			
	Course Content													
	Introduction to Value Education												3 Hours	
	Value Education- Self-exploration as the Process for Value Education- Basic Human Aspirations and their Fulfilment- Right Understanding, Relationship and Physical Facility- Happiness and Prosperity – Current Scenario- Method to Fulfil the Basic Human Aspirations.													
	Harmony in the Human Being												3 Hours	
Human Being as Co-existence of the Self and the Body- Distinguishing between the Needs of the Self and the Body- The Body as an Instrument of the Self- Understanding Harmony in the Self- Harmony of the Self with the Body- Programs to Ensure Self- regulation and Health.														

Harmony in the Family and Society		3 Hours							
<p>Harmony in the Family –The Basic Unit of Human Interaction-‘Trust’ – The Foundational Value in Relationship-Respect – As the Right Evaluation- Other Values in</p> <p>Human-to-Human Relationship- Understanding Harmony in the Society Lecture Vision for the Universal Human Order.</p>									
Harmony in the Nature (Existence)		3 Hours							
<p>Understanding Harmony in Nature- Interconnectedness, Self-regulation and Mutual Fulfilment among the Four Orders of Nature- Realizing Existence as Co-existence at All Levels- The Holistic Perception of Harmony in Existence.</p>									
Implications of the Holistic Understanding- A Look at Professional Ethics		3 Hours							
<p>Basis for Universal Human Values-Definitiveness of (Ethical) Human Conduct</p> <p>professional Ethics in the Light of Right Understanding-A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order- Holistic Technologies, Production Systems-and Management Models-Typical Case Studies Strategies</p> <p>for Transition towards Value-based Life and Profession</p>									
Theory Hours	15	Tutorial Hours	0	Practical Hours	0	Project Hours	0	Total Hours	15
Learning Resources									
Textbooks:									
Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.									
Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.									
References:									
Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, Jeevan Vidya:Publishers, 1999.									
Online Resources (Weblinks)									
https://www.uhv.org.in/uhv-ii									
Assessment (Theory course)									
Presentation, MCQ, Assignment, Case Study and E Chart.									
Course Curated by									

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
	Sh. Umesh Jadhav, NCCIP (National Co-ordination Committee)- AICTE	Dr.S.Sivakumar, Associate Professor, SFS Dr.R.Prakasam, Assistant Professor, Department of Physics Mr.J.Sivaguru, Assistant Professor, Department of Mechatronics
Recommended by BoS on	03-05-2025	
Academic Council Approval		Date 26-06-2025

SEMESTER IV

24HSP006	Mastering Group Discussion and Presentation Skills	L	T	P	J	C
		0	0	2	0	1
Practical		SDG		4&8		

Pre-requisite courses	Nil	Data Book / Codes / Standards (If any)	
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Course Objectives:	The purpose of taking this course is to:
1	To equip learners with techniques for organizing and presenting ideas effectively, ensuring logical flow and engaging delivery through appropriate visual and verbal strategies.
2	To enhance students' ability to evaluate diverse viewpoints and articulate reasoned arguments, fostering meaningful participation in collaborative discussions.
3	To strengthen students' ability to adapt their speaking style and content to different audiences and contexts, utilizing digital tools for enhanced presentation effectiveness.

Course Outcomes:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Create and deliver structured presentations with a clear introduction, body, and conclusion, utilizing effective visual tools and appropriate pacing to enhance clarity and impact.	C
CO 2	Analyse issues from multiple perspectives, articulate ideas effectively within group discussions	An
CO 3	Deliver confident presentations and speeches in professional and social settings, leveraging digital tools and technologies to enhance quality and effectiveness.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis		2												
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage					1	2								
The Engineer and The World														
Ethics														
Individual and Collaborative Team work								3	3					
Communication														
Project Management and Finance														
Life-Long Learning											3			
1		2			1	2		3	3		3			
2		2			1	2		3	3		3			
3		2			1	2		3	3		3			

Course Content	
MODULE 1 Introduction to Group Discussions - Key skills for effective participation - Phases in a GD - Conversational Phrases in GD.	6 Hours

<p>Group Dynamics - Understanding group roles and dynamics - Conflict resolution and management in groups - Techniques for fostering collaboration.</p> <p>Presentations - Introduction to Visual Aids and Technology in Presentations.</p> <p>Delivery Techniques - Voice modulation and speech clarity - Body language and gestures – audience analysis.</p> <p>Handling Q&A Sessions - Preparing for audience questions - Techniques for handling difficult questions - Mock Presentation with Q&A sessions.</p>	
<p>MODULE 2</p> <p>Factual Group Discussions: Focus on sharing and verifying accurate information on a given topic. Participants base their contributions on verifiable data and concrete evidence.</p> <p>Opinion-based / Argumentative Group Discussion: Encourages participants to express and defend their point of view on a topic. Evaluate different perspectives and build critical thinking skills.</p>	6 Hours
<p>MODULE 3</p> <p>Case Study Group Discussion: Involves analyzing the complexities, identifying key issues, and developing insights or solutions based on the group's collective knowledge.</p> <p>Abstract Discussion: Deals with intangible concepts, ideas, or themes without concrete reference points. Encourages creative thinking and theoretical exploration.</p>	6 Hours
<p>MODULE 4</p> <p>Impromptu Presentations: Participants speak on a given topic with little to no preparation. Helps develop quick thinking and effective communication skills.</p> <p>Informative Presentation: Aims to educate the audience on a specific topic by providing clear, factual information. The focus is on clarity, accuracy, and comprehensiveness.</p> <p>Demonstrative Presentation: Interactive sessions where participants engage in hands-on activities to learn practical skills. Often includes exercises, demonstrations, and collaborative tasks.</p>	6 Hours
<p>MODULE 5</p> <p>Training and Technical Presentation: Designed to teach specific technical skills or procedures. Includes detailed instructions, demonstrations, and may involve technical jargon.</p> <p>Academic Presentation: Involves presenting research findings or theoretical concepts in an academic setting. Emphasizes clarity, evidence-based arguments, and adherence to scholarly standards.</p> <p>Pitch Presentation: A concise, persuasive presentation aimed at securing support, investment, or approval. Focuses on the value proposition, potential benefits, and unique selling points.</p>	6 Hours


<p>Persuasive Presentation: Seeks to convince the audience to adopt a particular viewpoint or take a specific action. Utilizes logical arguments, emotional appeals, and credible evidence.</p> <p>Multimedia Presentations: Uses visual and auditory media to convey information and present arguments. Enhances engagement and aids in illustrating complex concepts.</p>	
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Theory Hours:	-	Tutorial Hours:	-	Practical Hours:	2	Project Hours:	-	Total Hours:	30
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Learning Resources*	
Reference books/ Web Links	
<ol style="list-style-type: none"> 1. Powell, M. (2010). Dynamic presentations student's book with audio CDs (2). Cambridge University Press. 2. Reynolds, G. (2011). Presentation Zen: Simple ideas on presentation design and delivery. New Riders. 3. Galanes, G. J., Adams, K., & Brilhart, J. K. (2020). Effective group discussion: Theory and practice (15th ed.). McGraw-Hill Education. 4. Adams, K., & Galanes, G. (2018). Communicating in groups: Applications and skills, a practical guide (18th ed.). McGraw-Hill Education. 5. Ivy, D. K., & Backlund, P. (2018). Speak with confidence: A practical guide. Pearson. 6. Reynolds, G. (2019). Presentation Zen: Simple ideas on presentation design and delivery. New Riders. 	
Online Resources	
<ol style="list-style-type: none"> 1. https://www.coursera.org/learn/verbal-communications-and-presentation-skills 2. https://www.coursera.org/learn/present-with-purpose 3. https://www.coursera.org/learn/teamwork-skills-effective-communication 	

Assessment	
Formative	Summative
-----	<ol style="list-style-type: none"> 1. Participation in group discussions (40%) 2. Individual presentations (40%) 3. Quizzes and written assignments (20%)

Course Curated By		
Expert(s) from Industry	Expert(s) from Higher Education Institutions	Internal Expert(s)
Mr. Bhuvana Sundar Soorappaiah Program Manager Bosch, Coimbatore	Dr Kishore Selva Babu Head and Associate Professor Department of English and Cultural Studies Christ University Bangalore-560029	Dr. J Srikala- AP III Dr. C Tissaa Tony - AP III Dr. S G Mohanraj – AP III Dr. S Sreejana – AP III Dr. R Hema – AP II Dr. A S Mythili - AP II

Approved by: BoS Chairman	With Signature and date
BoS Approval date:	 25.04.2025

24BTI206	CELL CULTURE TECHNIQUES	L	T	P	J	C
		2	0	4	0	4
PC		SDG		4, 9		

Pre-requisite courses	-	Data Book / Code book (If any)	-
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Course Objectives:	
The purpose of taking this course is to study and understand	
1	Fundamental knowledge of cell and tissue culture principles, laboratory organization, sterilization techniques, and biosafety practices
2	Concepts and methodologies of plant tissue culture and their role in <i>in-vitro</i> plant growth and regeneration.
3	Mammalian cell culture systems and the biological and technical factors influencing animal cell growth and maintenance.
4	To Integrate theoretical concepts with practical laboratory techniques in plant and mammalian cell culture.
5	To Develop awareness of the applications, ethical considerations, and regulatory frameworks associated with cell culture technologies in biotechnology.

Course Outcomes		
		Revised Bloom's Taxonomy Levels (RBT)
After successful completion of this course, the students shall be able to		
CO 1	Describe the basic concepts, historical development, laboratory requirements, biosafety practices, and types of cell culture systems used in biotechnology.	U
CO 2	Compare various plant tissue culture techniques such as callus culture, cell suspension culture, organogenesis, somatic embryogenesis, and micropropagation	U
CO 3	Apply plant tissue culture techniques for in vitro propagation, stress tolerance screening, secondary metabolite production, and development of transgenic plants.	Ap
CO 4	Understand the principles and techniques involved in the establishment, maintenance, passaging, and cryopreservation of primary and established mammalian cell cultures.	U
CO 5	Apply mammalian cell culture techniques and analytical assays, including cell viability, cytotoxicity, and migration assays, for biomedical and industrial research applications.	Ap

CO 6	Design basic experimental strategies while considering industrial applications, ethical issues, regulatory guidelines, and quality control aspects of cell culture technologies.	Ap
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Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2
Engineering Knowledge													
Problem Analysis													
Design/Development of Solutions													
Conduct Investigations of													
Engineering Tool Usage													
The Engineer and The World													
Ethics													
Individual and Collaborative Team													
Communication													
Project Management and Finance													
Life-Long Learning													
1	3												
2	3	2										3	
3	3	2	3	2	3					2	2	3	3
4	3	3	2	3	3					2	3	2	3
5	3	3	2	3	3			2		3		3	3
6	2	2			2	2	3				2		2

Course Content	
<p>BASICS OF CELL CULTURE</p> <p>History and scope of cell culture. Comparison of plant and animal cell culture systems. Laboratory design and instrumentation. Biosafety levels and good laboratory practices. Aseptic techniques and contamination control; Contamination sources and control strategies.</p> <p>Practical Component:</p> <ul style="list-style-type: none"> • Introduction to laboratory safety, sterilization methods, and aseptic handling techniques. 	<p>5 Hours</p> <p>2 Hours</p>
<p>BASIC PLANT TISSUE CULTURE TECHNIQUES</p> <p>Plant tissue culture principles; media preparation and role of growth regulators; aseptic techniques and culture conditions; callus and explant cultures (shoot tip, root tip, anther, pollen, and protoplast); organogenesis and somatic embryogenesis; micropropagation techniques for crop and ornamental plants. case study on banana tissue culture.</p> <p>Practical Component:</p> <ul style="list-style-type: none"> • Media and stock solution preparation for plants • Selection of explants and Induction of callus • Suspension culture and production of secondary metabolites 	<p>5 Hours</p> <p>6 Hours</p>

- Biosafety guidelines and Good Manufacturing Practices (GMP) in cell culture laboratories
- Good Laboratory Practice (GLP) and quality compliance in biological research
- Case studies on micropropagation techniques in horticultural and medicinal plants
- Industrial applications of plant cell and tissue culture technologies
- Review of industrial biopharmaceutical case studies
- Quality by Design (QbD) principles in cell culture–based biomanufacturing
- Scale-up challenges and bioreactor design for plant and mammalian cell cultures
- Ethical, regulatory, and biosafety issues in advanced cell culture research
- Automation, sensors, and AI-assisted monitoring in modern cell culture labs
- Cryopreservation, cell banking, and long-term storage strategies
- Production of secondary metabolites using plant cell suspension cultures
- Role of cell culture models in
 - vaccine development and biosimilar testing
- Comparative analysis of 2D, 3D, and organoid culture systems for industrial use
- Intellectual property rights (IPR), patents, and technology transfer in biotechnology
- Sustainability, green bioprocessing, and circular bioeconomy approaches in cell culture

Theory Hours:	30	Tutorial Hours:	30	Practical Hours:	30	Project Hours:	60	Total Hours:	60
Learning Resources									
Textbooks:									
<ol style="list-style-type: none"> 1. Stewart, C. N. Jr. (Ed.), <i>Plant Biotechnology and Genetics: Principles, Techniques, and Applications</i>, John Wiley & Sons, Hoboken (2025). 2. Trigiano, R. N. (Ed.), <i>Plant Tissue Culture: Concepts and Laboratory Exercises</i>, Routledge, New York (2018). 3. Hauser, H., & Wagner, R. (Eds.), <i>Mammalian Cell Biotechnology in Protein Production</i>, de Gruyter, Berlin (1997). 									
References:									
<ol style="list-style-type: none"> 38. Haycock, J. W., <i>3D Cell Culture: A Review of Current Approaches and Techniques</i>, Humana Press, Totowa (2010). 39. Freshney, R. I., <i>Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications</i>, John Wiley & Sons, Hoboken (2015). 40. Razdan, M. K., <i>An Introduction to Plant Tissue Culture</i>, Oxford & IBH Publishing, New Delhi (2002). 41. Lanza, R., Langer, R., Vacanti, J. P., & Atala, A. (Eds.), <i>Principles of Tissue Engineering</i>, Academic Press, San Diego (2020). 42. Masters, J. (Ed.), <i>Animal Cell Culture: A Practical Approach</i>, Oxford University Press, Oxford (2000). 43. Feder, J. (Ed.), <i>Large-Scale Mammalian Cell Culture</i>, Elsevier, Amsterdam (2012). 44. Smith, R. H., <i>Plant Tissue Culture: Techniques and Experiments</i>, Academic Press, San Diego (2013). 									
Online Educational Resources:									
<ol style="list-style-type: none"> 1. Cell Culture: Growing Cells as Model Systems In Vitro - PMC 2. Cell culture techniques (Chapter 2) - Principles and Techniques of Biochemistry and Molecular Biology 3. Cell Culture Techniques SpringerLink 4. Cell Culture Technique - an overview ScienceDirect Topics 5. Introduction to cell culture - PubMed 									

Assessment (Embedded course)

SA I, SA II 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 M.K. Harishankar M Tech PhD Sr Research Scientist Biocon Park, Bengaluru, Karnataka, 560099	Dr Shashank K. Singh., M.Pharm., PhD (Pharm.Sci) Senior Principal Scientist & Professor (AcSIR)., Pharmacology Division, CSIR-Indian Institute of Integrative Medicine, Canal Road, Jammu-Tawi 180 001	Dr Kumaresan K Dr P Muthukumaran Dr Padhmanand Sudhakar Department of Biotechnology Kumaraguru College of Technology
Recommended by BoS on	07/05/2025	
Academic Council Approval	28	Date 26/06/2025

24BTI207	GENETIC ENGINEERING	L	T	P	J	C
PC		2	0	4	0	4
	SDG	3				

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

Course Objectives

The purpose of taking this course is to:

1	Explain the fundamental principles, techniques, and applications of genetic engineering.
2	Describe gene cloning strategies, vector systems, and recombinant gene expression in host organisms.
3	Discuss the ethical, regulatory, and societal aspects of genetic modifications and GMOs.

