DEPARTMENT OF BIOTECHNOLOGY

I TO VIII SEMESTER
CURRICULUM AND SYLLABI

Applicable to the students admitted to

R-2021: CBCS

Academic year 2021-2022 onwards

VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

#60, Avadi – Vel Tech Road, Vel Nagar,
Avadi, Tamil Nadu 600062

LIST OF ABBREVIATIONS

S. No.	Abbreviations	Detailed Description
1	**HSMC**	Humanities & Social Science including Management Courses
2	**BSC**	Basic Science Courses
3	**ESC**	Engineering Science Courses
4	**PCC**	Professional Core Courses
5	**PEC**	Professional Elective Courses
6	**OEC**	Open Elective Courses
7	**PROJ**	Project Work
8	**EEC**	Employability Enhancement Courses
9	**MC**	Mandatory Courses

Category Based Credit Split-Up – Semester Wise

Semester	HSMC	BSC	ESC	PCC	PEC	OEC	Project /EEC	MC	Total Credit
1	3	12	10	-	-	-	-	1	**26**
2	3	7	8	5	-	-	-	1	**24**
3	-	4	-	16	-	-	-	0	**20**
4	-	4	-	16	-	-	1	0	**21**
5	-	-	-	18	3	3	-	-	**24**
6	-	-	-	12	3	3	2	-	**20**
7	3	-	-	9	6	-	3	-	**21**
8	-	-	-	-	6	-	6	-	**12**
Total Credits	**9** (5.42%)	**24** (14.46%)	**24** (14.46%)	**72** (43.37%)	**18** (10.84%)	**6** (3.61%)	**13** (7.83%)	**2** (0.01%)	**168**

B.Tech Biotechnology Curriculum (R2021)

SEMESTER I										
S. No.	Course Code	Course Title	Category	CIE Marks	SEE Marks	Total marks	Credits			
							L	T	P	C
THEORY										
1	21EN11T	Communicative English	HSMC	40	60	100	3	0	0	3
2	21MA12T	Matrices and Differential Calculus	BSC	40	60	100	3	1	0	4
3	21PH13T	Engineering Physics I	BSC	40	60	100	3	0	0	3
4	21CY14T	Engineering Chemistry	BSC	40	60	100	3	0	0	3
5	21CS15IT	Problem Solving and Python Programming	ESC	50	50	100	2	0	4	4
6	21ME16T	Engineering Graphics	ESC	40	60	100	2	0	4	4
7	21MC04T	தமிழர் மரபு / Heritage of Tamils	MC	40	60	100	1	0	0	1
PRACTICAL										
8	21BS17P	Physics and Chemistry Laboratory	BSC	60	40	100	0	0	4	2
9	21ME18P	Engineering Practices Laboratory	ESC	60	40	100	0	0	4	2
TOTAL										**26**

SEMESTER II										
S. No.	Course Code	Course Title	Category	CIE Marks	SEE Marks	Total marks	Credits			
							L	T	P	C
THEORY										
1	21EN21T	Technical English	HSMC	40	60	100	3	0	0	3
2	21MA22T	Vector Calculus and Complex Integration	BSC	40	60	100	3	1	0	4
3	21BT23T	Anatomy and Human Physiology	BSC	40	60	100	3	0	0	3
4	21EE24T	Basic Electrical, Electronics and Instrumentation Engineering	ESC	40	60	100	3	0	0	3
5	21BT25T	Chemistry of Biomolecules	PCC	40	60	100	3	0	0	3
6	21IT26T	Programming in C	ESC	40	60	100	3	0	0	3
7	21MC05T	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	MC	40	60	100	1	0	0	1
PRACTICAL										
8	21BT27P	Biochemistry Laboratory	PCC	60	40	100	0	0	4	2
9	21IT28P	Programming in C Laboratory	ESC	60	40	100	0	0	4	2
TOTAL										**24**

SEMESTER III										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21BT31T	Applied Microbiology	PCC	40	60	100	3	0	0	3
2	21BT32T	Process Calculations for Biotechnologist	PCC	40	60	100	3	0	0	3
3	21BT33T	Bioorganic chemistry	PCC	40	60	100	3	0	0	3
4	21MA34T	Series, Transforms and Partial Differential Equations	BSC	40	60	100	3	1	0	4
5	21BT35T	Cell Biology	PCC	40	60	100	3	0	0	3
6	21MC01T	Constitution of India	MC	40	60	100	2	0	0	0
PRACTICAL										
7	21BT37P	Applied Microbiology Laboratory	PCC	60	40	100	0	0	4	2
8	21BT38P	Cell Biology Laboratory	PCC	60	40	100	0	0	4	2
TOTAL										**20**

SEMESTER IV										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21BT41T	Research Methodology and Biostatistics	BSC	40	60	100	3	1	0	4
2	21BT42T	Fluid Mechanics and Heat Transfer Operations for Biotechnologist	PCC	40	60	100	3	0	0	3
3	21BT43T	Applied Thermodynamics for Biotechnologists	PCC	40	60	100	3	0	0	3
4	21BT44T	Principles and Techniques of Molecular Biology	PCC	40	60	100	3	0	0	3
5	21BT45T	Basics of Industrial Biotechnology	PCC	40	60	100	3	0	0	3
6	21MC02T	Environmental Sciences	MC	40	60	100	2	0	0	0
PRACTICAL										
7	21BT47P	Chemical Engineering Laboratory for Biotechnologists	PCC	60	40	100	0	0	4	2
8	21BT48P	Molecular Biology Laboratory	PCC	60	40	100	0	0	4	2
9	21EE01P	Mini Project – I	EEC	60	40	100	0	0	2	1
TOTAL										**21**

SEMESTER V										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21BT51T	Bioprocess Engineering	PCC	40	60	100	3	0	0	3
2	21BT52T	Mass Transfer Operations	ESC	40	60	100	3	0	0	3
3	21BT53IT	Analytical Techniques in Biotechnology	PCC	50	50	100	2	0	4	4
4	21BT54T	Principles of Genetic Engineering	PCC	40	60	100	3	1	0	4
5	-	Professional Elective - I	PEC	40	60	100	3	0	0	3
6	-	Open Elective - I	OEC	40	60	100	3	0	0	3
PRACTICAL										
7	21BT57P	Bioprocess Laboratory	PCC	60	40	100	0	0	4	2
8	21BT58P	Genetic Engineering Laboratory	PCC	60	40	100	0	0	4	2
TOTAL										**24**