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Comprehend the key steps involved in recombinant DNA construction and select appropriate cloning strategies.	U
CO 2	Analyse the structural and functional features of various gene cloning vectors and design suitable expression vectors for recombinant protein production.	An

CO 3	Compare different gene isolation and screening methods to identify specific genetic elements.	E
CO 4	Apply modern genetic engineering tools to address real-world problems and Evaluate the regulatory, ethical, environmental, and societal implications of genetically modified organisms (GMOs).	Ap
CO 5	Analyse and interpret omics methods for real world applications.	An
CO 6	Acquire hands-on experience in DNA manipulation, PCR mediated gene isolation, and genetic transformation	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2
Engineering Knowledge								3				3	
Problem Analysis								3				3	
Design/Development of Solutions								3				3	
Conduct Investigations of Complex Problems								3			1	3	
Engineering Tool Usage						2	1	3			1	3	
The Engineer and The World								3			1	3	
Ethics													
Individual and Collaborative Team													
Communication													
Project Management and Finance													
Life-Long Learning													

Course Content	
<p>DNA MANIPULATION TOOLS</p> <p>DNA manipulating enzymes, restriction enzymes and types, cloning strategies: TA cloning, GATEway cloning, selection and screening of recombinants : antibiotic, GFP, Blue-white method. Sticky ends vs. blunt ends, T4 DNA ligase and its mechanism, Role of linkers, adapters, and homopolymer tailing,</p> <p>Practical Component:</p> <ol style="list-style-type: none"> 1. Amplification of gene of interest using End point PCR 2. Selection of recombinant using fluorescent reports or Blue-white selection 	<p>8 Hours</p> <p>16 Hours</p>
<p>GENE ISOLATION AND VECTORS BIOLOGY</p> <p>Construction of gene and cDNA libraries, screening of libraries using colony PCR, Gene expression analysis: qualitative (RT PCR) and Quantitative (qPCR), components of a cloning vector, Desirable properties of cloning vectors (origin of replication, selectable markers, MCS) types of cloning vectors: plasmid, phase, hybrid vectors (Phagemid & Cosmid), CRISPR/Cas vectors for genome editing, Lentiviral and retroviral vectors for gene delivery, Vectors for siRNA</p> <p>Practical Component:</p>	<p>8 Hours</p> <p>16 Hours</p>

<ol style="list-style-type: none"> Ligation of insert into plasmid vector Transformation by electroporation/Heat-Shock method and calculation of transformation efficiency 	
<p>RECOMBINANT PROTEIN EXPRESSION</p> <p>Components of expression vectors (RBS, fusion tags, Signal peptides, inducible promoters). Expression host systems (prokaryotic and eukaryotic), Induction systems (IPTG), Codon optimization for expression, recombinant protein purification using fusion tags(His Tag) Inclusion bodies and refolding strategies for recombinant proteins</p> <p>Practical Component:</p> <ol style="list-style-type: none"> Analysis of recombinant protein expression using SDS-PAGE Visualization of recombinant protein using western blot 	<p>8 Hours</p> <p>16 Hours</p>
<p>APPLICATION OF GENETIC ENGINEERING</p> <p>Production of recombinant proteins (e.g., insulin, growth hormone, erythropoietin, Transgenic animals for studying gene function and human diseases, Cloning and gene editing in livestock for trait enhancement, Engineering algae for CO₂ capture and bioenergy production, Development of genetically modified (GM) crops for pest, herbicide, and drought resistance, Biofortification of crops (e.g., Golden Rice), CRISPR-mediated crop genome editing for trait improvement</p> <p>Practical Component:</p> <ol style="list-style-type: none"> In-silico gRNA design using CRISPR-Cas9 gene editing Analysis of cycle threshold using cycle RT-PCR (SYBR Chemistry) 	<p>10 Hours</p> <p>12 Hours</p>

Self-Learning Topics: (Hours:)

Theory	Tutorial	Practical	Project	Total
Hours: 30	Hours: 0	Hours: 60	Hours: 0	Hours: 90

Learning Resources
<p>Textbooks:</p> <ol style="list-style-type: none"> Primrose, S. B., & Twyman, R. M. (2006). <i>Principles of Gene Manipulation and Genomics</i> (7th ed.). Blackwell Publishing. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). <i>Molecular Biotechnology: Principles and Applications of Recombinant DNA</i> (5th ed.). ASM Press. Lewin, B. (2017). <i>Genes XI</i>. Jones & Bartlett Learning. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2017). <i>Molecular biology of the gene</i> (7th ed.). Pearson
<p>References:</p> <ol style="list-style-type: none"> Michael R. Green and Joseph Sambrook, <i>Molecular Cloning: A Laboratory Manual</i>, CSHL, 2005 Sambrook, J., & Russell, D. W. (2010). <i>Molecular Cloning: A Laboratory Manual</i> (3 vols.). Cold Spring Harbor Laboratory Press.
<p>Online Educational Resources:</p> <ol style="list-style-type: none"> https://learn.genetics.utah.edu/ https://www.biointeractive.org/classroom-resources/crispr-cas9-mechanism-applications https://cshprotocols.cshlp.org/

Course Outcomes (CO)	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team	Communication	Project Management and Finance	Life-Long Learning	(PSO)	
												PSO1	PSO2
1	3										3	2	2
2	3										3	3	3
3	3	3									3	3	3
4	3	3									3	3	3
5	3	3									3	3	3
6	3	3			3	3		3	3		3	3	3

Course Content	
<p>STRUCTURE OF PROTEIN Levels of protein structure: primary, secondary, tertiary, quaternary; Ramachandran plot; Mechanism of protein folding; Molecular chaperones; Protein denaturation and renaturation -Overview.</p> <p>Practical Component</p> <ol style="list-style-type: none"> <i>In silico</i> visualization of structures of proteins using a software tool. Qualitative analysis of Protein Partial purification of enzyme by salt precipitation SDS-PAGE for protein separation 	<p>6 Hours</p> <p>8 Hours</p>
<p>INTRODUCTION TO ENZYME BIOLOGY Enzyme activity – definition, calculation and influence of enzyme concentration (“p” versus “t” curve); Specific activity – definition and calculation; Factors influencing the rate of the reactions – concentration of the substrate, pH and temperature; Allosteric Regulation of Enzymes (Feedback Inhibition).</p> <p>Practical Component</p> <ol style="list-style-type: none"> Determination of an enzyme activity (plotting ([“p” versus “t” curve])). 	<p>6 Hours</p> <p>2 Hours</p>
<p>ENZYME KINETICS – FOUNDATIONS & MODELS Lock and Key model; Koshland’s induced fit model; Hypothesis of enzyme kinetics – rapid equilibrium (Henri - Michaelis – Menten) assumption models of single substrate (derivations are NOT mandatory); Relationship between K_m and substrate concentration (derivation are NOT mandatory); K_m and K_{cat} – definition and significance; Lineweaver – Burk (double reciprocal) and Eadie-Hofstee plots (derivations are NOT mandatory) – significance.</p> <p>Practical Component</p> <ol style="list-style-type: none"> Effect of pH and Temperature on enzyme activity. Effect of metal ions on enzyme activity. Calculation of V_{max}, K_m and K_{cat} using Michaelis – Menten (effect of substrate concentration) and LB plots. 	<p>6 Hours</p> <p>6 Hours</p>
INHIBITORY KINETICS	

Reversible and irreversible inhibition – overview; Competitive and non-competitive, Uncompetitive inhibition – concept and applications; and mixed inhibition – concept and applications; – mechanism. Practical Component 14. Evaluation of inhibitory kinetics pattern of an enzyme (any ONE type of inhibition)	6 Hours 2 Hours
ENZYME IMMOBILIZATION AND INDUSTRIAL APPLICATIONS Methods of immobilization - overview; Entrapment – mechanism of gel entrapment and microencapsulation; Advantages and Disadvantages of Immobilized enzymes; Applications of free enzymes in different industrial sectors– medicine (diagnosis), food, detergent and textile, Cosmetic application of enzymes. Practical Component (any TWO, and Sl. No. 1 is compulsory) 15. Immobilization of an enzyme using an entrapment method. 16. Activity comparison of free and immobilized enzymes 17. Degradation of a reactive dye/ analyte using an enzyme (Environment/ textile application) 18. Clarification of fruit juices through enzymes (Food applications) 19. Investigation of an enzyme (uricase/ creatininase/ GOD-POD/ urease etc.,) using kit-based method (Healthcare applications)	6 Hours 4 Hours

Self-Learning Topics: (Hours: 30)

- Causal mechanism of TATA box binding protein with eukaryotic DNA.
- Structure–function correlation – catalytic mechanism of chymotrypsin.
- Transition state theory of chemical reaction (a model to understand the influence of activation energy of enzymes).
- Acid-base and covalent catalysis – general principle.
- Double displacement or ping pong reactions.
- Significance of King and Altmann equation multisubstrate kinetics.
- Irreversible inhibition – mechanism.
- Cross linking – mechanism.
- Applications of free enzymes in different industrial sectors– leather and wool, detergent.

Theory Hours:	Tutorial Hours:	Practical Hours:	Project Hours:	Total Hours:
30	0	30	0	60

Learning Resources

Textbooks:

3. Palmer T and Bonner P. L. *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry* (2nd Ed.). Elsevier. (2007).
4. Copeland R. A. *Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis* (2nd Ed.). John Wiley & Sons. (2000).
5. Shanmugam S, Sathishkumar T and Shanmugaprakash M. *Enzyme Technology* (2nd Ed.). I. K. International Pvt Ltd. 2nd Ed.(2012).

References:

5. Carl Branden and John Tooze. *Introduction to Protein Structure* (2nd Ed.). Garland Science, Taylor & Francis Group, LLC. (1999).
6. Illanes, A. *Enzyme biocatalysis: Principles and Applications*. Springer Science &

Business Media. (2008).
Online Educational Resources:
3. https://ocw.mit.edu/courses/5-07sc-biological-chemistry-i-fall-2013/pages/module-i/session-3/
4. https://ocw.mit.edu/courses/5-07sc-biological-chemistry-i-fall-2013/pages/module-i/session-4/
5. https://ocw.mit.edu/courses/5-60-thermodynamics-kinetics-spring-2008/resources/lecture-32-steady-state-and-equilibrium-approximations/
6. https://www.youtube.com/watch?v=oaWQWB1S5Q4 (NPTEL – enzyme kinetics)

Assessment (Embedded course)	
Formative	Summative
Assignments / Mini project, MCQ, Lab Workbook, Experimental Cycle tests, viva-voce.	SA- I, SA – II and End Semester Examination (ESE)

Course Curated by		
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
1. Mr. M. Kannan, Manager Healthium Medtech Ltd Bengaluru, Karnataka, India. 2. Mr. V S Ravindran, CEO CapriEnzymes, Nanganallur, Chennai, Tamil Nadu, India.	Dr. J. Hema Associate Professor Dept. of Biotechnology PSG College of Technology Coimbatore – 641004.	Dr. T. Sathish Kumar, BT Dr. P. Muthukumaran, BT Dr. V. Stephen Raphael, BT
Recommended by BoS on	07/05/2025	
Academic Council Approval	28	Date 26/06/2025

24BTI209	BIOPROCESS ENGINEERING PRINCIPLES	L	T	P	J	C
		3	0	2	0	4
PC		SDG	9, 12			

Pre-requisite courses	24BTT102 Bioprocess Calculation	Data Book / Code book (If any)	--
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Course Objectives	
The purpose of taking this course is to study and understand	
1	Fluid flow, mixing, heat transfer, and mass transfer phenomena governing bioprocess systems and their influence on bioreactor performance.
2	Application of transport principles and separation techniques such as distillation and drying for the design, analysis, and optimization of bioprocess operations.
3	Determination of transport parameters and interpreting experimental data for validating theoretical models in bioprocess engineering.

Course Outcomes		Revised Bloom's Taxonomy Levels (RBT)
After successful completion of this course, the students shall be able to		
CO 1	Apply principles of fluid flow to determine flow behavior, viscosity, and rheological characteristics of Newtonian and non-Newtonian fluids used in bioprocessing.	Ap
CO 2	Analyze mixing performance in stirred tanks by evaluating flow patterns, power requirements, shear effects, and scale-up considerations in fermenters.	An
CO 3	Apply heat transfer principles to estimate heat transfer coefficients and evaluate the performance of heat exchange systems used in bioprocess operations	Ap
CO 4	Analyze mass transfer processes to evaluate oxygen transfer rates, kLa, and factors affecting oxygen supply in bioreactors	An
CO 5	Apply principles of distillation and drying to analyze separation efficiency and drying kinetics of biological materials.	Ap
CO 6	Analyze experimental data to determine transport parameters and evaluate the performance of fluid flow, mixing, heat transfer, mass transfer, and separation processes in bioprocess systems.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2
Engineering Knowledge													
Problem Analysis													
Design/Development of Solutions													
Conduct Investigations of													
Engineering Tool Usage													
The Engineer and The World													
Ethics													
Individual and Collaborative Team													
Communication													
Project Management and Finance													
Life-Long Learning													
1	3	2	1	2	2						1		3
2	3	3	2	2	2	1					1		3
3	3	2	2	2	2	1					1		3
4	3	3	2	3	2	2					1		3
5	3	2	2	2	2	1					1		3
6	2	3	2	3	3	1		3	3		2		3

Course Content	
FLUID FLOW Classification of fluids, Fluids in motion, Laminar and turbulent, Viscosity, Momentum transfer, Newtonian fluid, non-Newtonian fluids, Viscosity measurements, Rheological properties of fermentation broths, Factors affecting broth viscosity, Flow measurements and fluid transportation.	9 Hours
Practical Component: 1. Determination of Discharge and Flow Rate of Fluids through Pipes	6 Hours

- CFD applications in bioreactors
- Review of industrial bioreactor designs
- Gas–liquid–solid systems
- Reactive and vacuum distillation
- Spray drying of probiotics
- Freeze drying kinetics
- Industrial dryers

Learning Resources				
Textbooks:				
1. Doran Pauline M., <i>Bioprocess Engineering Principles</i> , Elsevier Science, 2 nd Edition (2013).				
2. Treybal, Robert E., <i>Mass Transfer Operations</i> , CBS Publishers & Distributors 4 th Edition (2026).				
References:				
47. McCabe W. L., Smith J. C., and Harriott P., <i>Unit Operations of Chemical Engineering</i> , McGraw-Hill, 7 th Edition. (2005)				
48. Geankoplis, Christie J., <i>Transport Processes and Separation Process Principles (includes Unit Operations)</i> : United Kingdom, Prentice Hall Professional Technical Reference, 4 th Edition. (2015).				
49. Stanbury P. F., Whitaker A., Hall S. J., <i>Principles of Fermentation Technology</i> , United Kingdom, Elsevier Science, 4 th Edition (2013).				
50. Shuler, Michael L., and Kargi, Fikret. <i>Bioprocess Engineering: Basic Concepts</i> . India, Pearson Education, 4 th Edition (2017).				
Online Educational Resources:				
7. https://www.bioprocessdigital.com/online-courses/bioprocess-engineering-basics-and-principles				
8. https://www.bioprocessonline.com/search?keyword=bioprocess+engineering+principles				
9. https://onlinecourses.nptel.ac.in/noc25_ch70/preview				
10. https://onlinecourses.nptel.ac.in/noc25_ch68/preview				
Theory	Tutorial	Practical	Project	Total
Hours: 45	Hours: 0	Hours: 30	Hours: 0	Hours: 75

Assessment (Embedded course)
SA 1, SA 2, Activity and Learning Task(s): MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, and viva-voce,

Course Curated by		
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
Dr. Sindhuamuthan K, Senior Scientist, Downstream, Neuland Laboratories Limited, Hyderabad, Telangana Ksamuthan@neulandlabs.com Sindhuamuthan.kathiravan@gmail.com	Dr. C. Ravikumar Associate Professor Chemical Engineering Indian Institute of Technology Dharwad	1. Dr.M.Shanmugaprakash 2. Dr.D.R.Manimaran 3. Dr.N.Sivarajasekar Department of Biotechnology Kumaraguru College of Technology
Recommended by BoS on	07/05/2025	
Academic Council Approval	28	Date 26/06/2025

24BTI209	BIOPROCESS ENGINEERING PRINCIPLES	L	T	P	J	C
		3	0	2	0	4
PC		SDG		9, 12		

Pre-requisite courses	24BTT102 Bioprocess Calculation	Data Book / Code book (If any)	--
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Course Objectives	
The purpose of taking this course is to study and understand	
1	Fluid flow, mixing, heat transfer, and mass transfer phenomena governing bioprocess systems and their influence on bioreactor performance.
2	Application of transport principles and separation techniques such as distillation and drying for the design, analysis, and optimization of bioprocess operations.
3	Determination of transport parameters and interpreting experimental data for validating theoretical models in bioprocess engineering.

Course Outcomes		Revised Bloom's Taxonomy Levels (RBT)
After successful completion of this course, the students shall be able to		
CO 1	Apply principles of fluid flow to determine flow behavior, viscosity, and rheological characteristics of Newtonian and non-Newtonian fluids used in bioprocessing.	Ap
CO 2	Analyze mixing performance in stirred tanks by evaluating flow patterns, power requirements, shear effects, and scale-up considerations in fermenters.	An
CO 3	Apply heat transfer principles to estimate heat transfer coefficients and evaluate the performance of heat exchange systems used in bioprocess operations	Ap
CO 4	Analyze mass transfer processes to evaluate oxygen transfer rates, kLa, and factors affecting oxygen supply in bioreactors	An
CO 5	Apply principles of distillation and drying to analyze separation efficiency and drying kinetics of biological materials.	Ap
CO 6	Analyze experimental data to determine transport parameters and evaluate the performance of fluid flow, mixing, heat transfer, mass transfer, and separation processes in bioprocess systems.	An

Co urs	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)
	1	2	3	4	5	6	7	8	9	10	11	

	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2
1	3	2	1	2	2						1		3
2	3	3	2	2	2	1					1		3
3	3	2	2	2	2	1					1		3
4	3	3	2	3	2	2					1		3
5	3	2	2	2	2	1					1		3
6	2	3	2	3	3	1		3	3		2		3

Course Content	
<p>FLUID FLOW Classification of fluids, Fluids in motion, Laminar and turbulent, Viscosity, Momentum transfer, Newtonian fluid, non-Newtonian fluids, Viscosity measurements, Rheological properties of fermentation broths, Factors affecting broth viscosity, Flow measurements and fluid transportation.</p> <p>Practical Component: 9. Determination of Discharge and Flow Rate of Fluids through Pipes 10. Study of Rheological Behaviour of Non-Newtonian Fluids</p>	<p>9 Hours</p> <p>6 Hours</p>
<p>MIXING Functions of mixing, mixing equipment, Flow patterns in stirred tanks, Stirrer power requirements, Mechanisms of mixing, mixing time, scale up of mixing systems, Improving mixing in fermenters, Rheologic properties in mixing, Shear in stirred fermenters.</p> <p>Practical Component: 11. Determination of Stirrer Effectiveness in a Stirred Tank with and without Sparging</p>	<p>9 Hours</p> <p>6 Hours</p>
<p>HEAT TRANSFER Mechanism of heat transfer, Conduction and convection, Heat transfer equipment, Heat transfer between fluids, Design equations for heat transfer systems, Application of the design equations, Hydrodynamics considerations with cooling coils.</p> <p>Practical Component: 12. Estimation of Overall Heat Transfer Coefficient in a Heat Exchanger</p>	<p>9 Hours</p> <p>6 Hours</p>
<p>MASS TRANSFER Molecular diffusion, Diffusion in Bioprocessing, Film theory, Convective mass transfer, Oxygen uptake in cell cultures, Factors affecting oxygen transfer in fermenters, Measuring dissolved oxygen concentration, Estimating oxygen solubility, Mass transfer correlations for oxygen transfer, Measurement of k_{La}, Measurement of the specific oxygen uptake rate, Oxygen transfer in large fermenters, Methods for oxygenation without sparging, Oxygen transfer within the flask.</p> <p>Practical Component:</p>	<p>9 Hours</p> <p>6 Hours</p>

13. Estimation of Volumetric Mass Transfer Coefficient (k_{La}) by Dynamic Gassing-Out Method / Sodium Sulphite method	
UNIT OPERATIONS Distillation – Vapour-Liquid Equilibria, Flash vaporization, Simple distillation, Steam distillation, Azeotropic distillation, Extractive distillation, Rayleigh equation, McCabe-Thiele method. Drying – Mechanism - Drying curves - Time of drying; Equipment for drying - Batch and continuous dryers. Practical Component: 14. Simple Distillation of Binary Liquid Mixture 15. Steam Distillation of Heat-Sensitive Biological Compounds 16. Determination of Drying Kinetics of Biological Materials	9 Hours 6 Hours

Self-Learning Topics: (Hours: 45)

- Dimensionless numbers (Re, Pr, Nu, Sh, Sc)
- Dimensional analysis of flow through pipes
- Time dependency of fluids
- Flow through beds (packed & fluidized)
- Power number correlations of stirrers
- Impeller comparison studies
- Dead zones & macro-mixing issues
- Shear-sensitive cell systems
- Metabolic heat generation in live cell bioreactors
- Dynamic cooling load calculations
- Fouling and heat exchanger degradation
- Microbubble and nano-bubble systems
- Membrane aeration technology
- Scale-up issues in OTR & k_{La} enhancement strategies
- CFD applications in bioreactors
- Review of industrial bioreactor designs
- Gas-liquid-solid systems
- Reactive and vacuum distillation
- Spray drying of probiotics
- Freeze drying kinetics
- Industrial dryers

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

Learning Resources	
Textbooks:	
3.	Doran Pauline M., <i>Bioprocess Engineering Principles</i> , Elsevier Science, 2 nd Edition (2013).
4.	Treybal, Robert E., <i>Mass Transfer Operations</i> , CBS Publishers & Distributors 4 th Edition (2026).
References:	
51.	McCabe W. L., Smith J. C., and Harriott P., <i>Unit Operations of Chemical Engineering</i> , McGraw-Hill, 7 th Edition. (2005)
52.	Geankoplis, Christie J., <i>Transport Processes and Separation Process Principles (includes Unit Operations)</i> : United Kingdom, Prentice Hall Professional Technical Reference, 4 th Edition. (2015).
53.	Stanbury P. F., Whitaker A., Hall S. J., <i>Principles of Fermentation Technology</i> , United Kingdom, Elsevier Science, 4 th Edition (2013).
54.	Shuler, Michael L., and Kargi, Fikret. <i>Bioprocess Engineering: Basic Concepts</i> . India, Pearson Education, 4 th Edition (2017).
Online Educational Resources:	
11.	https://www.bioprocessdigital.com/online-courses/bioprocess-engineering-basics-and-principles
12.	https://www.bioprocessonline.com/search?keyword=bioprocess+engineering+principles
13.	https://onlinecourses.nptel.ac.in/noc25_ch70/preview
14.	https://onlinecourses.nptel.ac.in/noc25_ch68/preview

Assessment (Embedded course)
SA 1, SA 2, Activity and Learning Task(s): MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, and viva-voce,

Course Curated by			
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)	
Dr. Sindhuamuthan K, Senior Scientist, Downstream, Neuland Laboratories Limited, Hyderabad, Telangana Ksamuthan@neulandlabs.com Sindhuamuthan.kathiravan@gmail.com	Dr. C. Ravikumar Associate Professor Chemical Engineering Indian Institute of Technology Dharwad	4.	Dr.M.Shanmugaparakash
		5.	Dr.D.R.Manimaran
		6.	Dr.N.Sivarajasekar
			Department of Biotechnology Kumaraguru College of Technology
Recommended by BoS on	07/05/2025		
Academic Council Approval	28	Date	26/06/2025

24BTI210	ENVIRONMENTAL BIOTECHNOLOGY AND SUSTAINABILITY	L	T	P	J	C
		1	0	0	2	2
PC		SD G	12, 13, 15			

Pre-requisite courses	-	Data Book / Code book (If any)	-
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Course Objectives:	
The purpose of taking this course is to:	
1	Introduce students to the principles of environmental biotechnology and systems thinking for understanding sustainability challenges across food systems, climate change, One Health, and the water–xenobiotics nexus.
2	Enable students to apply biotechnology-based approaches to design and evaluate context-specific, sustainable solutions through project-based and reflective learning.
3	To foster critical thinking, ethical reasoning, and project-based problem solving skills for developing context-specific, scalable, and sustainable biotechnological interventions aligned with circular bio-economy and global sustainability frameworks.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Explain and analyze environmental sustainability challenges across food systems, climate change, One Health, and the water–xenobiotics nexus using systems thinking and environmental biotechnology principles.	An
CO 2	Design context-specific, biotechnology-enabled solutions to environmental problems and justify design choices considering sustainability, risk, and ethical implications.	Ap
CO 3	Evaluate the environmental and societal impacts of proposed biotechnological interventions using qualitative sustainability indicators, trade-off analysis, and reflective reasoning.	E

	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11		
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communication	Project Management and Finance	Life-Long Learning	PSO-1	PSO-2
1	3	3	3	3	2	3	2	3	3	2	2	3	2
2	3	3	3	3	2	3	2	3	3	2	2	3	2
3	3	3	3	3	2	3	2	3	3	2	2	3	2

<u>Course Content</u>	
<p>Sustainable Food Systems and Environmental Biotechnology: Integrated socio-ecological food systems; carbon and water footprint analysis; environmental biotechnology applications (biofertilizers, biopesticides, fermentation, alternative proteins); food waste valorization and circular bioeconomy; sustainability metrics and accounting frameworks; environmental, health, and socio-economic dimensions of GM crops in relation to food security.</p>	7 hours
<p>Climate Change Mitigation and Adaptation through Environmental Biotechnology: Carbon and nitrogen biogeochemical cycles; microbial mediation of carbon, nitrogen, and methane fluxes; biotechnology-enabled climate mitigation (algal, microbial, and soil-based carbon sequestration, bioenergy systems); nature-based and hybrid resilience strategies; sustainability assessment metrics for mitigation and adaptation technologies; circular and alternative bioeconomic models for climate resilience.</p>	7 hours
<p>One Health: Integrating Human, Animal, and Environmental Systems: Integrated One Health framework linking human, animal, and environmental systems; ecological and anthropogenic drivers of emerging and re-emerging diseases; environmental biotechnology applications (wastewater-based epidemiology, microbiome analysis, antimicrobial resistance surveillance); environmental monitoring and disease prevention strategies; biosensors and biotechnological diagnostics; ethical, governance, and sustainability dimensions of One Health implementation.</p>	8 hours
<p>Water–Xenobiotic Interactions and Biotechnological Remediation: Xenobiotic classification, sources, transport, transformation, and fate in aquatic systems; water contamination by pharmaceuticals, pesticides, and plastics with health and sustainability implications; environmental biotechnology for pollutant removal (bioremediation, biodegradation, biofilms, constructed wetlands); biological and nature-based water treatment systems; risk assessment and sustainability evaluation frameworks; emerging bio-radiation and bio-electrochemical remediation technologies.</p>	8 hours

Project:

Students shall undertake structured project work aligned with the course modules. Project 1 will be based on Module 1 or 2, and Project 2 on Module 3 or 4. A Final Project will require developing a business or implementation case study derived from either Project 1 or Project 2. Projects will be evaluated through multiple components, including hand-drawn poster presentations, oral

presentations with viva voce, and a Design Workbook documenting analytical and design tools. Assessment will focus on originality, conceptual clarity, relevance, and feasibility. Top-ranked projects may be supported for implementation or nominated for competitions, subject to guidelines and resource availability.

Self Learning Topics (Hours : 15)

- Precision Fermentation and AI-Enabled Food Bioprocessing: Study of precision fermentation, digital process control, and AI applications advancing sustainable protein and ingredient production.
- Indigenous and Traditional Fermented Foods as Sustainable Systems: Analysis of traditional fermentation, microbial diversity, and contributions to resilient, low-carbon food systems.
- Microbial Geoengineering and Ethical Boundaries: Evaluation of microbial climate interventions and associated ethical, ecological, and governance implications.
- Climate-Smart Biotechnology for Extreme Weather Resilience: Study of biological solutions addressing floods, droughts, heatwaves, and ecosystem instability.
- Environmental Dimensions of Antimicrobial Resistance (AMR): Examination of wastewater, agricultural, and industrial drivers of AMR and mitigation approaches.
- Urbanization, Biodiversity Loss, and Zoonotic Spillover Risks: Assessment of land-use change and ecosystem disruption in emerging infectious disease risk. Microplastics as Emerging
- Xenobiotics in Aquatic Systems: Review of sources, biological effects, detection limits, and removal strategies. Biological Treatment of PFAS and Persistent Pollutants: Analysis of research on biodegradation and transformation of “forever chemicals.”

Theory Hours: 15	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 15	Total Hours: 30
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<p>Textbooks:</p> <p>Sustainable Food Systems and Environmental Biotechnology</p> <ol style="list-style-type: none"> 1. Agarwal, S. K. (2018). <i>Environmental Biotechnology</i>. New Delhi: APH Publishing Corporation. 2. FAO & INRAE. (2020). <i>Enabling sustainable food systems: Innovators 'handbook</i>. Rome: Food and Agriculture Organization of the United Nations. https://doi.org/10.4060/ca9917en <p>Climate Change Mitigation and Adaptation through Environmental Biotechnology</p> <ol style="list-style-type: none"> 1. Talwar, A. K., & Juneja, S. <i>Global Climate Change</i>. New Delhi: Commonwealth Publishers. ISBN: 9788131101568. 2. World Intellectual Property Organization (WIPO). (2023). <i>Green Technology Book 2023: Solutions for Climate Change Adaptation and Mitigation</i>. Geneva: World Intellectual Property Organization. 3. National Academies of Sciences, Engineering, and Medicine (NASEM). (2024). <i>Microbial Solutions for Climate Change</i>. Washington, DC: The National Academies Press.

4. United Nations Framework Convention on Climate Change (UNFCCC). (2006). *Technologies for Adaptation to Climate Change*. Bonn: United Nations Framework Convention on Climate Change.

One Health – Integrating Human, Animal, and Environmental Systems

1. Zinsstag, J., Schelling, E., Crump, L., Whittaker, M., Tanner, M., & Stephen, C. (2020). *The Theory and Practice of Integrated Health Approaches*. Wallingford, Oxfordshire, UK; Boston, USA: CAB International.

2. Ottinger, M. A., & Geiselman, C. (2023). *One Health Meets the Exposome: Human, Wildlife, and Ecosystem Health*. Amsterdam: Elsevier.

Water–Xenobiotics Nexus and Biotechnological Remediation

1. Singh, A., & Ward, O. P. *Biodegradation & Bioremediation*. New Delhi: Daya Publishing House.

2. Bhat, R. A., Hakeem, K. R., & Al-Saud, N. B. S. (Eds.). (2020). *Bioremediation and Biotechnology, Vol. 3: Persistent and Recalcitrant Toxic Substances*. Cham: Springer.

References:

Sustainable Food Systems and Environmental Biotechnology

1. Ericksen, P., Ingram, J., & Liverman, D. (Eds.). (2010). *Food Security and Global Environmental Change*. Oxford: Oxford University Press.
2. Nigam, P. S., & Pandey, A. (Eds.). (2009). *Biotechnology for Agro-Industrial Residues Utilisation*. Dordrecht: Springer.
3. Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, 360(6392), 987–992.
4. Herrero, M., et al. (2020). Innovation can accelerate the transition towards a sustainable food system. *Nature Food*, 1, 266–272.

Climate Change Mitigation and Adaptation through Environmental Biotechnology

1. Lehmann, J., & Joseph, S. (Eds.). (2015). *Biochar for Environmental Management: Science, Technology and Implementation* (2nd ed.). London: Routledge.
2. Singh, S. N. (Ed.). (2014). *Microbe-Induced Degradation of Pesticides*. Cham: Springer.
3. Smith, P., et al. (2016). Biological mitigation of climate change. *Nature Climate Change*, 6, 1–10.
4. Lehmann, J., & Joseph, S. Biochar for environmental management. *Science*.

One Health – Integrating Human, Animal, and Environmental Systems

1. Zinsstag, J., Schelling, E., Waltner-Toews, D., & Tanner, M. (2015). *One Health: The Theory and Practice of Integrated Health Approaches*. Wallingford, Oxfordshire, UK: CABI.
2. Fletcher, S., & Martin, B. (Eds.). (2018). *Environmental Health and One Health*. Cham: Springer.
3. Destoumieux-Garzón, D., et al. (2018). The One Health concept: 10 years old. *Frontiers in Veterinary Science*, 5, 14.
4. Larsson, D. G. J., & Flach, C. F. (2022). Antibiotic resistance in the environment. *Nature Reviews Microbiology*, 20, 257–269.

Water–Xenobiotics Nexus and Biotechnological Remediation

1. Henze, M., van Loosdrecht, M., Ekama, G., & Brdjanovic, D. (2008). *Biological Wastewater Treatment: Principles, Modelling and Design*. London: IWA Publishing.
2. Vidali, M. (2001). Bioremediation: An overview. *Pure and Applied Chemistry*, 73(7), 1163–1172.
3. Schwarzenbach, R. P., et al. (2006). The challenge of micropollutants in aquatic systems. *Science*, 313(5790), 1072–1077.
4. Ali, H., Khan, E., & Sajad, M. A. (2013). Bioremediation of xenobiotics: mechanisms and applications. *Bioresource Technology*, 143, 534–549.

Online Educational Resources:

Sustainable Food Systems and Environmental Biotechnology

Online Resources

1. CGIAR – Global Food Systems Research Network (*Research-focused*)
<https://www.cgiar.org>
2. FAO – Agrifood Systems & Bioeconomy Innovation (*Policy-focused*)
3. *Nature Food* (Journal) (*Research-focused*)
<https://www.nature.com/natfood>

Explainer Videos

1. FAO – Transforming Food Systems for Sustainability
<https://www.youtube.com/watch?v=xG6lKSwal28>
2. Wageningen University – Future of Sustainable Food Systems
<https://www.youtube.com/watch?v=Jz1Vj5r5zV8>

India-Linked Global Initiatives

1. ICAR – National Initiative on Climate Resilient Agriculture (NICRA)
2. DBT – BioE3 Policy and iBRIC+ Bioeconomy Mission
3. FAO–India Partnership on Sustainable Agrifood System

Climate Change Mitigation and Adaptation through Environmental Biotechnology

Online Resources

1. IPCC – Interactive Reports and Data (*Policy & Research synthesis*)
<https://www.ipcc.ch>
2. Global Carbon Project (*Research-focused*)
<https://www.globalcarbonproject.org>
3. Mission Innovation – Climate & Bioenergy Hub (*Technology-focused*)
<https://mission-innovation.net>

Explainer Videos

1. IPCC – *Climate Change Explained*
https://www.youtube.com/watch?v=G4H1N_yXBiA
2. NASA – *The Carbon Cycle and Climate Change*
<https://www.youtube.com/watch?v=1o4J3k0yK1E>

India-Linked Global Initiatives

1. DBT – National Bioenergy & Advanced Biofuels Programme
2. ICAR–NICRA Climate Adaptation Technologies
3. UNEP–India Climate and Bioeconomy Partnerships

One Health – Integrating Human, Animal, and Environmental Systems

Online Resources

1. WHO–FAO–WOAH–UNEP One Health Joint Platform (*Policy-focused*)

- <https://www.who.int/teams/one-health>
2. The Lancet Planetary Health (Research-focused)
<https://www.thelancet.com/journals/lanplh>
 3. CDC – One Health Resources (*Technology-focused*)
<https://www.cdc.gov/onehealth>

Explainer Videos

1. WHO – *What is One Health?*
<https://www.youtube.com/watch?v=Vbq7JYzHkUQ>
2. FAO – One Health and Food Systems
<https://www.youtube.com/watch?v=aq4j3TjuY-s>

India-Linked Global Initiatives

1. DBT – National One Health Programme for Prevention and Control of Zoonoses (NOHP-PCZ)
2. FAO–WOAH–WHO–UNEP – Quadripartite One Health Joint Plan of Action
3. GHSA–India – Global Health Security Agenda (One Health Framework Participation)

Water–Xenobiotics Nexus and Biotechnological Remediation Online Resources

Online Resources

1. NORMAN Network – Emerging Contaminants (*Research & Policy-linked*)
<https://www.norman-network.net>
2. UNESCO – Water Quality & Emerging Pollutants (*Policy-focused*)
<https://www.unesco.org/en/water-quality>

Explainer Videos

1. UNESCO – Emerging Pollutants in Water Systems
<https://www.youtube.com/watch?v=rYm8mKaol2Q>
2. MIT OpenCourseWare – *Biological Wastewater Treatment*
<https://www.youtube.com/watch?v=0xjQnPzY7aY>

India-Linked Global Initiatives

1. DBT – Mission Clean Technologies (Water & Waste)
2. CPCB–UNEP Water Quality Monitoring Programmes
3. Institute of Bioresources and Sustainable Development (DBT)

Assessment (Embedded course)

SA1, Comprehensive MCQ, Group discussions/debate followed by MCQ, Design workbook, Business case study presentation + viva, Business case study report.