SEMESTER VI										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21BT61T	Protein Engineering	PCC	40	60	100	3	1	0	4
2	21BT62T	Applied Chemical Reaction Engineering	PCC	40	60	100	3	0	0	3
3	21BT63T	Principles of Immunology	PCC	40	60	100	3	0	0	3
4	-	Professional Elective - II	PEC	40	60	100	3	0	0	3
5	-	Open Elective - II	OEC	40	60	100	3	0	0	3
PRACTICAL										
6	21BT66P	Principles of Immunology Laboratory	PCC	60	40	100	0	0	4	2
7	21EE04P	Internship	EEC	100	-	100	0	0	0	1
8	21EE02P	Mini Project - II	EEC	60	40	100	0	0	2	1
TOTAL										**20**

SEMESTER VII											
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**				
							L	**T**	**P**	**C**	
THEORY											
1	21HM812PT	Total Quality Management	HSMC	40	60	100	3	0	0	3	
2	21BT72T	Principles of Bioseparation Processes	PCC	40	60	100	3	0	0	3	
3	21BT73IT	Computational Biology	PCC	50	50	100	2	0	4	4	
4	-	Professional Elective - III	PEC	40	60	100	3	0	0	3	
5	-	Professional Elective - IV	PEC	40	60	100	3	0	0	3	
PRACTICAL											
6	21BT76P	Principles of Bioseparation Processes Laboratory	PCC	60	40	100	0	0	4	2	
7	21EE05P	Project Phase - I	PROJ	60	40	100	0	0	4	2	
8	21EE03P	Technical Seminar	EEC	100	-	100	0	0	2	1	
TOTAL										**21**	

SEMESTER VIII										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	-	Professional Elective - V	PEC	40	60	100	3	0	0	3
2	-	Professional Elective - VI	PEC	40	60	100	3	0	0	3
PRACTICAL										
3	21EE06P	Project Phase - II	PROJ	60	40	100	0	0	12	6
TOTAL										**12**

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Engineering Stream Courses
		PROFESSIONAL ELECTIVE I
1	21BT551PT	Frontiers in Biomedicine
2	21BT552PT	Fundamentals of Nano Science
3	21BT553PT	Green and Renewable energy
4	21BT554PT	Bioethics and IPR
5	21BT555PT	Enzyme Technology
		PROFESSIONAL ELECTIVE II
6	21BT641PT	Molecular Pathogenesis of Infectious Diseases
7	21BT642PT	Bio-inspired AI
8	21BT643PT	Principles of Food Processing
9	21BT644PT	Creativity, Innovation and New Product Development
10	21BT645PT	Animal Biotechnology
		PROFESSIONAL ELECTIVE III
11	21BT741PT	Bioprocess Instrumentation Dynamics and control
12	21BT742PT	Cancer Biology
13	21BT743PT	Stem Cell Technology
14	21BT744PT	Medical Biotechnology
15	21BT745PT	Bio-business Startup Policy and Human Rights
		PROFESSIONAL ELECTIVE IV
16	21BT751PT	Clinical Nutrition
17	21BT752PT	Marine Bioprospecting and Pharmacology
18	21BT753PT	Tissue Engineering
19	21BT754PT	Bioproduct Planning and Strategy
20	21BT755PT	Forensic Biotechnology
		PROFESSIONAL ELECTIVE V
21	21BT811PT	Lifestyle Diseases and Clinical Trials
22	21BT812PT	Bioconjugate Technology and Applications
23	21BT813PT	Bioprocess Equipment and Plant Design
24	21BT814PT	Clinical Data Management
25	21BT815PT	Agricultural Biotechnology
		PROFESSIONAL ELECTIVE VI
26	21BT821PT	Biopharmaceutical Technology
27	21BT822PT	Neurobiology and Cognitive Sciences
28	21BT823PT	Bioentrepreneurship
29	21BT824PT	Biosafety and Hazard Management
30	21BT825PT	Plant Biotechnology

LIST OF OPEN ELECTIVE COURSES

S. No	COURSE CODE	OFFERING DEPARTMENT	NAME OF THE COURSE
1	21CS01OT	CSE	Bio Python
2	21CS02OT		Cyber Security
3	21CS03OT		Java Programming
4	21CS04OT		Database System Design
5	21IT01OT	IT	Business Intelligence
6	21HI52T		Data Analytics
7	21IT03OT		Augmented Reality and Virtual Reality
8	21IT04OT		Introduction to Cloud Computing
9	21AI651PT	AI & DS	Advanced Python Programming
10	21AI31T		Introduction to Artificial Intelligence
11	21AI03OT		Machine Learning Techniques for Engineers
12	21ML33T		Python for Data Science
13	21EC01OT	ECE	Microcontroller System Design
14	21EC743PT		Digital Image Processing
15	21EC03OT		Internet of Things and Applications
16	21EC556PT		Automotive Electronics
17	21ME01OT	MECHANICAL	Industry 4.0
18	21ME02OT		Robotics and Industrial Automation
19	21ME03OT		3D Printing
20	21ME04OT		Fundamentals of Electric and Hybrid Vehicles
21	21CE01OT	CIVIL	Traffic Engineering and Management
22	21CE02OT		Air Pollution Control Engineering
23	21CE763PT		Municipal solid waste management
24	21CE04OT		Safety in Civil Engineering Practices
25	21BT01OT	BIOTECHNOLOGY	Basics of Environmental Biotechnology
26	21BT02OT		Introduction to Biofuels and Bioenergy
27	21BT03OT		Lifestyle Diseases: A Biotechnological Approach
28	21BT04OT		Biology for Engineers
29	21CH25T	CHEMICAL	Principles of Chemical Engineering
30	21CH02OT		Process Modeling and Simulation
31	21CH03OT		Energy Management and Audit
32	21CH04OT		Process Plant Utilities
33	21MB01OT	MBA	Business Intelligence for Administration
34	21MB02OT		Personality Development
35	21MB03OT		Entrepreneurship Development
36	21EN01OT	S & H	Foreign Language – French
37	21PH02OT		Fundamentals of Photovoltaic and its Applications
38	21CY03OT		Recent Trends in Batteries
39	21CY04OT		Green Chemistry

LIST OF HONORS COURSES

S. No	COURSE CODE	DEPARTMENT	NAME OF THE COURSE
1	21BT01HT	BIOTECH	Plant Anatomy
2	21BT02HT		Therapeutic Application of Phytochemicals
3	21BT03HT		Bio-Fertilizer Production and Mushroom Cultivation
4	21BT04HT		Biotechnological Approach in Crop Improvement
5	21BT05HT		Advance Techniques in Agro Forestry
6	21BT06HT		Plant Tissue Culture and Transformation Techniques