Course Curated by			
Expert(s) from Industry	Expert from Higher Education Institution	Internal Expert(s)	
Dr. Sridharan Jegadeesan Founder and CEO Craftzymes, Coimbatore	Dr. Velmurugan G, Scientist, KMCHRF	Dr. Padhmanand Sudhakar	Dr. Vinohar Stephen Raphael Dr. Sivarajasekar Natesan
Recommended by BoS on	21/11/2025		
Academic Council Approval	No.29	Date	24/12/2025

SEMESTER V

24BTI301	UPSTREAM BIOPROCESSING		L	T	P	J	C
			3	0	2	0	4
PC			SDG		9, 12		
Pre-requisite courses	Bioprocess Calculations (24BTT102), Bioprocess Engineering Principles (24BTI209)	Data Book / Codes / Standards (If any)	Nil				

Course Objectives	The purpose of taking this course is to
1	To develop a comprehensive understanding of fermentation processes, fermenter configuration, media formulation and optimization, sterilization design, and bioreactor engineering for the rational design of industrial bioprocesses.
2	To apply bioreactor design principles using Monod kinetics, process instrumentation and control, and scale-up methodologies including non-ideal reactor analysis for transitioning bioprocesses from laboratory to industrial scale.

Course Outcomes	After successful completion of this course, the students shall be able to	Revised Bloom's Taxonomy Levels (RBTL)
CO 1	Describe the general requirements, types, and process flow of fermentation processes; identify the basic configuration, ancillary equipment, instrumentation, control parameters, and inoculum development principles of industrial fermenters.	UN
CO 2	Formulate fermentation media using stoichiometric principles and optimize media components using statistical methods — Plackett-Burman design, Simplex design, and Response Surface Methodology (RSM).	CR
CO 3	Apply sterilization design criteria — Del factor (∇) and F_0 value — to design batch and continuous sterilization systems for fermentation media and air.	AP
CO 4	Design and evaluate batch, fed-batch, continuous stirred tank (CSTR), and plug flow bioreactors using Monod kinetics and mass balance equations for target productivity.	CR
CO 5	Apply scale-up criteria (constant $k_L a$, P/V, tip speed) and RTD analysis to transition bioprocesses from laboratory to pilot and production scale.	AP

<p>selection criteria for aerobic, anaerobic, and cell culture processes. Bioreactor design for animal cell culture: shear sensitivity and CO₂ management.</p> <p>Practical Component: 6. Determination of Specific Growth Rate (μ), Maximum Specific Growth Rate (μ_{max}), and Monod Saturation Constant (K_s) for Bacterial Cell Production in Batch Culture using Lineweaver-Burk Plot (<i>Wet Lab</i>) 7. Study of Batch Fermentation Kinetics — Determination of Biomass Yield Coefficient ($Y_{X/S}$) and Productivity in Batch Culture (<i>Wet Lab</i>)</p>	6 Hours
<p>SCALE-UP AND NON-IDEAL REACTOR ANALYSIS</p> <p>Scale-up criteria: geometric similarity, constant k_La, constant P/V, constant impeller tip speed — comparison and selection. Scale-up challenges: heat removal, mixing time increase, and shear stress at production scale. Scale-up of animal cell culture systems: mammalian and insect cells. Introduction to non-ideal reactors: reasons for non-ideality in industrial reactors. Residence Time Distribution (RTD) — RTD functions $E(t)$ and $F(t)$, measurement methods. RTD in plug flow and mixed flow (CSTR) — comparison and dispersion model.</p> <p>Practical Component: 8. Residence Time Distribution (RTD) Studies in a Stirred Tank Fermenter using Pulse Tracer Technique — Determination of $E(t)$, $F(t)$ Functions, Mean Residence Time, and Non-Ideality Parameters at Different Agitation Speeds (<i>Wet Lab</i>) 9. Scale-Up of Aerobic Fermentation from 5 L Laboratory Fermenter to 500 L Pilot Scale — Comparative Evaluation of Constant k_La, Constant Power-per-Volume (P/V), and Constant Impeller Tip Speed Criteria using Spreadsheet Computation (<i>Computation Lab</i>)</p>	9 Hours 9 Hours

Self-Learning Topics: (Hours: 5)

- Pilot plant design principles and technology transfer protocols
- Industrial bioreactor configurations — airlift, bubble column, fixed-bed and hollow fibre bioreactors
- Single-use (disposable) bioreactor systems — wave bag and stirred single-use bioreactors
- Computational Fluid Dynamics (CFD) applications in bioreactor design and scale-up
- Overview of GMP requirements and regulatory considerations for upstream bioprocessing

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	30	Project Hours:	0	Total Hours:	75
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Learning Resources
Textbooks
1. Stanbury P.F., Whitaker A. and Hall S.J., Principles of Fermentation Technology, Elsevier Science, 4th Edition (2013).

<p>2. Shuler M.L., Kargi F. and DeLisa M., Bioprocess Engineering: Basic Concepts, Prentice Hall, 3rd Edition (2017).</p> <p>3. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press / Elsevier, 2nd Edition (2013).</p>
<p>Reference books/ Web Links</p> <p>1. Bailey J.E. and Ollis D.F., Biochemical Engineering Fundamentals, McGraw-Hill, 2nd Edition (1986).</p> <p>2. Asenjo J.A. and Merchuk J.C., Bioreactor System Design, Marcel Dekker (1995).</p> <p>3. Levenspiel O., Chemical Reaction Engineering, Wiley, 3rd Edition (1999).</p> <p>4. Nielsen J., Villadsen J. and Liden G., Bioreaction Engineering Principles, Springer, 3rd Edition (2011).</p>
<p>Online Resources</p> <p>1. https://archive.nptel.ac.in/courses/103/103/103103165/ (Bioprocess Engineering — IIT Kharagpur)</p> <p>2. https://archive.nptel.ac.in/courses/103/105/103105209/ (Biochemical Engineering — IIT Bombay)</p> <p>3. https://www.stat-ease.com/design-expert.html (Design Expert Software tutorials, Stat-Ease Inc.)</p>

<p>Assessment (Embedded course)</p> <p>SA 1, SA 2, Activity and Learning Task(s)*, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle Tests, Viva-Voce</p>

<p>Course Curated by</p>			
<p>Expert(s) from Industry</p> <p>Dr. Sindhuamuthan K, Senior Scientist, Downstream, Neuland Laboratories Limited, Hyderabad, Telangana Ksamuthan@neulandlabs.com Sindhuamuthan.kathiravan@gmail.com</p>	<p>Expert(s) from Higher Education Institution</p> <p>Dr. C. Ravikumar Associate Professor Chemical Engineering Indian Institute of Technology Dharwad</p>	<p>Internal Expert(s)</p> <p>1. Dr.M.Shanmugaprakash 2. Dr.D.R.Manimaran 3. Dr.N.Sivarajasekar</p>	
<p>Recommended by BoS on</p>			
<p>Academic Council Approval</p>		<p>Date</p>	

Course Content	
<p>BIOLOGICAL DATABASES & DATA RETRIEVAL</p> <p>Introduction to bioinformatics – Scope and applications; Biological databases – Primary: GenBank, EMBL, DDBJ; Secondary: UniProt, Pfam; Structural: PDB; Data formats – FASTA, GenBank, GFF, PDB; Database search systems – Entrez Sequence retrieval; Functional annotation – Gene vs protein annotation</p> <p>Practical Component</p> <p>1. Database Search and Retrieval (NCBI, Uniprot, RCSB)- Search queries using Boolean operators and filters.</p>	<p>7 Hours</p> <p>2 Hours</p>
<p>SEQUENCE ALIGNMENT & DATABASE SEARCHING</p> <p>Pairwise alignment – Global vs local; Scoring systems – PAM, BLOSUM; Gap penalties; Dynamic programming – Needleman-Wunsch, Smith-Waterman; Database Searching: BLAST – algorithm, types (BLASTN, BLASTP, BLASTX, TBLASTN, TBLASTX), statistical significance (E-value, bit score); FASTA program; PSI-BLAST, PHI-BLAST – concepts and applications. Multiple Sequence Alignment (MSA): CLUSTALW, CLUSTAL Omega, MUSCLE, MAFFT; T-Coffee; MSA interpretation and visualization with ESPript and Jalview.</p> <p>Practical Component</p> <p>1. BLAST search: BLASTP and BLASTN against NCBI databases – interpreting results, E-value, score.</p> <p>2. Multiple sequence alignment using CLUSTAL Omega or MUSCLE – analyze conserved regions.</p>	<p>7 Hours</p> <p>2 Hours</p>
<p>PHYLOGENETICS AND GENOMIC ANALYSIS</p> <p>Phylogenetic Analysis: Concepts of molecular evolution; Homology – orthologs and paralogs; Distance-based methods – UPGMA, Neighbor-Joining; Character-based methods – Maximum Parsimony, Maximum Likelihood; Bayesian inference – overview; Tree visualization using MEGA, FigTree, iTOL.</p> <p>Genome Analysis: Whole genome sequencing overview; Genome annotation – ab initio vs. similarity-based; Gene prediction tools – AUGUSTUS, Glimmer, GeneMark; Functional annotation – COG, GO terms, KEGG pathways; Comparative genomics – synteny, genome rearrangements; Genome browsers – UCSC, Ensembl.</p> <p>Practical Component</p> <p>1. Construct a phylogenetic tree using MEGA from aligned sequences – NJ and Maximum Likelihood methods.</p> <p>2. Annotate a genome region using NCBI Genome browser or Ensembl.</p> <p>3. Functional annotation of a set of sequences using BLAST2GO or KEGG Mapper.</p> <p>4. Predict genes in a given genome using AUGUSTUS or Glimmer (web server).</p>	<p>7 Hours</p> <p>2 Hours</p>

5. Long-read sequencing technologies – PacBio and Oxford Nanopore bioinformatics.
6. Single-cell RNA-Seq analysis overview – Seurat, UMAP visualization.
7. Post-translational modifications and their bioinformatics detection tools.
8. CRISPR off-target analysis using bioinformatics tools (Cas-OFFinder, CRISPOR).
9. Data integration in multi-omics studies – concepts and tools.

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	30	Project Hours:	0	Total Hours:	75
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Learning Resources

Textbooks:

1. Mount D.W. Bioinformatics: Sequence and Genome Analysis (2nd Ed.). Cold Spring Harbor Laboratory Press. (2004).
2. Lesk A.M. Introduction to Bioinformatics (5th Ed.). Oxford University Press. (2019).
3. Pevsner J. Bioinformatics and Functional Genomics (3rd Ed.). Wiley-Blackwell. (2015).

References:

1. Baxevanis A.D. and Ouellette B.F.F. (Eds.). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3rd Ed.). Wiley-Interscience. (2004).
2. Durbin R., Eddy S., Krogh A. and Mitchison G. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press. (1998).
3. Xiong J. Essential Bioinformatics. Cambridge University Press. (2006).

Online Educational Resources:

1. <https://www.ncbi.nlm.nih.gov/home/learn/> (NCBI Learning Resources)
2. <https://www.ebi.ac.uk/training/> (EMBL-EBI Training)
3. <https://www.coursera.org/specializations/bioinformatics> (Bioinformatics Specialization, UC San Diego – Coursera)
4. <https://nptel.ac.in/courses/102103065> (NPTEL – Bioinformatics: Algorithms and Applications)
5. <https://usegalaxy.org/training> (Galaxy Training Network)

Assessment (Embedded course)

Formative	Summative
Assignments / Mini project, MCQ, Lab Workbook, Experimental Cycle tests, viva-voce.	SA- I, SA – II and End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		Dr. V. Stephen Raphael, BT
Recommended by BoS on	07/05/2025	
Academic Council Approval	28	Date 26/06/2025

24BTI303	IMMUNOTECHNOLOGY	L	T	P	J	C
		2	0	2	0	3
PC		SDG		3, 9		

Pre-requisite courses	24BTT104 Cell Biology	Data Book / Code book (If any)	Nil
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Course Objectives:

The purpose of taking this course is to:

1	To understand the fundamentals of the immune system , including immune cells, organs, and types of immunity..
2	To explain the structure and function of antigens and antibodies and the mechanisms of immune responses.
3	To apply knowledge of immunological techniques and their applications in diagnostics, vaccine development, and immunotherapy.

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Explain the structure and functions of the immune system , including immune cells, lymphoid organs, and types of immunity.	An
CO 2	Describe the properties of antigens and antibodies , including immunoglobulin structure, classes, and antigen–antibody interactions.	An
CO 3	Illustrate the mechanisms of immune responses , including humoral and cell-mediated immunity, antigen presentation, cytokines, and complement system.	An
CO 4	Apply knowledge of immunological techniques such as ELISA, Western blotting, immunofluorescence, and flow cytometry for analysis and diagnostics.	Ap
CO 5	Analyze various immunological disorders including hypersensitivity, autoimmune diseases, immunodeficiency, and tumor immunology.	An
CO 6	Evaluate the applications of immunotechnology in vaccine development, monoclonal antibodies, immunodiagnostics, and immunotherapy .	Ev

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1	3										3	2	2	
2	3										3	3	3	
3	3	3									3	3	3	
4	3	3									3	3	3	
5	3	3									3	3	3	

6	3	3			3	3		3	3		3	3	3	
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Course Content	
Basics of Immune system Types of immunity: Innate & Adaptive; Cells of immune system (T-cells, B-cells, macrophages, etc.); Primary & secondary lymphoid organs; Hematopoiesis; Immune response- overview. Practical Component 20. Blood smear preparation and identification of Leucocytes 21. ABO blood group determination	6 Hours
Immune Responses Humoral immunity (B-cell mediated); Cell-mediated immunity (T-cell mediated); Antigen presentation (MHC I & II); Cytokines & complement system. Practical Component 1. Isolation and identification of PBMC cells 2. Isolation of separation of leucocytes from blood by dextran methods	6 Hours
Antigens & Antibodies Antigen properties & immunogenicity; Concepts of haptens, epitopes, adjuvants; Structure & types of immunoglobulins (IgG, IgM, IgA, IgE, IgD); Function of Immunoglobulins. Practical Component 1. Detection of antigen - Widal test 2. Determination of antigen concentration by Single radial assay	6 Hours
Immunological Techniques Antigen-antibody reactions; ELISA, RIA, Western blotting; Immunofluorescence; Flow cytometry (FACS); Hybridoma technology (monoclonal antibodies) Practical Component 1. Detection of antigen by using dot plot ELISA 2. Western Blotting - Demonstration	6 Hours
Advanced Immunotechnology Monoclonal antibodies production; Vaccines (traditional & recombinant); Immunodiagnosics- Cancer diagnosis; Immunotherapy (modern trends). Practical Component 1. Kit based diagnosis - Corona detection (COVID-19) 2. Kit based diagnosis - Dengue NS1 antigen test	6 Hours

Self Learning Topics: (Hours: 9)

Theory Hours:	Tutorial Hours:	Practical Hours:	Project Hours:	Total Hours:
30	0	20	0	50

Learning Resources
Textbooks:
6. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2021). <i>Cellular and molecular immunology</i> (10th ed.). Elsevier.
7. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). <i>Roitt's essential</i>

<i>immunology</i> (13th ed.). Wiley-Blackwell.
References:
7. Owen, J. A., Punt, J., & Stranford, S. A. (2018). <i>Kuby immunology</i> (8th ed.). W.H. Freeman.
8. Coico, R., & Sunshine, G. (2015). <i>Immunology: A short course</i> (7th ed.). Wiley-Blackwell.
9. Sompayrac, L. (2019). <i>How the immune system works</i> (6th ed.). Wiley-Blackwell.
Online Educational Resources:
7. https://www.sciencedirect.com/journal/immunotechnology
8. https://link.springer.com/chapter/10.1007/978-1-0716-2372-5_10
9. https://www.nature.com/articles/243246a0
10. https://www.immunology.org/public-information/what-immunology

Assessment (Embedded course)	
Formative	Summative
Assignments / Mini project, MCQ, Lab Workbook, Experimental Cycle tests, viva-voce.	SA- I, SA – II and End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)	
		Dr. P. Muthukumaran, BT	
Recommended by BoS on			
Academic Council Approval	No:	Date	

24BTT305	Core Competencies in Biotechnology (Conceptual Foundations)	L	T	P	J	C
		1	0	0	0	0
Professional Core		SDG	4			
Pre-requisite courses	-	Data Book / Code book (If any)	-			
Course Objectives:						
The purpose of taking this course is to:						
1	Reinforce fundamental concepts in molecular biology, biochemistry, cell biology, and genetics					

2	Enable integration of concepts across biological domains
3	Develop analytical thinking using conceptual MCQs and problem-solving
4	Prepare students for competitive examinations like GATE
5	Standardize foundational knowledge across the cohort

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Recall and understand core biological concepts	U
CO 2	Apply conceptual knowledge to solve MCQs	Ap
CO 3	Analyze biological problems and eliminate incorrect options	An
CO 4	Integrate concepts across disciplines	An
CO 5	Identify biological scenarios logically	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2
Engineering Knowledge													
Problem Analysis													
Design/Development of Solutions													
Conduct Investigations of Complex Problems													
Engineering Tool Usage													
The Engineer and The World													
Ethics													
Individual and Collaborative Team work													
Communication													
Project Management and Finance													
Life-Long Learning													
1	3	1									2	3	2
2	3	2		1							2	3	2
3	3	3		2							2	2	3
4	3	3		2							3	2	3
5	3	3		2							3	2	3

Course Content

Central Dogma & Information Flow DNA replication, transcription, translation Gene regulation (prokaryotes & eukaryotes)	1 Hour
Protein Structure & Function Protein structure levels Enzyme kinetics and inhibition	1 Hour
Cell Biology Cell organelles and functions Cell signaling and transport mechanisms	1 Hour
Genetics Mendelian genetics Mutation and gene expression	1 Hour
Integration Metabolic pathways Systems biology approach	1 Hour

Theory Hours:	Tutorial Hours:	Practical Hours:	Project Hours:	Total Hours:
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Learning Resources
Textbooks:
12. Nelson, David L., Cox, Michael M., Lehninger Principles of Biochemistry, W.H. Freeman (2017) 13. Alberts, Bruce., Molecular Biology of the Cell, Garland Science (2015).
References:
55. Watson, James D., Molecular Biology of the Gene, Pearson (2013) 56. Lodish, Harvey., Molecular Cell Biology, W.H. Freeman (2016)
Online Educational Resources:
15. MIT OpenCourseWare Free Online Course Materials 16. NPTEL Online Courses
Assessment (Theory course)
Weekly MCQs: 40% Mid Tests: 30% Final GATE-style Exam: 30%

Course Curated by		
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
[Name, Organization]	[Name, Institution]	Dr. Vinohar Stephen Rapheal Dr. Kumaresan
Recommended by BoS on	XX/YY/2024	

Academic Council Approval	No.	Date	XX/YY/2024
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SEMESTER VI

3		3		3	2	3	2			3			
4		3	3	3	2	3	2			3			3
5		3	3		2	2	3			3			3
6		3	3		2	2	3	3	3	3			3

Course Content

<p>Introduction to Bio-separations: Important downstream processes in biochemical processes. Selection of downstream process. Characteristics of bioseparations. Physico-chemical basis. Heuristic principles for bioseparations. Green chemistry approaches. Process economy. Industrial examples: Purification of bioproducts on a large scale.</p> <p>Removal of Insolubles: Cell disruption methods for recovery of intracellular products – Mechanical, Chemical & Enzymatic. Solid-liquid separations: Theory of settling, Centrifugation, Industrial centrifuges: Tubular and Disc Bowl Centrifuge, Ultra-centrifugation,</p> <p>Practical Component:</p> <ul style="list-style-type: none"> Filtration – Batch and Continuous; Filter equipment. Disruption of cell walls and estimation of intracellular proteins 	<p>9 Hours</p> <p>9 Hours</p>
<p>Enrichment Operations: Membrane-based separations – Membrane Modules; Flow patterns in membrane separations: Microfiltration, Ultrafiltration, Dial-filtration. Nominal Molecular Weight Cut-off (NMWCO), Transport equations for cross flow filtration. Precipitation methods using salts, organic solvents and polymers. Industrial scale precipitations.</p> <p>Practical Component:</p> <ul style="list-style-type: none"> Concentration of yeast cells using Microfiltration Isolation of proteins using ammonium sulphate precipitation Isoelectric precipitation 	<p>9 Hours</p> <p>9 Hours</p>
<p>Product Isolation: Chemistry and modes of extraction – Partition coefficient. Batch & Continuous counter current co-current, differential extractions. Aqueous Two-Phase Extractions (ATPE) – phase diagrams; Reverse micellar extractions – critical micellar concentration, ionic liquid, supercritical fluid, microwave assisted extraction. Adsorption: Principles, isotherms; Batch adsorption and its applications.</p> <p>Practical Component:</p> <ul style="list-style-type: none"> Polymer-assisted extraction of polyphenols Recovery of proteins using aqueous two-phase extraction (ATPE) Reverse micellar extraction Adsorption of biological molecules 	<p>9 Hours</p> <p>9 Hours</p>
<p>Purification: Chromatographic purification: particle coefficient and terminologies, process scale considerations for gel filtration, ion exchange and hydrophobic interaction. Protein A chromatography, chromatography, chromatography calculations, large scale, Preparative HPLC. Purification from inclusion bodies.</p> <p>Practical Component:</p> <ul style="list-style-type: none"> Ion exchange chromatography Gel filtration chromatography 	<p>9 Hours</p> <p>9 Hours</p>
<p>Product polishing: Drying – Theory, Time of drying, Industrial dryer, Spray drying, Freeze drying (Lyophilization). Crystallization – Theory of super saturation; Factors governing nucleation and crystal growth, Industrial crystallizers.</p> <p>Practical Component:</p> <ul style="list-style-type: none"> Freeze-drying (Lyophilization) Spray drying 	<p>9 Hours</p> <p>9 Hours</p>

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	15	Project Hours:	0	Total Hours:	60
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Learning Resources

Textbooks:

14. Belter P.A, Cussler, E.L and Wei-Houhu . Bioseparations- Downstream Processing for Biotechnology, Wiley Interscience Publications, USA.), (1998)

15. Sivashankar, B. Bioseparation : Principles and Techniques, Prentice Hall of India, New Delhi. (2005).
References:
57. Roger G.Harrison, Paul Todd, Scott R.Ruger and Demetri P. Petrides. Bioseparation Science and Engineering. Oxford University Press, 2nd ed. NewYork. (2009).
Online Educational Resources:
1. http://nptel.ac.in/courses/102106022/
2. http://www.intelligen.com/superpro_features.html

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

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

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

*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)
Er. Baluchinnasamy Founder and Director Ayaraa Foods, Coimbatore	Dr. N. Selvaraju Professor, Department of Biosciences and Bioengineering IIT Gwahati	Dr. N. Sivarajasekar Dr. D.R. Manimaran Dr. M. Shanmugaprakash Dr. K.Ram APIII/ Biotechnology
Recommended by BoS on	XX/YY/2024	
Academic Council Approval	No.	Date XX/YY/2024

24BTI307	BIostatistics and EXPERIMENTAL DESIGN	L	T	P	J	C
		1	0	2	0	2
PC		SDG	2, 3 & 9			
Pre-requisite courses	Nil	Data Book / Code book (If any)	Statistics table book			

Course Objectives:	
The purpose of taking this course is to:	
1	To develop the ability to analyze and summarize biological data using appropriate descriptive statistical measures and correlation techniques.
2	To enable application of inferential statistical methods and experimental designs for hypothesis testing and interpretation of biological experiments.
3	To develop proficiency in performing and visualizing statistical analyses of biological data using spreadsheet and computational tools.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Evaluate the complex biological datasets by applying suitable descriptive, and inferential statistical tools to draw valid scientific conclusions.	Ev
CO 2	Critically analyse the biological data and regression models by choosing appropriate experimental designs.	An
CO 3	Execute and integrate appropriate statistical analyses (descriptive, inferential, and regression) and graphical representations using digital tools to accurately interpret biological datasets and validate experimental results.	An

	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11			
Course Outcomes (CO)	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communication	Project Management and Finance	Life-Long Learning	PSO1	PSO2	PSO3
1	3				3						3	3	2	
2	3				3						3	3	3	
3	3	3			3			3	3		3	3	3	

Course Content	
DESCRIPTIVE AND INFERENTIAL BIostatISTICS	10 Hours
Introduction to descriptive and inferential biostatistics; Descriptive statistics - Arithmetic average, Median, Standard deviation, Coefficient of variance (CV). Spearman's Rank	

<p>coefficient; Karl-Pearson correlation coefficient; Inferential biostatistics (testing hypothesis) – Student’s t-Test (paired and unpaired), One way ANOVA and Chi square test.</p> <p>[Biological data ALONE should be used as examples and ONLY problems to be solved]</p> <p>Practical Component [MS excel or any free online / commercial tools]</p> <p>22. Construction of a calibration curve (Arithmetic mean, standard deviation, CV, correlation coefficient and simple regression analysis) (descriptive statistics).</p> <p>23. Plotting bar diagram, histogram and boxplot (descriptive statistics).</p> <p>24. Student’s t-Test (paired and unpaired).</p> <p>25. One way ANOVA (single factor).</p> <p>26. Two way ANOVA (without replicates).</p>	10 Hours
<p>EXPERIMENTAL DESIGN AND REGRESSION ANALYSIS</p> <p>Simple regression and multiple regression analyses (ONLY problems to be solved); Experimental designs (overview and significance) - Completely Randomized Designs, Block designs, Response surface methodology designs.</p> <p>Practical Component [MS excel or any free online / commercial tools]</p> <p>2. Multiple regression analysis (calculation of predicted values from experimental values and residual error for biological data).</p> <p>3. Analysis of a biological data generated using response surface designs (DEMO).</p> <p>4. Plotting “x” and “y” coordinates using a programming language.</p>	5 Hours 5 Hours

Self Learning Topics: (Hours: 2)

- Arithmetic average and Standard deviation.
- Significance of confidence interval (CI) and level of significance.

Theory Hours:	Tutorial Hours:	Practical Hours:	Project Hours:	Total Hours:
15	0	15	0	30
Learning Resources				
Textbooks:				
8. Brian Williams. <i>Biostatistics (concepts and applications for biologists)</i> . CRC Press. (2017).				
9. Gupta S. P. <i>Statistical Methods</i> (46 th revised Ed.). Sultan Chand and Sons, Delhi, India (2021).				
References:				

10. Seltman, Howard J. <i>Experimental design and analysis</i> . Pittsburgh: Carnegie Mellon University. (2012)
11. Devore, Jay L. <i>Probability and Statistics for Engineering and the Sciences</i> (8 th Ed.). Boston: Cengage Learning. (2012).
Online Educational Resources:
11. http://www.digimat.in/nptel/courses/video/102106051/L02.html
12. http://www.digimat.in/nptel/courses/video/102106051/L39.html

Assessment (Embedded course)	
Formative	Summative
Assignments, MCQ, Lab Workbook, Experimental Cycle tests, viva-voce.	SA- I

Course Curated by			
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)	
Mr. M. Kannan Manager Healthium Medtech Ltd Bengaluru Karnataka, India.	Dr. J. Hema Associate Professor Dept. of Biotechnology PSG College of Technology Coimbatore – 641004.	Dr. T. Sathish Kumar, BT Dr. K. Ram, BT	
Recommended by BoS on			
Academic Council Approval	No:	Date	

24BTI308	INTEGRATIVE HUMAN PHYSIOLOGY	L	T	P	J	C
		3	0	0	0	3
PC		SDG	3			
Pre-requisite courses	24BTI103 Biochemistry and Cellular Energetics	Data Book / Code book (If any)		Nil		
Course Objectives:						
The purpose of taking this course is to:						
1	Analyze the integrated role of physiological systems in maintaining homeostasis and fluid balance under normal and pathological conditions.					
2	Evaluate the mechanisms of digestion, circulation, excretion, and respiration in relation to metabolic demands and disease states.					

3	Interpret clinical and biochemical parameters (e.g., glucose levels, HbA1c, cholesterol, INR, renal tests) for diagnosis and monitoring of physiological disorders.
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Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Critically analyze mechanisms of homeostasis, including feedback systems and body fluid distribution,	An
CO 2	Analyse the role of different gastrointestinal (GI) tract based glandular secretory components in the aid of digestion and absorption processes.	An
CO 3	Interpret the mechanism of beating of heart (cardiac cycle), and the various regulatory modes of hypertension.	An
CO 4	Relate the anatomical features of nephron in the formation of urine and reabsorption processes, and anatomical features of alveolus in the phenomenon of gaseous exchange in lungs.	Ap
CO 5	Examine the influence of male and female sex hormones in the process of formation of sperms and ovum.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1	3										3	3		
2	3	3									3	3		
3	3										3	3		
4	3	3									3	3		
5	3										3	3		

Course Content	
HOMEOSTASIS AND BODY FLUIDS Homeostasis – role of various physiological systems (overview); Mechanism of action of homeostatic system – positive feedback (clotting of blood); negative feedback (maintenance of water balance in kidneys); Body fluids - distribution (intra and extracellular fluids) and composition; Measurement of body fluid volume – characteristics of marker substances; total body water (calculation using a marker), extracellular fluid (calculation using sucrose), plasma volume (calculation using a marker) and blood cell volume (hematocrit value); Maintenance of	8 Hours

water balance – dehydration and overhydration (causes and treatment); Blood - composition, properties and functions; Lymph – composition and functions; Tissue fluid (interstitial fluid) – overview.	
GASTROINTESTINAL PHYSIOLOGY Introduction to digestive system; Overview anatomy of GI tract layers; Overview of digestion and absorption processes; Composition and functions - salivary, gastric, pancreatic and bile juices; Functions of small and large intestines. Functions of liver; Pathophysiology - diabetes mellitus (DM). Clinical interpretations - Plasma glucose levels (fasting & postprandial); Serum glycated haemoglobin (HbA1c) levels.	12 Hours
CARDIOVASCULAR PHYSIOLOGY Overview anatomy of heart wall and heart valves; Physiology of blood circulation process; Cardiac cycle – mechanism of pumping of blood (briefing the stages is sufficient); Hypertension - overview and mechanism of renin-angiotensin-aldosterone (RAAS) and baroreceptor systems to control hypertension; Pathophysiology - Myocardial infarction. Clinical interpretations – serum cholesterol levels (hypo- & hypercholesterolemia); International Normalized Ratio (INR) in critical cardiac diseases.	12 Hours
RENAL AND RESPIRATORY PHYSIOLOGY Functions of renal system (kidney); Overview of structure of nephron; Mechanism of urine formation; Overview of structure of respiratory tract; Mechanism of gaseous exchange in lungs. Clinical interpretations - microscopic and biochemical analysis of urine (renal functional tests).	8 Hours
REPRODUCTIVE PHYSIOLOGY Physiological phases - spermatogenesis, oogenesis and menstrual cycle; Functions of sex hormones.	5 Hours

Self Learning Topics: (Hours: 9)

- Measurement of body fluid volume – characteristics of marker substances; total body water (calculation using a marker).
- Measurement of body fluid volume – extracellular fluid (calculation using sucrose).
- Functions of small and large intestines.
- Functions of liver.
- Physiology of blood circulation process.
- Functions of renal system (kidney).

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours:	45
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Learning Resources

Textbooks:

16. Sembulingam, K., and Sembulingam, P. Essentials of medical physiology. Jaypee Brothers Medical Publishers (P) Ltd., (2012).
17. Hall, J. E. Guyton and Hall Textbook of Medical Physiology. Elsevier Health Sciences. (2015).

References:

58. Varley, H., and Gowenlock, A. H. Varley's Practical clinical biochemistry. CRC Press LLC. (2022). 6th Ed (8th reprint).
59. Loscalzo, J., Kasper, D. L., Wiener, C., Fauci, A. S., Hauser, S. L., Longo, D. L., and Jameson, J. L. Harrison's Principles of Internal Medicine Self-Assessment and Board Review, 20th Edition. McGraw-Hill Education / Medical. (2021).

Online Educational Resources:

17. <https://youtu.be/T0qR4S1VgvA>
18. <https://youtu.be/N34OPiF3bVY>

Assessment

Formative	Summative
Exit ticket / Quiz	SA- I, SA – II and End Semester Examination (ESE)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
Mr. M. Kannan Manager, Healthium Medtech Ltd Bengaluru, Karnataka, India.	Dr. J. Hema, Associate Professor, Dept of Biotechnology, PSG College of Technology, Coimbatore, Tamil Nadu, India.	Dr. T. Sathish Kumar Dr. V. Stephen Rapheal
Recommended by BoS on	XX/YY/2026	
Academic Council Approval	No.	Date XX/YY/2026

SEMESTER VII

24BTT401	DRUG DEVELOPMENT AND REGULATORY AFFAIRS	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
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Course Objectives:

The purpose of taking this course is to:

1	Understand the drug discovery and development pipeline from target identification to commercialization.
2	Familiarize students with preclinical and clinical trial processes used in pharmaceutical industries
3	Explain regulatory frameworks and approval procedures followed by global regulatory agencies
4	Develop competency in documentation, regulatory submissions, and compliance requirements
5	Analyze ethical, safety, and quality issues involved in pharmaceutical product development

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Explain the stages involved in drug discovery and development.	U
CO2	Interpret preclinical evaluation and pharmacokinetic studies.	An
CO3	Describe clinical trial phases and Good Clinical Practice	U
CO4	Analyze regulatory approval processes across global agencies.	An
CO5	Evaluate regulatory documentation, intellectual property and compliance procedures	E

C/O	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1	3	2									2	3	
2	3	3		2			3				2	3	
3	2	2					3		2		2	2	
4	3	3		2		2	3				2	3	
5	3	2				2	3		2		3	2	

Course Content

DRUG DISCOVERY PROCESS	9 Hours
Topics: <ul style="list-style-type: none"> • Introduction to pharmaceutical product development • Drug discovery pipeline • Target identification and validation • Lead compound identification • High-throughput screening techniques • Structure-activity relationship (SAR) 	

PRECLINICAL DEVELOPMENT Topics:	9 Hours
<ul style="list-style-type: none"> • Preclinical studies and objectives • In vitro and in vivo pharmacological studies • Toxicological evaluation • Pharmacokinetics and pharmacodynamics • ADME studies (Absorption, Distribution, Metabolism, Excretion) 	
CLINICAL TRIALS Topics:	9 Hours
<ul style="list-style-type: none"> • Clinical trial design and methodology • Phase I, II, III and IV clinical trials • Good Clinical Practice (GCP) guidelines • Ethical considerations in clinical trials • Role of Institutional Review Boards (IRB) and Ethics Committees 	
REGULATORY AFFAIRS Topics:	9 Hours
<ul style="list-style-type: none"> • Regulatory framework in pharmaceutical industry • Role of regulatory agencies: <ul style="list-style-type: none"> ○ US FDA ○ EMA ○ CDSCO (India) ○ WHO • Investigational New Drug (IND) application • New Drug Application (NDA) submission process • Drug approval pathways 	
QUALITY, IPR AND REGULATORY DOCUMENTATION Topics:	9 Hours
<ul style="list-style-type: none"> • Good Manufacturing Practices (GMP) • Quality assurance and quality control • Regulatory documentation and dossier preparation • Intellectual Property Rights (IPR) and patent filing • Regulatory compliance and pharmacovigilance 	

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours:	45
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Learning Resources
Textbooks:
<ol style="list-style-type: none"> 1. Singh, S. K., <i>Drug Discovery and Development</i>, Wiley, New Jersey (2019). 2. Gad, S. C., <i>Drug Safety Evaluation</i>, Wiley-Interscience, New York (2016).
References:

- Walker, J. M., *Clinical Trials and Regulatory Affairs*, CRC Press, Florida (2017).
- Abraham, J., *Pharmaceutical Regulation and Policy*, Oxford University Press (2018).
- FDA Guidance Documents for Industry (www.fda.gov).
- WHO Guidelines on Good Clinical Practice.