LIST OF NPTEL COURSES

1.	Biomechanics
2.	Microsensors, Implantable Devices and Rodent Surgeries for Biomedical Applications

I SEMESTER

SEMESTER I											
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY											
1	21EN11T	Communicative English	HSMC	40	60	100	3	0	0	3
2	21MA12T	Matrices and Differential Calculus	BSC	40	60	100	3	1	0	4
3	21PH13T	Engineering Physics I	BSC	40	60	100	3	0	0	3
4	21CY14T	Engineering Chemistry	BSC	40	60	100	3	0	0	3
5	21CS15IT	Problem Solving and Python Programming	ESC	50	50	100	2	0	4	4
6	21ME16T	Engineering Graphics	ESC	40	60	100	2	0	4	4
7	21MC04T	தமிழர் மரபு / Heritage of Tamils	MC	40	60	100	1	0	0	1
PRACTICAL											
8	21BS17P	Physics and Chemistry Laboratory	BSC	60	40	100	0	0	4	2
9	21ME18P	Engineering Practices Laboratory	ESC	60	40	100	0	0	4	2
TOTAL										**26**

Course code	21EN11T	Semester	I			
Category	HUMANITIES & SOCIAL SCIENCE INCLUDING MANAGEMENT COURSES (HSMC)		L	T	P	C
Course Title	COMMUNICATIVE ENGLISH (COMMON FOR ALL BRANCHES)		3	0	0	3

COURSE OBJECTIVES:

- To exhibit the students of Engineering and Technology to develop their listening and to recall the pattern of listening.
- To facilitate the learners to develop speaking skills to convey their ideas and views in the real context.
- To develop their reading skills and grasp the central ideas of the text.
- To expose them to acquire writing technique with basic grammar.
- To motivate the students to use appropriate vocabulary in academic and categorize the inferences in writings.

PREREQUISITE:

- Foundation of language with Basic English Grammar.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C101. 1	***Listen*** to different talks and lectures and understand them easily.	K1
C101. 2	***Communicate*** their thoughts confidently using communicative strategies	K2
C101. 3	***Read*** and grasp different genres of texts effortlessly	K2
C101. 4	***Write*** grammatically correct academic, business and technical texts	K3
C101. 5	***Apply*** the appropriate vocabulary to communicate efficiently in all forms of communication.	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C101. 1	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 2	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 3	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 4	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 5	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 6	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I BASIC GRAMMAR I AND READING FOR INFORMATION 9

PRACTICAL

LISTENING: Listening to short dialogues with good accent

SPEAKING : Introducing oneself - Exchanging personal information

TUTORIAL

READING : Reading short comprehension passages- practice skimming and scanning for specific information

WRITING: Parts of speech - Sentence patterns – Tenses – ‘wh’- questions - Yes/No questions -Countable and Uncountable nouns

VOCABULARY AND GRAMMAR: Affixation – word formation - Synonyms and Antonyms.

UNIT II BASIC GRAMMAR II AND SHARING INFORMATION 9

PRACTICAL

LISTENING : Listening to documentaries - inspiring speeches of great leaders and practicing opinion sharing

SPEAKING : Self-introduction - peer introduction - picture description - JAM

TUTORIAL

READING: Note-making- Critical reading finding key information in a given text - shifting facts from opinions and paraphrasing

WRITING: Autobiographical writing (writing about one’s leisure time activities, hometown - favourite place and school life) - Biographical writing (place, people)

VOCABULARY AND GRAMMAR: Compound Words – Guessing meaning of words contexts - One Word substitutes – Pronouns- Adjectives – Adverbs – Imperatives - Direct and Indirect questions.

UNIT III BASIC GRAMMAR III AND FREE WRITING 9

PRACTICAL

LISTENING : News Bulletins - Ted talks - telephonic conversations

SPEAKING : functions of Language - giving reasons - talking about future plans - comparing and contrasting - making suggestions

TUTORIAL

READING: Current Affairs - newspaper reading /magazines - loud in the classroom

WRITING: Coherence and cohesion in writing- cause and effect - compare & contrast and narrative & analytical paragraphs.

VOCABULARY AND GRAMMAR: Discourse marker - Reference words - Process description - Conjunctions – Prepositions - Articles - Degrees of comparison.

UNIT IV BASIC GRAMMAR IV AND FREE WRITING 9

PRACTICAL

LISTENING : Listen to audio/ Conversation from BEC/IELTS /TOFEL.

SPEAKING : Interpersonal Skills: Role play/group discussion/debate/ conduct of meeting

TUTORIAL

READING: Reading different types of texts /genres/ for comprehension and pleasure – related with human values.

WRITING: Letter writing (informal letters) and formal letters – rejecting and accepting Letters - Personal emails and etiquette.

VOCABULARY AND GRAMMAR: Single Word substitutes - Use of abbreviations Acronyms - Cloze reading - interpreting visual materials - Jumbled sentences - Subject verb agreement - Modal verbs - Phrasal verbs.

UNIT V BASIC GRAMMAR V AND LANGUAGE DEVELOPMENT 9

PRACTICAL

LISTENING : Listen to official meetings to know about the project proposal.

SPEAKING : Discussing the project and the proposals in the group - Creative writing and speaking - Poster making and description - project proposals.

TUTORIAL

READING: Reading comparison and contrast text with the deeper level of meaning **WRITING : ** Essay writing - different types of essays - dialogue writing

VOCABULARY AND GRAMMAR: Word association (connotations) - Lexical items (fixed / semi fixed expressions) - Clause - Direct and indirect speech - Correction of errors.

Total: 45 Periods

Extensive Reading:

Kalam , Abdul. The Wings of Fire , Universities Press, Hyderabad. 19

LEARNING RESOURCES:

TEXT BOOKS:

1. Board of Editors, Department of English, Anna University, Chennai. Using English:A Course Book for Undergraduate Engineers and Technologists, Orient Black Swan: Chennai,2017.

2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Black Swan Publications, Chennai,2011.

REFERENCES:

1. Raman, Meenakshi & Sangeetha Sharma, Technical Communication: English Skills for Engineers. Oxford University Press, NewDelhi.2011.

2. Regional Institute of English. English for Engineers. Cambridge University Press, New Delhi. 2006

3. Rizvi M, Ashraf. Effective Technical Communication. Tata McGraw- Hill Publishing Company Limited, New Delhi, 2007.

4. Rutherford, Andrea J. Basic Communication Skills for Technology. Pearson Edition (II Edition), NewDelhi, 2001.

5. Mandel, Steve. *Effective Presentation Skills*. New Delhi: Viva Books Pvt. Ltd., 2004.

6. Kilmet, Stephen. "The Resume and "The Computerized Resume." In Writing for Design Professionals.

7. Writing Cover Letters-Kilmet, Stephen. "Cover Letter, "and" Enclosures and Attachments." in Writing for Design Professionals New York.

VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21MA12T	Semester	I			
Category	BASIC SCIENCE COURSE (BSC)		L	T	P	C
Course Title	MATRICES AND DIFFERENTIAL CALCULUS (COMMON FOR ALL BRANCHES)		3	1	0	4

COURSE OBJECTIVES:

- To apply advanced matrix knowledge to solve engineering problems
- To improve their ability in solving geometrical applications of differential calculus
- To familiarize with the application of differential equations

PREREQUISITE:

- Basic Mathematics skills at 12^{th} level

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C102.1	***Solve*** Engineering problems using matrices.	K3
C102.2	***Use*** various test to discuss the convergence of infinite series.	K2
C102.3	***Apply*** the geometrical concepts to solve differential calculus.	K4
C102.4	***Compute*** partial derivatives of functions of several variables.	K2
C102.5	***Apply in Engineering many physical initial*** and boundary value problems can be described by ODE.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C102.1	3	3	-	-	-	-	-	-	-	-	-	-
C102.2	3	2	-	-	-	-	-	-	-	-	-	-
C102.3	3	3	-	-	-	-	-	-	-	-	-	-
C102.4	3	2	-	-	-	-	-	-	-	-	-	-
C102.5	3	2	-	-	-	-	-	-	-	-	-	-
C102	3	2	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 4

UNIT I MATRICES 12

Matrix operations, special types of matrices, matrices as linear transformations, linear independence, Orthogonalization, Eigen values and Eigen vectors of a real matrix – Properties of Eigen values – Cayley – Hamilton theorem, Orthogonal reduction of a symmetric matrix to diagonal form – Orthogonal matrices – Reduction of quadratic form to canonical form by orthogonal transformations- Nature of quadratic forms.

UNIT II INFINITE SERIES 12

Sequences of real numbers-Series-General properties of series-Comparison test- Integral test, D' Alemberts ratio test and Cauchy's root test- Power series, radius and interval of convergence of power series, Convergence of exponential, logarithmic and Binomial Series, Properties of uniformly convergence series

UNIT III APPLICATIONS OF DIFFERENTIAL CALCULUS 12

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelops – Evolute as envelope of normals

UNIT IV DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES 12

Limits and Continuity –Partial derivatives –Homogeneous Functions-Total derivative –Change of variables –Jacobian and properties –Taylor's series for functions of two variables –Maxima and minima of functions of two variables –Lagrange's method of undetermined multipliers.

UNIT V ORDINARY DIFFERENTIAL EQUATIONS 12

Second and Higher Order Equations, homogeneous and non-homogeneous linear equations and linear systems with constant coefficients, method of variation of parameters, method of undetermined coefficients, Equations reducible to linear equations with constant coefficients- Simultaneous linear equations with constant coefficients.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2015.

REFERENCES:

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons. Singapore, 10thEdition, 2015.
2. M.K. Venkataraman, Engineering Mathematics- First Year, 2nd Edition, National Publishing., Chennai 2001.
3. T. Veerarajan, Engineering Mathematics-I, Tata McGraw Hill Publishing Co, New Delhi, 2017.

Course code	**21PH13T**	**Semester**	**I**			
Category	**BASIC SCIENCE COURSE (BSC)**		**L**	**T**	**P**	**C**
Course Title	**ENGINEERING PHYSICS I (COMMON FOR ALL BRANCHES)**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the importance of polarization, optical fiber and Lasers
- To familiar the knowledge of electromagnetic waves oscillations
- To understand the importance of quantum physics
- To cognize the basics of heat and thermodynamics
- To express the basics of crystal physics

PREREQUISITE:

- High School Maths and Physics

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C103.1	***Utilize*** the concepts of polarization, optical fiber and Lasers for engineering applications	K3
C103.2	***Apply*** the knowledge of electromagnetic waves oscillations	K3
C103.3	***Understand*** the importance of quantum physics.	K2
C103.4	***Cognize*** the basics of heat and thermodynamics	K2
C103.5	***Express*** the basics of crystal physics	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
C103.1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
C103.2	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C103.3	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C103.4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
C103.5	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-
C103	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I PHOTONICS 9

Polarization and Fiber Optics: Electromagnetic waves - Production and analysis of linearly, elliptic and circularly polarized light-Polaroid and applications of polarization. Fiber optics - principle of operation – numerical aperture - acceptance angle and applications of fiber optics.

Optical Sources: Characteristics of Lasers - Spontaneous and Stimulated Emission of Radiation - Population Inversion - Einstein's Coefficients and Relation between them - Applications of Lasers.

UNIT II WAVES AND OSCILLATION 9

Oscillatory motion: Differential equation of SHM- Velocity and acceleration- Restoring Force- Frequency response - phase response and resonance-Analogy with LCR circuits and oscillators- Energy and energy loss- Damped oscillations- Significance in control systems - vibration and vibration isolation.

Wave motion: Definition of a plane progressive wave- Attenuation of waves- Phase Velocity- Introduction to numerical methods for solution of wave equation- Importance of spherical and plane wave fronts.

UNIT III QUANTUM MECHANICS 9

Need for Quantum Physics-Historical overviews - Matter waves - De-Broglie's concept of matter waves - Properties of matter waves - Photo electric effect - Heisenberg's uncertainty principle – Statement - Interpretation and application - Schrödinger's time dependent and time independent equations - Operators - Eigen values and Eigen functions - Expectation values -Physical significance of wave function-Quantum superposition and entanglement for Qbits (quantitatively)

UNIT IV HEAT AND THERMODYNAMICS 9

Heat and internal energy - Specific heat and calorimetry - Latent Heat coefficient of linear thermal expansion - Methods of measurement of thermal expansion - Thermal expansion -Applications - The bimetallic strip - Differential equation of one-dimensional heat flow - Lee's disc apparatus for determination of thermal conductivity - Thermal Insulation- Heat dissipation and heat sinking of electronic devices-solid state refrigerators (qualitatively)

UNIT V CRYSTAL PHYSICS 9

Introduction of Crystallography - Space Lattice - Unit Cell - Lattice Parameters – Crystal Systems - Bravais Lattices - Miller Indices and its applications - Crystal Planes and Directions- Inter Planar Spacing of Orthogonal Crystal Systems - Atomic Radius - Co-ordination Number and Packing Factor of SC, BCC, FCC – Crystal growth –Solution growth -Structure determination by x-ray diffraction method (cubic structure).

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Richard Wolfson, "Essential University Physics", Vols. 1 and 2. Pearson Education, Singapore, 2011.
2. Gaur R K, Gupta S L, "Engineering Physics", DhanpatRai Publications, 2013.