Online Educational Resources:

- <https://nptel.ac.in/courses/102106065>
- <https://swayam.gov.in>
- <https://www.fda.gov>
- <https://cdsco.gov.in>

Assessment (Theory course)

Course Curated by

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
[Name, Organization]	[Name, Institution]	Dr Kumaresan K Department of Biotechnology
Recommended by BoS on	XX/YY/2026	
Academic Council Approval	No.	Date XX/YY/2026

24BTT402	BIOENTREPRENEURSHIP AND INNOVATION	L	T	P	J	C
		3	0	0	0	3
PE		SDG	12			
Pre-requisite courses	Nil	Data Book / Code book (If any)		Nil		

Course Objectives:

The purpose of taking this course is to:

1	Introduce the principles of entrepreneurship and innovation in biotechnology sectors.
2	Develop understanding of biotech startups, technology commercialization, and intellectual property management
3	Equip students with skills to develop business models and entrepreneurial strategies for biotechnology ventures
4	Familiarize learners with funding mechanisms, regulatory pathways, and innovation ecosystems.
5	Encourage entrepreneurial thinking for translation of biotechnology research into commercial products

Course Outcomes

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Explain the concepts of entrepreneurship, innovation and startup ecosystems in biotechnology.	U
CO2	Analyze business opportunities and market potential in biotechnology sectors.	An
CO3	Apply business model frameworks for biotechnology startups.	Ap
CO4	Evaluate funding strategies, intellectual property and regulatory requirements for biotech ventures.	E
CO5	Develop entrepreneurial strategies for commercialization of biotechnology innovations.	C

C O	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1	3	2	-	2	-	-	-	-	-	-	-	3	1
2	2	3	-	2	2	-	-	-	-	-	-	3	1
3	2	3	-	3	3	-	-	-	-	-	-	3	2
4	3	2	-	3	3	1	-	-	-	-	-	3	2
5	2	2	1	2	1	2	2	2	1	1	1	2	2

Course Content	
INTRODUCTION TO BIO-ENTREPRENEURSHIP Topics: <ul style="list-style-type: none"> • Concept of entrepreneurship and innovation • Biotechnology entrepreneurship ecosystem • Global and Indian biotech industry landscape • Role of startups in biotechnology innovation 	9 Hours
OPPORTUNITY IDENTIFICATION AND BUSINESS MODELS Topics: <ul style="list-style-type: none"> • Opportunity recognition in biotechnology sectors • Market analysis and feasibility assessment • Business model development • Lean startup methodology and value proposition 	9 Hours
TECHNOLOGY COMMERCIALIZATION Topics: <ul style="list-style-type: none"> • Technology transfer and commercialization pathways • Product development cycle in biotech startups • Intellectual Property Rights and patent strategies • Licensing and technology partnerships 	9 Hours
FUNDING AND REGULATORY ENVIRONMENT Topics: <ul style="list-style-type: none"> • Venture capital and angel investment • Government funding schemes and incubation programs • Biotechnology regulatory requirements • Startup India and biotech innovation policies 	9 Hours

ENTREPRENEURIAL MANAGEMENT AND CASE STUDIES Topics: <ul style="list-style-type: none"> • Business planning and financial management • Leadership and team building in startups • Risk management and scaling strategies • Case studies of successful biotech startups 	9 Hours

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours:	45
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Learning Resources	
Textbooks:	
<ol style="list-style-type: none"> 1. Shimasaki, C., <i>Biotechnology Entrepreneurship: Starting, Managing and Leading Biotech Companies</i>, Academic Press, New York (2014). 2. Hisrich, R., Peters, M., and Shepherd, D., <i>Entrepreneurship</i>, McGraw Hill Education, New York (2020). 	
References:	
<input type="checkbox"/> Auerswald, P., <i>The Coming Prosperity: How Entrepreneurs Are Transforming the Global Economy</i> , Oxford University Press (2012). <input type="checkbox"/> OECD, <i>Biotechnology Innovation and Entrepreneurship</i> , OECD Publishing (2018). <input type="checkbox"/> Government of India, <i>Biotechnology Industry Research Assistance Council (BIRAC) Guidelines</i> .	
Online Educational Resources:	
<input type="checkbox"/> https://nptel.ac.in/courses/110105159 <input type="checkbox"/> https://swayam.gov.in <input type="checkbox"/> https://www.birac.nic.in <input type="checkbox"/> https://startupindia.gov.in	

Assessment (Theory course)

Course Curated by		
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
[Name, Organization]	[Name, Institution]	Dr Kumaresan K Department of Biotechnology
Recommended by BoS on	XX/YY/2026	
Academic Council Approval	No.	Date XX/YY/2026

SEMESTER VIII

24BTJ405 Capstone Project Phase II -12 credits

PROFESSIONAL ELECTIVES

24BTT5XX	BIOMASS VALORISATION AND TECHNO-ECONOMIC ASSESSMENT	L	T	P	J	C
		3	0	0	0	3
PE	SDG 7, 12, 13					

Pre-requisite courses	Bioprocess Calculations (24BTT102), Biochemistry, Microbiology	Data Book / Code book (If any)	-
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Course Objectives	
The purpose of taking this course is to	
1	To develop understanding of biomass feedstocks, biorefinery concepts, pre-treatment strategies and biological conversion routes for the production of biofuels, biochemicals, bioplastics and biomaterials from waste biomass.
2	To apply techno-economic analysis (TEA) and life cycle assessment (LCA) methodologies to evaluate the economic feasibility and environmental sustainability of biomass valorisation processes.

Course Outcomes	Revised Bloom's Taxonomy Levels (RBT)
After successful completion of this course, the students shall be able to	
CO 1 Describe the concept of biomass valorisation, classify biomass feedstocks by type and composition, and explain biorefinery concepts and circular bioeconomy principles.	UN
CO 2 Apply physical, chemical and biological pre-treatment methods to enhance biomass digestibility and evaluate enzymatic hydrolysis strategies for lignocellulosic and algal biomass.	AP
CO 3 Analyze biological conversion routes — fermentation, anaerobic digestion, enzymatic hydrolysis — for production of biofuels, organic acids, bioplastics and bioactive compounds from biomass.	AN

CO 4 Apply techno-economic analysis (TEA) — capital cost estimation, operating cost, minimum selling price, NPV, IRR and sensitivity analysis — to evaluate economic feasibility of biomass valorisation processes.	AP
CO 5 Analyze life cycle assessment (LCA) methodology and apply it to quantify environmental impacts — carbon footprint, energy balance, water usage — of biomass valorisation processes.	AN
CO 6 Evaluate integrated biorefinery concepts by combining valorisation routes, TEA and LCA to assess commercial viability and sustainability of industrial biomass valorisation case studies.	EV

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, I					
	1	2	3	4	5	6
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World
1	3	1				1
2	3	2	2	2	1	1
3	3	3	2	2	1	2
4	3	3	3	2	2	1
5	3	3	2	2	2	3
6	3	3	3	3	2	3

<u>Course Content</u>	
BIOMASS FEEDSTOCKS AND VALORISATION CONCEPTS	9 Hours

<p>Concept of biomass valorisation — definition, scope and industrial significance. Classification of biomass feedstocks: lignocellulosic biomass (agricultural residues, forestry waste), algal biomass, food processing waste, municipal solid waste (MSW) and animal waste. Composition of lignocellulosic biomass: cellulose, hemicellulose and lignin — structure and properties. Biorefinery concept: analogous to petroleum refinery — integrated production of fuels, chemicals and materials from biomass. Types of biorefineries: lignocellulosic, algal and waste-based. Value pyramid: high-value low-volume vs low-value high-volume products. Circular bioeconomy — policy framework, SDG alignment (SDG 7, 12, 13).</p>	
<p>BIOMASS PRE-TREATMENT AND HYDROLYSIS</p> <p>Need for pre-treatment — recalcitrance of lignocellulosic biomass. Physical pre-treatment: size reduction (milling, grinding), steam explosion, extrusion. Chemical pre-treatment: dilute acid (H_2SO_4), alkali (NaOH), ionic liquids, organosolv process. Biological pre-treatment: white-rot fungi (lignin degradation), microbial consortia. Physicochemical methods: hydrothermal treatment, ammonia fibre explosion (AFEX). Enzymatic hydrolysis: cellulase and hemicellulase systems — synergistic action, inhibition and enzyme recycling. Pre-treatment of algal biomass: cell disruption methods — bead milling, ultrasonication, high-pressure homogenisation. Comparison of pre-treatment methods — efficiency, cost, inhibitor formation and environmental impact.</p>	<p>9 Hours</p>
<p>BIOLOGICAL CONVERSION ROUTES — PRODUCTS AND PROCESSES</p> <p>Biofuel production: bioethanol — simultaneous saccharification and fermentation (SSF), consolidated bioprocessing (CBP); biobutanol — ABE fermentation; biogas — anaerobic digestion (AD), stages of AD, biogas upgrading to biomethane; biodiesel — transesterification of microalgal lipids. Organic acid production: lactic acid, succinic acid, citric acid and itaconic acid — fermentation routes and applications. Biopolymer and bioplastic production: polyhydroxyalkanoates (PHA) and polyhydroxybutyrate (PHB) — microbial production and downstream recovery. Bioactive compound extraction: phenolics, carotenoids and pigments from agricultural waste — applications in food, pharma and cosmetics. Single cell protein (SCP) production from waste biomass. Lignin valorisation: platform chemicals — vanillin, phenolic compounds and lignin-based materials.</p>	<p>9 Hours</p>
<p>TECHNO-ECONOMIC ANALYSIS (TEA) OF BIOPROCESSES</p>	<p>9 Hours</p>

<p>Introduction to techno-economic analysis (TEA) — purpose, scope and methodology. Process design basis: mass and energy balance as foundation for TEA. Capital expenditure (CAPEX): equipment cost estimation — Lang factor method, factored estimates, cost indices (CEPCI). Operating expenditure (OPEX): raw material costs, utility costs, labour, maintenance and overhead. Cost of goods (CoG) calculation — per kg or per litre of product. Minimum selling price (MSP) — break-even analysis. Profitability metrics: Net Present Value (NPV), Internal Rate of Return (IRR) and payback period. Sensitivity analysis: effect of feedstock price, product titre and yield on MSP — tornado plots. Case studies: TEA of bioethanol plant, PHA production facility and biogas plant.</p>	
<p>LIFE CYCLE ASSESSMENT (LCA) AND INTEGRATED BIOREFINERY EVALUATION</p> <p>Life cycle assessment (LCA) — definition, purpose and ISO 14040/14044 framework. Four phases of LCA: goal and scope definition, life cycle inventory (LCI), life cycle impact assessment (LCIA) and interpretation. Impact categories: global warming potential (GWP), energy demand, water footprint, eutrophication and acidification. Functional unit and system boundary — allocation methods (mass, energy, economic). LCA of biofuels vs fossil fuels — comparative environmental assessment. Carbon footprint of bioprocesses: greenhouse gas (GHG) accounting. Integrated biorefinery evaluation: combining TEA and LCA for holistic assessment. Industrial symbiosis — zero-waste biorefinery design. Case studies: LCA of bioethanol from sugarcane bagasse; TEA + LCA of algal biorefinery; PHA production from food waste.</p>	<p>9 Hours</p>

Self-Learning Topics: (Hours: 5)

- Thermochemical conversion routes — pyrolysis, gasification and hydrothermal liquefaction of biomass
- Metabolic engineering strategies for improved biofuel and biochemical production
- Process simulation tools for bioprocess TEA — SuperPro Designer and Aspen Plus overview
- LCA software tools — SimaPro and OpenLCA overview
- Policy and regulatory frameworks for bioeconomy — National Biofuel Policy (India), EU Bioeconomy Strategy

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours: 45
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Learning Resources

Textbooks:

1. Clark J. and Deswarte F. (Eds.), Introduction to Chemicals from Biomass, Wiley, 2nd Edition (2015).
2. Pandey A., Negi S., Binod P. and Larroche C. (Eds.), Pretreatment of Biomass: Processes and Technologies, Elsevier (2015).
3. Turton R., Bailie R.C., Whiting W.B. and Shaeiwitz J.A., Analysis, Synthesis and Design of Chemical Processes, Prentice Hall, 4th Edition (2012).

References:

1. Moncada J., Cardona C.A. and Rincon L.E., Techno-economic analysis for a sugarcane biorefinery: Colombian case, Bioresource Technology (2014).
2. Spatari S., Zhang Y. and Maclean H.L., Life Cycle Assessment of Switchgrass and Corn Stover Derived Ethanol-Fueled Automobiles, Environ. Sci. Technol. (2005).
3. Peters M.S. and Timmerhaus K.D., Plant Design and Economics for Chemical Engineers, McGraw-Hill, 5th Edition (2003).
4. ISO 14040:2006 — Environmental Management — Life Cycle Assessment — Principles and Framework.

Online Educational Resources:

1. <https://archive.nptel.ac.in/courses/103/103/103103218/> (Biomass Conversion — IIT Kharagpur)
2. <https://archive.nptel.ac.in/courses/103/107/103107166/> (Bioenergy — IIT Roorkee)
3. <https://www.eea.europa.eu/publications/bioeconomy> (European Environment Agency — Bioeconomy Reports)

Assessment (Theory Course)

SA 1, SA 2, Activity and Learning Task(s)*, MCQ, End Semester Examination (ESE)

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
		1. 2. 3.
Recommended by BoS on		
Academic Council Approval		Date

24BTT5XX	BIOFUELS TECHNOLOGY	L	T	P	J	C
		2	0	1	0	3
PE	SDG 7, 12, 13					

Pre-requisite courses	Bioprocess Calculations (24BTT102), Biochemistry, Microbiology, Fermentation Engineering (24BTT3XX)	Data Book / Code book (If any)	-
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Course Objectives	
The purpose of taking this course is to	
1	To develop understanding of biomass feedstocks, bioenergy conversion routes and production processes for first, second and third generation biofuels including bioethanol, biodiesel, biohydrogen and biogas.
2	To apply techno-economic and life cycle assessment principles to evaluate biofuel systems and understand the policy, sustainability and regulatory framework governing biofuel development in India and globally.