REFERENCES:

1. Halliday D., Resnick R. and Walker J., "Fundamentals of Physics", Wiley Publications,2008.
2. Avadhanulu M. N., "Engineering Physics", S. Chand & Co., 2007.
3. Purcell E. M., "Electricity and Magnetism – Berkeley Physics Course", Vol. 2, Tata McGraw-Hill, 2008.
4. Paul A. Tipler and Geene Mosca, "Physics for Scientists and Engineers", W.H. Freeman and Company, New York, 2004.

Course code	21CY14T	Semester	I			
Category	BASIC SCIENCE COURSE (BSC)		L	T	P	C
Course Title	ENGINEERING CHEMISTRY (COMMON FOR ALL BRANCHES)		3	0	0	3

COURSE OBJECTIVES:

- To make the students conversant with water quality parameters and treatment techniques.
- To get the basic idea about the polymers, electrochemistry and corrosion.
- To deal with the information about various types of fuels and energy sources.

PREREQUISITE:

- Basic Chemistry Skills

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C104.1	***Understand*** the water related problems and their treatment techniques.	K2
C104.2	***Explain*** the applications of polymers and reinforced plastics.	K2
C104.3	***Acquire*** knowledge on electrochemistry and corrosion.	K2
C104.4	***Summarize*** the types of fuels and its production process and calculate the CV values.	K2
C104.5	***Classify*** the non-conventional energy sources and its applications.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C104.1	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104.2	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104.3	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104.4	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104.5	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I WATER AND ITS TREATMENT 9

Introduction - characteristics - alkalinity - types and determination - hardness - types expression of hardness - units - estimation of hardness of water by EDTA - numerical problems -boiler feed water-requirements-boiler troubles – scale & sludge -disadvantages (wastage of fuels, decrease in efficiency, boiler explosion) -softening of hard water - external treatment process - demineralization and zeolite, internal treatment - boiler compounds (carbonate, phosphate, Calgon, sodium aluminate and colloidal conditioning methods) – desalination of brackish water –reverse osmosis.

UNIT II POLYMERS AND REINFORCED PLASTICS 9

Introduction - classification of polymers - Natural and synthetic - Thermoplastic and Thermosetting, Functionality - Degree of polymerization, Properties of polymers: Tg, Tacticity, Molecular weight - weight average, number average and polydispersity index. Types – addition, condensation and Copolymerization – free radical, cationic and anionic polymerization mechanism - Preparation, properties and uses of PVC, Nylon- 6,6, Teflon and Epoxy resin. Plastics - Compounding of plastics – moulding methods – injection, extrusion and compression – Engineering plastics-applications-fibre-reinforced plastics (FRP) – carbon and glass– applications.

UNIT III ELECTROCHEMISTRY AND CORROSION 9

Electrochemical cell - redox reaction, electrode potential- origin of electrode potential-oxidation potential-reduction potential - measurement and applications - electrochemical series and its significance - Nernst equation (derivation and problems). Corrosion- causes- factors- types: chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method. Paints- constituents and function Electroplating of Copper and electroless plating of nickel-Chemical conversion coatings-phosphate, chromate, chemical oxide, and anodized coatings.

UNIT IV FUELS AND COMBUSTION 9

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum – refining-manufacture of synthetic petrol (Bergius process) – knocking - octane number- cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) – synthesis, advantages and commercial application of power alcohol and biodiesel. Combustion of fuels: Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value –problems- ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT Method).

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Energy-Types- Non-renewable energy- Nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries - primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells - H_2-O_2 fuel cell.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. P.C. Jain and Monika Jain, Engineering Chemistry, DhanpatRai, Publishing Company (P) Ltd., New Delhi, 2015.
2. S.S Dara&S.S Umare, A Text book of Engineering Chemistry, S.Chand & Company Ltd., New Delhi, 2015.

REFERENCES:

1. S. Vairam,P. Kalyani and Suba Ramesh., Engineering Chemistry, Wiley India Pvt. Ltd, New Delhi, 2013.
2. B.K.Sharma, Engineering Chemistry, Krishna Prakasan Media (P) Ltd., Meerut, 2014.
3. Prasanta Rath, Engineering Chemistry, Cengage Learning India Pvt. Ltd, Delhi, 2015.
4. Shikha Agarwal, Engineering Chemistry-Fundamentals and Applications, Cambridge University Press, Delhi, 2015.
5. V.R.Gowariker, N.V.Viswanathan, J.Sreedhar, Polymer Science, New Age International (P) Ltd., Publishers, New Delhi, 2011.

VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

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Course code	**21CS15IT**	**Semester**	**I**			
Category	**ENGINEERING SCIENCE COURSE (ESC)**		**L**	**T**	**P**	**C**
Course Title	**PROBLEM SOLVING AND PYTHON PROGRAMMING (COMMON FOR ALL BRANCHES)**		**2**	**0**	**4**	**4**

COURSE OBJECTIVES:

- To be familiar with the basics of algorithmic problem solving.
- To construct python programs with conditionals, loops and functions.
- To use python data structures-Lists, Tuples and Dictionaries.

PREREQUISITE:

- Basic Mathematics Skills and Computer Knowledge

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C105. 1	***Develop*** algorithmic solutions to simple computational problems	K3
C105. 2	***Construct*** simple Python programs for solving problems.	K3
C105. 3	***Build*** Python programs with conditionals and loops.	K3
C105. 4	***Demonstrate*** a Python program into functions.	K2
C105. 5	***Show*** compound data using Python lists, tuples, and dictionaries.	K2
C105. 6	***Read*** and write data from/to files in Python Programs.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
C105. 1	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 2	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 3	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 4	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 5	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 6	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105	3	2	1	-	-	-	-	-	-	-	-	-	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 4

UNIT- I ALGORITHMIC PROBLEM SOLVING AND BASICS OF PYTHON 8

Algorithms-building blocks of algorithms (statements, state, control flow, functions), simple Strategies for developing algorithms (iteration, recursion)-pseudo code- flow chart-programming language. Introduction to Python-Features of Python-Python Interpreter: Interactive and script mode- Values and types, variables, Keywords, Identifiers, operators, precedence of operators, expression, Comments.

UNIT-II CONTROL FLOW, FUNCTIONS 8

Conditional statements-Iterative statements, Functions: Built-in functions, user defined function-Function Arguments-Fruitful functions and void functions- local and global variable - function composition- recursion-Lambda Functions.

UNIT-III MODULES, PACKAGES, STRINGS 4

Modules-Packages-Strings-string operations, string functions and methods.

UNIT-IV LISTS, TUPLES, DICTIONARIES 5

Lists- list operations, list methods, list loop, mutability, aliasing, cloning lists-Tuples-Tuple assignment, Operations on Tuples, Tuple as return value- Dictionaries- operations and methods-Sets-Operations on sets.

UNIT-V FILES AND EXCEPTIONS 5

Files –Types of files, file operations, file methods, format operator-command line arguments-Errors and Exceptions, handling exceptions.

List of Experiments: 30 Periods

1. Write a python program to demonstrate basic data types in python.
2. Write a python program using conditional statements.
3. Write a python program using Iterative statements.
4. Write a python program using built-in and user defined functions.
5. Write a python program using lambda functions and recursions.
6. Write a python program to demonstrate Strings and its Operations.
7. Write a python program to demonstrate lists, tuples and its operations.
8. Write a python program to demonstrate Sets and its operations.
9. Write a python program to demonstrate Dictionaries and its operations.
10. Write a python program to demonstrate Files and its Operations.

30 Periods

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Reema Thareja, “Python Programming using Problem Solving Approach”, OXFORD University Press, 2017.
2. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist‘‘, 2nd edition, Updated for Python 3, Shroff/O‘Reilly Publishers, 2016.

REFERENCES:

1. Ashok Namdev Kamthane, Amit Ashok Kamthane, “Programming and Problem Solving with Python”, Mc-Graw Hill Education, 2018.
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd, 2016.
3. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, CENGAGE Learning, 2012.

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Course code	**21ME16T**	**Semester**	**I**			
Category	**ENGINEERING SCIENCE COURSE (ESC)**		**L**	**T**	**P**	**C**
Course Title	**ENGINEERING GRAPHICS (COMMON FOR ALL BRANCHES)**		**2**	**0**	**4**	**4**

COURSE OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
- To expose them to existing national standards related to technical drawings.

PREREQUISITE:

- Engineering Drawing Skills

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C106.1	***Familiarize*** with the fundamentals and standards of Engineering graphics.	K2
C106.2	***Develop*** freehand sketching of basic geometrical constructions and multiple views of objects.	K3
C106.3	***Draw*** orthographic projection of lines and plane surfaces.	K3
C106.4	***Construct*** projection of solids, Section and development of surfaces.	K3
C106.5	***Visualize*** isometric and perspective projections	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C106. 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C106. 2	3	3	-	-	-	-	-	-	-	-	-	1	1	-	-	-
C106. 3	3	3	2	-	-	1	-	1	-	1	-	1	1	-	-	-
C106. 4	3	3	2	-	-	1	-	1	-	1	-	1	1	-	-	-
C106. 5	3	3	2	-	-	1	-	1	-	1	-	1	1	-	-	-
C106	3	3	2	-	-	1	-	1	-	1	-	1	1	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 4

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING 7+12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square, Triangle and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views– Freehand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection– principles-Principal Planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method. Applications – Drawing interpretation and process planning, circuit design.

UNIT III PROJECTION OF SOLIDS 5+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method, auxiliary plane method. Applications – Engineering design, automotive modelling, X-rays.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Applications – Design of piping, Fabrication, body building, defect analysis.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6 + 12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones– combination of two solid objects in simple vertical positions – Perspective projection of simple solids–Prisms, pyramids and cylinders by visual ray method and vanishing point method. Applications–constructions, photography, animation and image processing.

Total: 90 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2010.
2. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 51th Edition, 2019.

REFERENCES:

1. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited,2015.
2. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy and Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 3rd Edition, 2013.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to Semester End Examination on Engineering Graphics:

1. There will be five questions, each of either-or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. Students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

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Course code	21MC04T	Semester	I			
Category	MANDATORY COURSE (MC)		L	T	P	C
Course Title	*தமிழர் மரபு*		1	0	0	1

SYLLABUS **No. of Credits: 1**

அலகு 1 மொழி மற்றும் இலக்கியம்: **3**

திராவிட மொழிகள்- சங்க இலக்கியம்- திருக்குறள் மேலாண்மை கருத்துக்கள்; தமிழ் காப்பியங்கள்; ஐம்பெருங் காப்பியங்களில் தமிழர் பண்பாடு- தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம்

அலகு 2 பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை: 3

ஐம்பொன் சிலைகள்: பழங்குடியினர் தயாரிக்கும் கைவினை பொருட்கள்; தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள்: இசை கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம்.

அலகு 3 நாட்டுப்புற கலைகள் மற்றும் வீர விளையாட்டுகள்: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, ஒயிலாட்டம், சிலம்பாட்டம், நாட்டுப்புற பாடல்கள்.

அலகு 4 தமிழர்களின் திணை கோட்பாடுகள்: **3**

தொல்காப்பியமும் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புற கோட்பாடுகள்: சங்ககால நகரங்களும் துறைமுகங்களும்.

அலகு 5 இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்கு தமிழர்களின் பங்களிப்பு: **3**

இந்திய மருத்துவத்தில் சித்த மருத்துவம் மற்றும் ஆயுர்வேத மருத்துவத்தின் பங்கு: தமிழ் புத்தகங்களின் அச்சு வரலாறு.

Total: 15 Periods

அடிகுறிப்புகள்

1) தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே. பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)

2) கீழடி வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

3) பெருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை)

Course code	21MC04T	Semester	I			
Category	MANDATORY COURSE (MC)		L	T	P	C
Course Title	HERITAGE OF TAMILS (COMMON FOR ALL BRANCHES)		1	0	0	1

SYLLABUS **No. of Credits: 1**

UNIT 1 LANGUAGE AND LITERATURE 3

Dravidian Languages – Tamil as Classical Language – Sangam Literature- Aimperum kappiyangalil tamilar panbaadu ; Tamil Epics and Impact of Buddhism & Jainism in Tamil Land.

UNIT 2 HERITAGE – ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Art of Temple Making – Massive Terracotta Sculptures – Art of Temple Care Making; Making of Musical Instruments – Mridhangam, Parai, Veenai, Yazh, Nadhaswaram.

UNIT 3 FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Oyillatam, Silambattam, nattupura padalgal.

UNIT 4 THINAI CONCEPTS OF TAMIL 3

Sangam Literature – Education and Literacy During Sangam Age – Ancient Cities and Ports of Sangam Age – Export and Import during Sangam Age.

UNIT 5 CONTRIBUTIONS OF TAMIL TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Culturals Influence of Tamil over the Other Parts of India – Role of Siddha and Ayurvedha in Indigenous System of Medicine – History of Tamil Books.