Course Outcomes	Revised Bloom's Taxonomy Levels (RBT)
After successful completion of this course, the students shall be able to	
CO 1 Describe the global energy scenario, classify biofuels by generation, identify biomass feedstock types and their chemical composition, and compare thermochemical and biochemical conversion routes.	UN
CO 2 Analyze first and second generation bioethanol production processes — feedstock processing, enzymatic hydrolysis, fermentation strategies and downstream purification — and evaluate relevant policy frameworks.	AN
CO 3 Apply principles of transesterification for biodiesel production, evaluate feedstock options and product quality parameters, and analyze microalgal biofuel production and biohydrogen generation processes.	AP

CO 4 Analyze the stages of anaerobic digestion, design operating parameters for biogas production systems, and evaluate biogas upgrading, digestate utilisation and national biogas programmes.	AN
CO 5 Evaluate advanced biofuel technologies, integrated biorefinery concepts, metabolic engineering strategies and sustainability and policy frameworks governing biofuel production.	EV
CO 6 Demonstrate practical skills in biomass characterisation, bioethanol and biodiesel production, biogas digester operation and techno-economic and LCA analysis of biofuel systems.	AP

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)								
	1	2	3	4	5	6	7	8	9
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics	Individual and Collaborative Team work	Communi
1	3	1				2			
2	3	3	2	2	1	1			
3	3	3	2	2	1	1			
4	3	3	2	2	1	2			
5	3	2	2	1	2	3			
6	2	2	1	3	2	2		1	2

<u>Course Content</u>	
BIOMASS AND BIOENERGY BASICS Global energy scenario and need for bioenergy. Classification of biofuels — 1st, 2nd and 3rd generation. Types of biomass: lignocellulosic, starch-based, oilseed and aquatic. Chemical composition of biomass — cellulose, hemicellulose, lignin, starch and lipids. Thermochemical vs biochemical conversion routes. Energy	6 Hours

<p>balance and carbon footprint — net energy ratio (NER) and life cycle assessment (LCA) introduction.</p> <p>Practical Component:</p> <p>P1. Biomass Characterisation — Determination of Moisture Content, Ash Content and Crude Fibre of Agricultural Residues (Rice Straw / Sugarcane Bagasse) using Standard AOAC Methods and Estimation of Total Reducing Sugars after Acid Hydrolysis by DNS Method (<i>Wet Lab</i>)</p>	
<p>BIOETHANOL PRODUCTION</p> <p>First-generation ethanol: starch and sucrose feedstocks; gelatinization, liquefaction and saccharification using amylases; yeast fermentation by <i>Saccharomyces cerevisiae</i>; batch and fed-batch modes. Second-generation ethanol: lignocellulosic pretreatment — dilute acid, steam explosion and alkali; cellulase enzyme systems; simultaneous saccharification and fermentation (SSF); pentose-fermenting organisms (<i>Pichia stipitis</i>, engineered <i>E. coli</i>); inhibitor tolerance (furfural, HMF). Downstream processing: distillation, azeotropic distillation and molecular sieve dehydration; fuel-grade ethanol standards; vinasse management; India's E20 blending policy.</p> <p>Practical Component:</p> <p>P2. Bioethanol Production by SSF — Preparation of Saccharified Starch Hydrolysate, Fermentation by <i>Saccharomyces cerevisiae</i> and Estimation of Ethanol by Dichromate Titration Method (<i>Wet Lab</i>)</p>	<p>8 Hours</p>
<p>BIODIESEL AND BIOHYDROGEN</p> <p>Biodiesel: transesterification reaction chemistry; edible oil feedstocks (palm, soybean) vs non-edible (<i>Jatropha</i>, <i>Karanja</i>); alkali-catalysed and enzyme-catalysed (lipase) transesterification; FAME quality parameters — viscosity, flash point and cetane number; glycerol valorisation. Microalgal biofuels: lipid-accumulating algae (<i>Chlorella</i>, <i>Nannochloropsis</i>); open raceway ponds vs photobioreactors; nitrogen starvation for lipid induction; wet lipid extraction; algal biodiesel vs conventional biodiesel. Biohydrogen: dark fermentation vs photo-fermentation; key organisms (<i>Clostridium</i>, <i>Rhodobacter</i>); substrates and yields; challenges for scale-up.</p> <p>Practical Component:</p> <p>P3. Biodiesel Preparation and Quality Testing — Transesterification of Non-Edible Oil (<i>Jatropha</i> / Waste Cooking Oil) using NaOH/Methanol and Quality Assessment by Viscosity, Flash Point and BIS Standard Comparison (<i>Wet Lab</i>)</p>	<p>6 Hours</p>

<p>BIOGAS AND ANAEROBIC DIGESTION</p> <p>Stages of anaerobic digestion: hydrolysis, acidogenesis, acetogenesis and methanogenesis; key microbial groups — acetogens and methanogens. CSTR and UASB reactor design. Operating parameters — pH, temperature (mesophilic vs thermophilic), HRT, OLR and C:N ratio. Common feedstocks — cattle dung, food waste and sewage sludge; co-digestion strategy. Inhibitors — ammonia and sulphide. Biogas composition and upgrading to biomethane. CHP (combined heat and power) applications. Digestate as biofertilizer. National biogas programmes in India — GOBAR-Dhan scheme.</p> <p>Practical Component:</p> <p>P4. Laboratory Biogas Digester Setup — Construction of Batch Anaerobic Digester using Cattle Dung, Monitoring of Daily Gas Production by Water Displacement Method and Calculation of Specific Biogas Yield (L/kg VS) (<i>Wet Lab</i>)</p>	<p>6 Hours</p>
<p>ADVANCED BIOFUELS, BIOREFINERY AND POLICY</p> <p>Biobutanol via ABE fermentation (<i>Clostridium acetobutylicum</i>). Drop-in aviation biofuels — HEFA and ATJ. Biorefinery concept — integrated utilisation of all biomass fractions. Metabolic engineering for biofuel strain improvement (CRISPR tools). Techno-economic analysis (TEA) overview. Food vs fuel debate and land use change. Sustainability certification — ISCC and RSB. Global biofuel policies — EU RED, US RFS and India National Biofuel Policy 2018.</p> <p>Practical Component:</p> <p>P5. LCA Case Study and Techno-Economic Analysis — Comparative Analysis of 1st Generation (Corn Ethanol) vs 2nd Generation (Sugarcane Bagasse Ethanol) Biofuel Systems: Calculation of GHG Savings (%), NER and Production Cost per Litre (<i>Computation Lab</i>)</p>	<p>4 Hours</p>

Self-Learning Topics: (Hours: 5)

- Thermochemical conversion of biomass — pyrolysis, gasification and hydrothermal liquefaction
- Cellulosic ethanol commercial plants — Raizen (Brazil), Poet-DSM (USA) — current status and challenges
- Synthetic biology approaches for biofuel production — isoprenoid and fatty acid pathway engineering
- Carbon capture and utilisation (CCU) in biorefinery — CO₂ as feedstock for biofuel production

- Biofuel sustainability standards — ISCC, RSB and Roundtable on Sustainable Biomaterials (RSB) certification

Theory Hours:	30	Tutorial Hours:	0	Practical Hours:	15	Project Hours:	0	Total Hours: 45
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Learning Resources

Textbooks:

1. Drapcho C.M., Nhuan N.P. and Walker T.H., Biofuels Engineering Process Technology, McGraw-Hill (2008).
2. Pandey A., Larroche C., Ricke S.C., Dussap C.G. and Gnansounou E. (Eds.), Biofuels: Alternative Feedstocks and Conversion Processes, Elsevier (2011).
3. Weiland P., Biogas production: current state and perspectives, Applied Microbiology and Biotechnology, 85(4): 849–860 (2010).

References:

1. Ministry of Petroleum and Natural Gas (MoP&NG), India — National Biofuel Policy 2018, Government of India.
2. Balat M. and Balat H., Recent trends in global production and utilization of bio-ethanol fuel, Applied Energy, 86: 2273–2282 (2009).
3. Chisti Y., Biodiesel from microalgae, Biotechnology Advances, 25: 294–306 (2007).
4. Cherubini F., The biorefinery concept: Using biomass instead of oil for producing energy and chemicals, Energy Conversion and Management, 51: 1412–1421 (2010).

Online Educational Resources:

1. <https://archive.nptel.ac.in/courses/103/103/103103218/> (Biomass Conversion — IIT Kharagpur)
2. <https://archive.nptel.ac.in/courses/103/107/103107166/> (Bioenergy — IIT Roorkee)
3. <https://mnre.gov.in/bio-energy/> (Ministry of New and Renewable Energy — Bioenergy, Government of India)

Assessment (Embedded Course)

SA 1, SA 2, Activity and Learning Task(s)*, 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)	
		1. 2. 3.	
Recommended by BoS on			
Academic Council Approval		Date	

24BTE	Stem Cell Technology	L	T	P	J	C
PE		3	0	0	0	3
		SDG	3			
Pre-requisite courses	Nil	Data Book / Code book (If any)		Nil		

Course Objectives:	
The purpose of taking this course is to:	
1	To explore techniques used in stem cell culture and characterization
2	To analyze applications in regenerative medicine and biotechnology

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Explain the basic concepts, types, and properties of stem cells	Exp
CO2	Describe methods of stem cell isolation, culture, and characterization	Des
CO3	Analyze molecular mechanisms regulating stem cell differentiation	An
CO4	Evaluate applications of stem cells in medicine and biotechnology	Eva
CO5	Assess ethical, legal, and social issues related to stem cell technology	As

CO	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1	3	2	-	-	-	-	-	-	-	-	-	-	3
2	2	3	-	-	2	-	-	2	-	-	-	-	3

3	2	3	-	-	2	-	-	2	-	-	-	-	3
4	3	2	-	-	2	-	-	2	-	-	-	-	3
5	-	-	-	-	-	-	-	3	-	-	-	-	3

Course Content	
Fundamentals of Stem Cells Definition and characteristics of stem cells; Potency: totipotent, pluripotent, multipotent; Types of stem cells: embryonic, adult, induced pluripotent stem cells (iPSCs); Stem cell niche and microenvironment, Key transcription factors (Oct4, Sox2, Nanog), Cell–cell and cell–matrix interactions,	12 Hours
Stem Cell Culture and Characterization Isolation of stem cells (embryonic and adult sources), Culture techniques and media requirements ,Feeder layers and serum-free culture Characterization techniques: Surface markers (flow cytometry), Molecular markers (RT-PCR, immunostaining), Lineage tracing techniques, Cryopreservation of stem cells	12 Hours
Stem Cell Differentiation and Engineering Mechanisms of self-renewal and differentiation, Signaling pathways (Wnt, Notch, Hedgehog), Directed differentiation protocols Tissue engineering and scaffolds, Reprogramming methods (viral, non-viral, chemical) Gene editing in stem cells (CRISPR-based approach), Disease modeling using edited stem cells 3D stem cell culture systems (organoids, spheroids), Organoid-based drug testing platforms,	12 Hours
Applications and Ethical Issues Regenerative medicine (cardiac, neural, hematopoietic therapies), Stem cells in disease modeling and drug screening, Cancer stem cells , Clinical trials and translational research , Ethical, legal, and social issues (ELSI), Regulatory guidelines (ICMR, international policies)	9 Hours

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours:	45
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Learning Resources
Textbooks:
1. Totey, S., & Deb, K. D. (2010). <i>Stem cell technologies: Basics and applications</i> . McGraw Hill Education. 2. Rao, M. S. (Ed.). (2019). <i>Essential current concepts in stem cell biology</i> . Springer.
References:
1.
Online Educational Resources:
1.

Assessment (Theory course)
Summative Assessments, Assignments, End Semester Examination (ESE)

Course Curated by Dr.S.Nithya Priya		
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
[Name, Organization]	[Name, Institution]	Dr.N.Saraswathy Department of Biotechnology
Recommended by BoS on	XX/YY/2026	
Academic Council Approval	No.	Date XX/YY/2026

24BTT5XX	BIOREACTOR DESIGN AND SCALE-UP PROCESS	L	T	P	J	C
		3	0	0	0	3
PE	SDG 7, 12, 13					

Pre-requisite courses	Bioprocess Calculations (24BTT102), 24BTI409 Bioprocess Engineering Principles, 24BTI50X, Upstream Processing	Data Book / Code book (If any)	-
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Course Objectives	
The purpose of taking this course is to	
1	To develop a comprehensive understanding of bioreactor types, operating modes, aeration and agitation principles, and equipment design considerations for industrial bioprocess systems.
2	To apply bioreactor scale-up and scale-down methodologies and evaluate design and operational requirements for specialised bioreactor systems used in microbial, plant cell and animal cell culture.

Course Outcomes	Revised Bloom's Taxonomy Levels (RBT)
After successful completion of this course, the students shall be able to	
CO 1 Describe bioreactor operating modes — batch, fed-batch, continuous (chemostat, turbidostat) and plug flow — and analyze their design equations, productivity and suitability for microbial and enzyme processes.	AN
CO 2 Apply principles of mass transfer, power requirement and mixing to design aeration and agitation systems in stirred tank bioreactors, and evaluate strategies to minimise shear and bubble damage to cells.	AP
CO 3 Evaluate selection criteria and design specifications for bioprocess equipment — bioreactor vessel, heat transfer systems, sterility maintenance, CIP/SIP and materials of construction — for industrial bioprocess plants.	EV
CO 4 Apply bioreactor scale-up and scale-down techniques — geometric similitude, constant P/V, constant kLa, constant mixing time, constant tip speed — and analyze case studies in industrial bioreactor scale-up.	AP
CO 5 Design and evaluate bioreactor systems for specialised applications — microbial fermentation, plant cell culture, animal cell culture, photobioreactors and single-use bioreactors — with consideration of operational requirements and challenges.	CR

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium-3, Weak-3)						
	1	2	3	4	5	6	7
	Engineering Knowledge	Problem Analysis	Design/Development of Solutions	Conduct Investigations of Complex Problems	Engineering Tool Usage	The Engineer and The World	Ethics
1	3	3	2	2	1		
2	3	3	3	2	1		
3	3	2	3	1	2	1	
4	3	3	3	2	2		

5	3	3	3	2	1		
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<u>Course Content</u>	
<p>BASIC BIOREACTOR CONCEPTS</p> <p>Bioreactor operating modes: batch operation, semi-continuous and fed-batch operation. Continuous operation: chemostat — dilution rate, washout, steady-state analysis; turbidostat — operating principle and applications. Microbiological reactors and enzyme reactors. Tank-type biological reactors vs column-type biological reactors — comparison and selection. Continuous fermentation with biomass recycle — design and analysis. Tanks-in-series model. Tubular plug flow bioreactors — design equations and applications. Case studies: continuous fermentation with biomass recycle; comparison of batch vs continuous productivity.</p>	9 Hours
<p>AERATION AND AGITATION IN BIOPROCESS SYSTEMS</p> <p>Mass transfer in agitated tanks — two-film theory, volumetric mass transfer coefficient (kLa). Power requirement for mixing — ungassed and gassed systems; power number correlations. Agitation rate studies — mixing time determination and measurement. Residence time distribution (RTD) in agitated bioreactors. Bioreactor geometry: reactor vessel design, impeller types and selection (Rushton turbine, pitched blade, marine propeller), sparger design, baffle configuration. Shear damage to microbial and mammalian cells — mechanisms and quantification. Bubble damage — mechanisms at bubble rupture; methods of minimising cell damage: Pluronic F-68, reduced agitation, marine impellers. Case studies for aeration and agitation in industrial fermenters.</p>	9 Hours
<p>SELECTION AND DESIGN OF BIOPROCESS EQUIPMENT</p> <p>Materials of construction for bioprocess plants — 316L stainless steel, glass, polymers; GMP material requirements and surface finish standards. Bioreactor vessel design: aspect ratio (H/D), working volume, head plate design, nozzle and port placement. Heat transfer system design: jacketed vessels vs internal coils — design equations, overall heat transfer coefficient, cooling water requirements. Design considerations for maintaining sterility of process streams — aseptic connections, steam traps, diaphragm valves. Clean-in-Place (CIP) system design: spray balls, flow velocity, cleaning agents. Sterilize-in-Place (SIP) design: steam supply, condensate removal, validation. Processing equipment selection and specification: centrifuges, filters, heat exchangers, pumps. Piping and instrumentation design for bioprocess plants — P&ID overview.</p>	9 Hours

<p>BIOREACTOR SCALE-UP AND SCALE-DOWN</p> <p>Scale-up techniques: scale-up by geometric similitude — maintaining geometric ratios across scales. Constant power consumption per unit volume (P/V) — calculation and limitations. Constant mixing time — implications for kLa and shear at large scale. Constant impeller tip speed — shear-sensitive culture scale-up. Constant volumetric mass transfer coefficient (kLa) — most common criterion for aerobic fermentations. Comparison of scale-up criteria — conflicts and practical trade-offs. Scale-down related aspects: designing laboratory-scale models to predict large-scale behaviour; scale-down of gradients (pH, DO, substrate). Case studies in bioreactor scale-up and scale-down: antibiotic production scale-up (5 L to 50,000 L); monoclonal antibody scale-up from lab to GMP manufacturing scale.</p>	<p>9 Hours</p>
<p>SPECIALISED BIOREACTOR SYSTEMS AND CASE STUDIES</p> <p>Microbial fermentation bioreactors: design and operational requirements for aerobic bacteria, yeast and filamentous fungi — foam control, viscosity effects, oxygen demand. Plant cell culture bioreactors: low shear requirements, low growth rates, aggregate formation; airlift and paddle bioreactors for plant cells. Animal cell culture bioreactors: shear sensitivity, CO₂ removal, serum-free media, perfusion culture; stirred tank vs hollow fibre bioreactors for mammalian cells. Photobioreactors for microalgae: light distribution, mixing, CO₂ supply, scale-up challenges; flat plate vs tubular photobioreactor design. Single-use (disposable) bioreactors: wave-motion, stirred single-use, advantages and limitations; regulatory acceptance and GMP considerations. Immobilised cell bioreactors: packed bed, fluidised bed, membrane bioreactors. Case studies: bioreactor design for penicillin production; CHO cell culture for monoclonal antibody production; microalgal biomass production in photobioreactor.</p>	<p>9 Hours</p>

Self-Learning Topics: (Hours: 5)

- Computational Fluid Dynamics (CFD) for bioreactor design — ANSYS Fluent and OpenFOAM overview
- Mathematical modelling of bioreactors — metabolic flux analysis (MFA) and population balance models
- Continuous manufacturing trends in biopharma — perfusion culture and integrated continuous bioprocessing
- Economic analysis of bioreactor design — CAPEX, OPEX and cost of goods (CoG) estimation
- Regulatory considerations for bioreactor design — GMP, FDA and EMA guidelines for pharmaceutical manufacturing

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours: 45
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Learning Resources

Textbooks:

1. Shuler M.L., Kargi F. and DeLisa M., Bioprocess Engineering: Basic Concepts, Prentice Hall, 3rd Edition (2017).
2. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press / Elsevier, 2nd Edition (2013).
3. James M. Lee, Biochemical Engineering, Prentice Hall (1992).

References:

1. Bailey J.E. and Ollis D.F., Biochemical Engineering Fundamentals, McGraw-Hill, 2nd Edition (1986).
2. Liu S., Bioprocess Engineering: Kinetics, Biosystems, Sustainability and Reactor Design, Elsevier (2016).
3. Levenspiel O., Chemical Reaction Engineering, Wiley, 3rd Edition (1999).
4. Nielsen J., Villadsen J. and Liden G., Bioreaction Engineering Principles, Springer, 3rd Edition (2011).