Total: 15 Periods

REFERENCE:

1) Social Life of Tamils (Dr. K. K. Pillay) A Joint Publications of Tntb & Esc and Rmrl – (in Print)
2) Social Life of the Tamils – The Classical Period (Dr. S Singaravelu)
3) Historical Heritage of Tamils (Dr. S.V Subatamanian, Dr. K.D Thirunavukkarasu)

VEL TECH HIGH TECH
Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE
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Course code	21BS17P	Semester	I			
Category	BASIC SCIENCE COURSE (BSC)		L	T	P	C
Course Title	PHYSICS AND CHEMISTRY LABORATORY (COMMON FOR ALL BRANCHES)		0	0	4	2

COURSE OBJECTIVES:

- To test basic understanding of physics of materials including properties of matter, thermal and optical properties.
- To encourage the students to familiarize with experimental determination of velocity of ultrasonic waves and band gap determination.

PREREQUISITE:

- Basic measurement skills

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C108.1	***Estimate*** the various water quality parameters like alkalinity, hardness (total, temporary, & permanent), dissolved oxygen content, and chloride content.	K2
C108.2	***Investigate*** the metals and ions present in any given sample using various analytical techniques.	K2
C108.3	***Analyze*** the properties such as conductance of solutions, and redox potentials.	K2
C108.4	***Determine*** various moduli of elasticity and also various thermal and optical properties of materials.	K2
C108.5	***Determine*** the velocity of ultrasonic waves, band gap determination and viscosity of liquids.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C108.1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108.2	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108.3	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108.4	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108.5	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

PHYSICS LABORATORY
LIST OF EXPERIMENTS
(Any SIX Experiments)

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of disc
2. Non-uniform bending - Determination of young's modulus
3. Lee's disc Determination of thermal conductivity of a bad conductor
4. Laser- Determination of the wave length of the laser using grating, Estimation of laser parameters
5. Optical fibre -Determination of Numerical Aperture and acceptance angle
6. Ultrasonic interferometer - determination of the velocity of sound and compressibility of Liquids
7. Determination of Band gap of a semiconductor
8. Spectrometer- Determination of wavelength using gating

Total: 30 Periods

REFERENCES:

1. Physics Practicals, Department of Physics, Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala Engineering College 2021
2. Wilson J.D. and Hernandez C.A., "Physics Laboratory Experiments", Houghton Mifflin Company, New York 2005

CHEMISTRY LABORATORY
LIST OF EXPERIMENTS
(Any SIX Experiments)

1. Determination of permanent, total and temporary hardness of water sample.
2. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
3. Determination of DO Content of water sample by Wrinkler's method.
4. Determination of chloride content of water sample by Argentometric method.
5. Determination of strength of given HCl using pH meter.
6. Estimation of Fe^{2+} by Potentiometric titration.
7. Determination of molecular weight of PVA using Ostwald viscometer.
8. Estimation of Iron content in water sample using spectrophotometer (1,10 – Phenanthroline/thiocyanate method).
9. Conductometric titrations of strong acid Vs strong base.
10. Determination of strength of acid in a mixture using conductivity meter.
11. Corrosion experiment-weight loss method.
12. Estimation of sodium and potassium present in water using flame photometer.

Total: 30 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Jeffery G.H., Bassett J., Mendham J. and Denny vogel's R.C, "Text book of quantitative analysis chemical analysis", ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
2. Kolthoff I.M., Sandell E.B. et al. "Quantitative chemical analysis", Mcmillan, Madras 1980.
3. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel's Textbook of practical organic chemistry", LBS Singapore (1994).

Course code	21ME18P	Semester	I			
Category	ENGINEERING SCIENCE COURSE (ESC)		L	T	P	C
Course Title	ENGINEERING PRACTICES LABORATORY (COMMON FOR ALL BRANCHES)		0	0	4	2

COURSE OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering

PREREQUISITE:

- Basic knowledge of engineering skills

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C109. 1	Demonstrate on Smithy operations, Foundry operations models and machine assembly practice of centrifugal pump and air-conditioner	K2
C109. 2	Experiment with pipe connections and plumbing works	K3
C109. 3	Make use of welding equipment to join the structures.	K3
C109. 4	Explain carpentry components, for the joint used in roofs, doors, windows and furniture.	K5
C109. 5	Develop sheet metal models, fitting models and do basic machining operations	K6

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C109. 1	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109. 2	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109. 3	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109. 4	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109. 5	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

I CIVIL ENGINEERING PRACTICE 12

Buildings:

a) Study of plumbing and carpentry components of residential and industrial buildings, Safety aspects.

Plumbing Works:

a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers and elbows in household fittings.
b) Study of pipe connections requirements for pumps and turbines.
c) Preparation of plumbing line sketches for water supply and sewage works.
d) Hands-on-exercise:
   Basic pipe connections-Mixed pipe material connection-Pipe connections with different joining components
e) Demonstration of plumbing requirements of high-rise buildings

Carpentry using Power Tools only:

a) Study of the joints in roofs, doors, windows and furniture.
b) Hands-on-exercise:
   Wood work, joints by sawing, Planning and cutting.

II MECHANICAL ENGINEERING PRACTICE 18

Welding:

a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
b) Gas welding practice

Basic Machining:

a) Simple Turning and Taper turning
b) Drilling Practice

Sheet Metal Work:

a) Forming & Bending:
b) Model making – Trays and funnels.
c) Different type of joints.

Machine assembly practice:

a) Study of centrifugal pump
b) Study of air conditioner

Demonstration on:

a) Smithy operations, upsetting, swaging, setting down and bending. Example –Exercise – Production of hexagonal headed bolt.
b) Foundry operations like mould preparation for gear and step cone pulley.
c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

Total: 30 Periods

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE **14**

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.

2. Fluorescent lamp wiring.

3. Stair case wiring

4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.

5. Measurement of energy using single phase energy meter.

6. Measurement of resistance to earth of an electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE **16**

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.

2. Study of logic gates AND, OR, EX-OR and NOT.

3. Generation of Clock Signal.

4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.

5. Measurement of ripple factor of HWR and FWR.

Total: 30 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Chapman, W.A.J. Workshop Technology, Edward Arnold, 2001.