Online Educational Resources:

1. <https://archive.nptel.ac.in/courses/103/103/103103165/> (Bioprocess Engineering — IIT Kharagpur)
2. <https://archive.nptel.ac.in/courses/103/105/103105209/> (Biochemical Engineering — IIT Bombay)
3. <https://www.bioprocessonline.com/search?keyword=bioreactor+design+scale+up>

Assessment (Theory Course)

SA 1, SA 2, 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)	
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		1.	
		2.	
		3.	
Recommended by BoS on			
Academic Council Approval		Date	

24BTE	NANOMATERIALS AND CHARACTERIZATION TECHNIQUES	L	T	P	J	C
PE		3	0	0	0	3
		SDG	12			
Pre-requisite courses	Nil	Data Book / Code book (If any)		Nil		

Course Objectives:	
The purpose of taking this course is to:	
1	To provide fundamental knowledge on types, synthesis, and properties of nanomaterials relevant to biological systems.
2	To develop competency in advanced characterization techniques for analyzing nanomaterials.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Explain classification, properties, and behavior of nanomaterials	Exp
CO2	Describe synthesis methods including green and biological approaches	Des
CO3	Analyze nanomaterials using basic characterization techniques	An
CO4	Evaluate advanced characterization methods for nanomaterial analysis	Eva
CO5	Assess safety, environmental, and ethical implications of nanotechnology	As

C O	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1	3	2	-	2	-	-	-	-	-	-	-	3	1
2	2	3	-	2	2	-	-	-	-	-	-	3	1
3	2	3	-	3	3	-	-	-	-	-	-	3	2
4	3	2	-	3	3	1	-	-	-	-	-	3	2
5	2	2	1	2	1	2	2	2	1	1	1	2	2

Course Content	
Introduction to Nanomaterials Scope, and importance of Nanomaterials, Classification: 0D, 1D, 2D, 3D nanomaterials, Size-dependent properties, Surface-to-volume ratio and quantum effects, Applications overview in bio-systems.	9 Hours
Synthesis of Nanomaterials General synthesis methods of nanoscale materials; top down and bottom up approaches. Top-down approaches: lithography, mechanical milling, Bottom-up approaches: Chemical methods: precipitation, hydrothermal, CVD, Green synthesis: plant extract, microbial synthesis, Surface modification and functionalization	9 Hours
Basic Characterization Techniques Microscopy Techniques: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Spectroscopy Techniques: UV-Visible Spectroscopy, FTIR Spectroscopy, Raman Spectroscopy, Diffraction Techniques: X-Ray Diffraction (XRD)	9 Hours
Advanced Characterization Techniques Dynamic Light Scattering (DLS), Zeta potential analysis, BET surface area analysis, Thermal analysis: TGA, DSC, Elemental analysis: EDX	9 Hours
Safety, Environmental Impact and Emerging Trends Nanotoxicology and biocompatibility, Environmental impact of nanomaterials, Risk assessment and regulatory aspects, Ethical issues in nanotechnology, Future trends: smart nanomaterials, nano-enabled systems	9 Hours

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours:	45
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Learning Resources
Textbooks: <ol style="list-style-type: none"> Ratner, M. & Ratner, D. – <i>Nanotechnology: A Gentle Introduction</i> Niemeyer, C.M. & Mirkin, C.A. – <i>Nanobiotechnology: Concepts and Applications</i> Hornyak, G.L. – <i>Introduction to Nanoscience and Nanotechnology</i>
References: <ol style="list-style-type: none"> Patrick Boisseau – <i>Nanoscience: Nanobiotechnology and Nanobiology</i> Juhi Saxena – <i>Nanobiotechnology: Principles and Applications</i> Dupas – <i>Nanoscience: Nanotechnologies and Nanophysics</i>
Online Educational Resources: <ol style="list-style-type: none"> NPTEL (Nanotechnology Courses): https://nptel.ac.in/courses/ Introduction to Nanotechnology Course: https://courseware.cutm.ac.in/courses/introduction-to-nanotechnology/

4. MIT OpenCourseWare (Nanotechnology):
<https://ocw.mit.edu>

Assessment (Theory course)

CAT I and CAT 2, Assignments, End Semester Examination (ESE)

Course Curated by Dr.S.Nithya Priya

Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)
[Name, Organization]	[Name, Institution]	Dr.S.Nithya Priya Department of Biotechnology
Recommended by BoS on	XX/YY/2026	
Academic Council Approval	No.	Date XX/YY/2026

24BT____	PRINCIPLES OF MEDICAL PHARMACOLOGY	L	T	P	J	C
		3	0	0	0	3
Professional Elective		SDG	3			

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

Course Objectives:

The purpose of taking this course is to:

1	Apply the general principles of pharmacology to investigate the drug action and adverse effects
2	Analyse the influence of drugs against the diseases that target the human physiological systems
3	Examine the impact of drugs against hormonal disorders

Course Outcomes:

After successful completion of this course, the students shall be able to

Bloom's Taxonomy Level (BTL)

CO 1	Apply general principles of pharmacology to investigate the factors that influence the drug action, and the various adverse effects of a drug	Ap
CO 2	Analyse the mechanism of action of cholinergic and adrenergic drugs against the target organs	An
CO 3	Investigate the mechanism of action of diuretics and antidiuretics in the maintenance of water balance	An
CO 4	Explore the causal action of proton pump inhibitors, antacids, expectorants and bronchodilators against GI tract and respiratory diseases	An
CO 5	Examine the mechanism of action of drugs against endocrine system mediated disorders	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of Complex Problems														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team work														
Communication														
Project Management and Finance														
Life-Long Learning														
1	3					3					3		3	
2	3					3					3		3	
3	3					3					3		3	
4	3					3					3		3	
5	3					3					3		3	

Course Content

GENERAL PRINCIPLES OF PHARMACOLOGY

Nomenclature of drugs – chemical name, non-proprietary name, and proprietary (brand) name; Drug compendia (overview) – Pharmacopoeias, formularies and Martindale; Essential medicines (drugs) concept - prescription and non-prescription drugs, and orphan Drugs; Drug dosage (overview) – standard dose, regulated dose, target level dose and titrated dose; Advantages of fixed dose combinations (FDCs) of drugs; Factors modifying drug action – body size, age, sex, species and race, genetics, routes of administration, environmental factors and time of administration, psychological factor, pathological states and cumulation, Adverse drug effects (overview) – side effects, secondary effects, toxic effects, intolerance, idiosyncrasy, drug allergy, drug dependence, drug withdrawal reactions, teratogenicity, mutagenicity and carcinogenicity.

9 Hours

DRUGS ACTING ON AUTONOMOUS NERVOUS SYSTEM AND CARDIOVASCULAR SYSTEM

Excitatory and inhibitory neurohumoral transmission – general mechanism; Mechanisms of termination of transmitters action – Parasympathetic, sympathetic and GABAergic neurones; Overview applications of co-transmission process; Mechanism of action of anticholinesterases (anti-ChEs) – carbamates and organophosphates; Pharmacological actions of anti-ChEs – cardiovascular and skeletal muscular systems; Mechanism of action of adrenergic drugs (epinephrine, norepinephrine and isoproterenol) in smooth and cardiac muscles – overview; Causal action of angiotensin converting enzyme (ACE) inhibitors – Captopril; Causal action of prodrug angiotensin-converting enzyme inhibitors – Enalapril; Mechanism of action of digoxin

15 Hours

against heart failure; Causal action of antiarrhythmic Drug – propranolol; Causal action of antianginal drugs - Glyceryl trinitrate.	
DRUGS ACTING ON RENAL SYSTEM Mechanism of action of high ceiling (loop) diuretics – Furosemide; Mechanism of action of thiazide and related diuretics – Chlorothiazide; Mechanism of action of carbonic anhydrase inhibitors – acetazolamide; Mechanism of action of potassium sparing diuretics – spironolactone; Inhibitors of renal epithelial Na ⁺ channel - Triamterene and amiloride; Mechanism of action of osmotic diuretics – mannitol; Mechanism of action of antidiuretics – lypressin.	8 Hours
DRUGS ACTING ON GASTROINTESTINAL AND RESPIRATORY SYSTEM General mechanism of secretion of HCl and its regulation by parietal cells; Mechanism of reduction of acid secretion – cimetidine and ranitidine; Mechanism of action of proton pump inhibitors (PPIs) – omeprazole and lansoprazole; Role of antacids – sodium bicarbonate, aluminium hydroxide gel and antacid combinations (digene and gelusil). Role of expectorants - bronchial secretion enhancers and mucolytics; General mechanism of action of opioids; Role of antitussives (Cough centre suppressants) – codeine; Mechanism of action of bronchodilators – salbutamol.	7 Hours
DRUGS ACTING ON ENDOCRINE SYSTEM Mechanism of action of oral hypoglycaemic drugs – Sulfonylureas; Causal action of α glucosidase inhibitors – acarbose; Mechanism of action of insulin; Causal action of antithyroid drugs – thionamides; Causal action of antiandrogens - 5 α -reductase inhibitor; Mechanism of action of drugs for erectile dysfunction - Phosphodiesterase-5 (PDE-5) inhibitors.	6 Hours

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Project Hours: 0	Total Hours: 45
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Learning Resources*
Textbooks
<ol style="list-style-type: none"> 1. Tripathi, K. D. <i>Essentials of Medical Pharmacology</i>. Jaypee Brothers Medical Publishers (P) Ltd., 7th Ed., (2013). 2. Satoskar, R., Rege, N., and Bhandarkar, S. <i>Pharmacology and Pharmacotherapeutics: Pharmacology and Pharmacotherapeutics</i>. Elsevier Health Sciences. (2020).
Reference books/ Web Links
<ol style="list-style-type: none"> 1. Craig, C. R., and Stitzel, R. E. <i>Modern Pharmacology with Clinical Applications</i>. Lippincott Williams & Wilkins. (2004).
Online Resources
https://dth.ac.in/medical/course-inner.php?id=306 https://www.ocw.mit.edu/courses/hst-151-principles-of-pharmacology-spring-2005/resources/lecture-notes/?utm_source=chatgpt.com

Assessment

Formative	Summative
Assignments / Mini project), Quiz, Lab	SA- I, SA – II and End Semester Examination (ESE)

Course Curated by			
Expert(s) from Industry	Expert(s) from Higher Education Institution	Internal Expert(s)	
Mr. M. Kannan Manager, Healthium Medtech Ltd Bengaluru, Karnataka, India.	Dr. J. Hema, Associate Professor, Dept of Biotechnology, PSG College of Technology, Coimbatore, Tamil Nadu, India.	Dr. T. Sathish Kumar	
Recommended by BoS on	XX/YY/2026		
Academic Council Approval	No.	Date	XX/YY/2026

Course Code	Industrial Biomanufacturing and Process Economics	L	T	P	J	C
		3	0	0	0	3
PE		SDG				

Pre-requisite courses	Course code(s)	Data Book / Code book (If any)	eg. Design Data book
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Course Objectives	
The purpose of taking this course is to	
1	Analyze industrial-scale biomanufacturing systems and identify process limitations affecting productivity, yield, and robustness.
2	Apply process engineering principles and computational tools (including flowsheeting approaches) to troubleshoot, debottleneck, and optimize bioprocesses.
3	Evaluate techno-economic aspects of biomanufacturing systems to support process selection, improvement, and industrial decision-making.

Course Outcomes		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Explain industrial biomanufacturing workflows and key performance metrics (titer, yield, productivity)	U
CO 2	Analyze scale-up challenges and identify process bottlenecks in industrial systems	An
CO 3	Apply debottlenecking and process optimization strategies using engineering principles and flowsheeting concepts	Ap
CO 4	Evaluate integrated bioprocess performance using simulation outputs and techno-economic considerations	E

CO 5	Design improved biomanufacturing workflows considering cost, efficiency, and scalability constraints	C
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Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)											Program Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	PSO-1	PSO-2	PSO-3
Engineering Knowledge														
Problem Analysis														
Design/Development of Solutions														
Conduct Investigations of														
Engineering Tool Usage														
The Engineer and The World														
Ethics														
Individual and Collaborative Team														
Communication														
Project Management and Finance														
Life-Long Learning														
1														
2														
3														
4														
5														
6														

Course Content	
<p>INDUSTRIAL BIOPROCESS LANDSCAPE AND PERFORMANCE METRICS :</p> <p>Industrial Biomanufacturing Overview - Industrial sectors (biopharmaceuticals, enzymes, biofuels), production platforms (microbial and mammalian), overview of industrial production workflow; Process Performance Metrics - Titer, yield and productivity (TYP), comparison of batch and fed-batch processes, benchmarking industrial processes; Industrial Constraints - Raw material variability, contamination risks, regulatory (GMP) considerations, facility limitations; Manufacturing Strategy - Batch scheduling concepts, equipment utilization, introduction to multi-product facilities</p> <p>Case Study: Comparative analysis of microbial and mammalian production systems in industrial biomanufacturing</p>	<p>__ Hours</p> <p>9 Hours</p>

<p>SCALE-UP CHALLENGES AND PROCESS LIMITATIONS :</p> <p>Scale-Dependent Effects - Oxygen transfer limitations, mixing inefficiencies, heat transfer challenges, gradients in large-scale systems; Industrial Bioreactor Constraints - Agitation vs shear effects, aeration limitations, foam formation and control; Scale-Up Challenges - Differences between lab-scale and industrial-scale behavior, process reproducibility issues; Process Variability - Batch-to-batch variation, robustness considerations, operational constraints in industrial environments</p> <p>Case Study: Industrial fermentation failure due to oxygen limitation and its impact on productivity</p>	<p>9 Hours</p>
<p>PROCESS BOTTLENECK IDENTIFICATION AND DEBOTTLENECKING :</p> <p>Bottleneck Identification in Bioprocesses - Concept of bottlenecks, throughput and cycle time, identifying limiting steps in simple bioprocess workflows; Upstream-Centric Bottlenecks - Reactor utilization, feeding strategies, oxygen transfer limitations, process delays; Introduction to Downstream Constraints - Basic concepts of separation (filtration, centrifugation, chromatography overview), impact on process flow; Process Improvement Strategies - Parallel processing, scheduling adjustments, reduction of idle time, basic process intensification; Industrial Troubleshooting Approach - Root cause analysis (RCA), cause-effect relationships, simple decision-making frameworks</p> <p>Case Study: Identification and improvement of a production delay due to reactor occupancy and scheduling inefficiency</p>	<p>9 Hours</p>
<p>PROCESS INTEGRATION, FLOWSHEETING AND OPTIMIZATION (SUPERPRO BASED) :</p> <p>Process Integration Concepts - Linking upstream and downstream operations conceptually, material flow across unit operations; Flowsheet Development - Representation of industrial processes using block diagrams, sequencing of unit operations, introduction to recycle streams; Introduction to SuperPro Concepts - Basic idea of process simulation, flowsheet representation, batch processing logic (conceptual level); Process Optimization Concepts - Trade-offs between yield, time and cost, resource utilization, basic sensitivity analysis (conceptual).</p> <p>Case Study: Conceptual flowsheet development and optimization of a fermentation-based production process</p>	<p>9 Hours</p>
<p>TECHNO-ECONOMIC ANALYSIS AND PROCESS IMPROVEMENT :</p> <p>Techno-Economic Concepts - Basic understanding of CAPEX, OPEX and cost of goods (COGS), major cost drivers in biomanufacturing; Economic Thinking in Bioprocesses - Cost vs productivity trade-offs, scale considerations, simple cost estimation concepts; Process Improvement Strategies - Yield improvement, reduction in process time, improving process robustness; Industrial Decision-Making - Introduction to economic decision criteria (qualitative NPV/IRR concepts), multi-criteria decision thinking.</p>	<p>9 Hours</p>

Case Study: Comparison of two production strategies based on productivity and cost considerations.	
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Self Learning Topics: (Hours: 15)

- Continuous biomanufacturing vs batch processing
- Single-use bioreactors in modern biomanufacturing
- Basic concepts of Good Manufacturing Practices (GMP)
- Process Analytical Technology (PAT) – overview and applications
- Introduction to Quality by Design (QbD) in bioprocessing
- Scale-down models for studying industrial processes
- Basic concepts of bioprocess automation and Industry 4.0
- Scheduling and resource utilization in manufacturing systems
- Introduction to digital twins in bioprocessing (conceptual)
- Sustainability and environmental impact of biomanufacturing
- Introduction to techno-economic analysis in biotechnology
- Overview of biosimilars and their manufacturing challenges

Theory Hours:	45	Tutorial Hours:	0	Practical Hours:	0	Project Hours:	0	Total Hours:	45
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Learning Resources

Textbooks:

1. Doran, P. M. (2013). Bioprocess engineering principles (2nd ed.). Academic Press. (For foundational linkage)
2. Shuler, M. L., Kargi, F., & DeLisa, M. (2017). Bioprocess engineering: Basic concepts (3rd ed.). Prentice Hall.

References:

1. Langer, E. S., & Rader, R. A. (2020). Biopharmaceutical manufacturing: Principles and practices. BioPlan Associates.
2. Kelley, B. (2018). Industrialization of mAb production technology: The bioprocessing industry at a crossroads. mAbs, 10(1), 1–12.
3. Rathore, A. S., & Sofer, G. (Eds.). (2017). Process validation in manufacturing of biopharmaceuticals (3rd ed.). CRC Press.
4. Sinclair, A., & Shukla, A. A. (2019). Process economics of industrial biotechnology. Current Opinion in Biotechnology, 60, 205–212

Online Educational Resources:

1. <https://biophorum.com>
2. <https://ispe.org>
3. <https://nptel.ac.in>

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. Harishankar BIOCON Biologics, Bangalore	Dr.Selvaraju Narayanasamy IIT Guwahati	Dr. Ram K Dr.D.R.Manimaran Dr. N. Sivarajasekar Dr.M.Shanmugaprabakash Department of Biotechnology
Recommended by BoS on		
Academic Council Approval	No.	Date XX/YY/2024