REFERENCES:

1. Raghuwanshi B.S., Workshop Technology Vol. I & II, DhanpathRai & Sons.
2. Kannaiah P. and Narayana K.L., Workshop Manual, 2 Edn, Scitech publishers.
3. John K.C., Mechanical Workshop Practice. 2nd Edn. PHI 2010.
4. JeyapoovanT. and Pranitha S., Engineering Practices Lab Manual, 3rd Edn. Vikas Pub.2008

II SEMESTER

SEMESTER II										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21EN21T	Technical English	HSMC	40	60	100	3	0	0	3
2	21MA22T	Vector Calculus and Complex Integration	BSC	40	60	100	3	1	0	4
3	21BT23T	Anatomy and Human Physiology	BSC	40	60	100	3	0	0	3
4	21EE24T	Basic Electrical, Electronics and Instrumentation Engineering	ESC	40	60	100	3	0	0	3
5	21BT25T	Chemistry of Biomolecules	PCC	40	60	100	3	0	0	3
6	21IT26T	Programming in C	ESC	40	60	100	3	0	0	3
7	21MC05T	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	MC	40	60	100	1	0	0	1
PRACTICAL										
8	21BT27P	Biochemistry Laboratory	PCC	40	60	100	0	0	4	2
9	21IT28P	Programming in C Laboratory	ESC	40	60	100	0	0	4	2
TOTAL										**24**

Course code	21EN21T	Semester	II			
Category	HUMANITIES & SOCIAL SCIENCE INCLUDING MANAGEMENT COURSES (HSMC)		L	T	P	C
Course Title	TECHNICAL ENGLISH (COMMON FOR ALL BRANCHES)		3	0	0	3

COURSE OBJECTIVES:

- To make the students of engineering and technology to enhance their ability on reading and comprehencing the different texts
- To improve their creative and critical thinking so as to use in demanding contexts
- To equip the learners with the skills of writing convincing job Applications and effective reports
- To develop their speaking skills to make technical presentations and participate in group discussions
- To facilitate them to hone their soft skills

PREREQUISITE:

- Technical writing and basic English grammar.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C201. 1	***Read*** and understand general and technical texts	K2
C201. 2	***Apply*** creative and critical thinking and communicate their ideas efficiently	K2
C201. 3	***Participate*** in group discussions and deliver short speeches effectively	K3
C201. 4	***Write*** effectively and persuasively in academic and workplace contexts	K3
C201. 5	***Experiment with*** the future challenges confidently and successfully	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C201. 1	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201. 2	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201. 3	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201. 4	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201. 5	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT-I TECHNICALWRITING AND VISUAL CONVERSION 9

PRACTICAL

LISTENING : Listening to pronunciation of longer words.

SPEAKING : Making out meaning of pictorial and graphical representations.

TUTORIAL

READING : Understanding logic and sequencing in reading inferring the exact meaning of text

WRITING : Extended Definition- Writing Instructions, Checklists & Recommendations- Reading short technical text from Journal.

VOCABULARY: Technical vocabulary- Regular and Irregular verbs.

UNIT- II TECHNICAL WRITING AND GUIDELINES PREPARATION 9

PRACTICAL

LISTENING : Comprehensive listening - Listening to telephonic conversations – short and long conversations from different domains, listening to various pre-recorded conversations and speeches.

SPEAKING : Delivering short speeches in the class.

TUTORIAL

READING : Technical reading on innovations and innovators.

WRITING : Conditional clauses, Numerical adjectives, Process Description

VOCABULARY: Collocation, Verbal Analogies.

UNIT-III TECHNICAL PROCESS WRITING 9

PRACTICAL

LISTENING : Listening to documentaries and making notes.

SPEAKING : Basic speaking practice based on BEC, IELTs, and TOFEL.

TUTORIAL

READING : longer text both general and technical –practice in speed reading

WRITING : Purpose statements, words are used as nouns and verbs- describing a process – use of sequence word - Interpretation of Graphs and Charts.

VOCABULARY: Sequence words –Misspelled words -Embedded sentences.

UNIT- IV TECHNICAL WRITING AND BUSINESS LETTERS 9

PRACTICAL

LISTENING : listening to native accents.

SPEAKING : Group Discussions - Process, Skills, Guidelines, Evaluation, Oral Presentation - Planning, Preparing, Organizing and Presenting.

TUTORIAL

READING : Reading for detailed comprehension.

WRITING : Cause and effect, impersonal passive voice, idioms and phrases, - Letter writing, job application, business correspondence (letters) – calling for quotations, placing order,complaint letters, preparing a memo, notice and e-mail itinerary.

VOCABULARY: clauses and If conditionals.

UNIT-V TECHNICAL WRITING AND REPORT WRITING 9

PRACTICAL

LISTENING : TED /ink talks

SPEAKING : Starting a Career — vision statement, preparing logo and tagline, making short term and long-term goals, setting plans.

TUTORIAL

READING : Reading and understanding technical articles.

WRITING : Degrees of comparison, editing, Email etiquette, Mispronounced words – Report writing survey, feasibility, industrial visit, reporting various incidents and accidents, Minutes of meeting.

VOCABULARY: Reported speech.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Department of English, Anna University, Chennai. Mindscapes: English for Technologists and Engineers. Orient Black Swan, Chennai.
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Black Swan Publications, Chennai, 2011.

REFERENCE BOOKS:

1. Rizvi, M. Ashraf, “Effective Technical Communication”, Tata McGraw— Hill,2006.
2. Ibbotson, Mark, “Cambridge English for Engineering”, Cambridge University Reference Press, 2008
3. Richard Johnson-Sheehan, “Technical Communication Today”4th EditionBooks Longman Publishing Group, 2011.
4. Richard Johnson-Sheehan, “Technical Communication Today”4th EditionBooks Longman Publishing Group, 2011
5. Porter, Patricia A., and Margaret Grant, “Communicating Effectively in English: Ora1 Communication for Non-Native Speakers”, 2nd Edition, Wadsworth, 1992.
6. Gopalaswamy, Ramesh & Ramesh Mahadevan. ACE of Soft Skills: Attitude, Communication and Etiquette for Success, New Delhi: Pearson, 2010.

Extensive Reading:

Wells, H G. The Time Machine, Peacock, India, 2008.

Course code	21MA22T	Semester	II			
Category	BASIC SCIENCE COURSE (BSC)		L	T	P	C
Course Title	VECTOR CALCULUS AND COMPLEX INTEGRATION (COMMON FOR ALL BRANCHES)		3	1	0	4

COURSE OBJECTIVES:

- To improve their ability in vector calculus
- To expose to the ideas of analytic functions
- To solve differential equation using the concept of Laplace Transform.

PREREQUISITE:

- Mathematics skills at Sem-I level

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C202.1	***Apply*** the vector calculus concepts to solve engineering problems.	K3
C202.2	***Apply*** the concept of mapping to solve Linear equation.	K3
C202.3	***Apply*** the complex integration problem ideas to solve engineering problems.	K3
C202.4	***Understand*** the concepts of multiple integrals.	K2
C202.5	***Apply*** the concepts of Laplace transformation to solve Differential Equations.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C202.1	3	2	-	-	-	-	-	-	-	-	-	-
C202.2	3	2	-	-	-	-	-	-	-	-	-	-
C202.3	3	2	-	-	-	-	-	-	-	-	-	-
C202.4	2	2	-	-	-	-	-	-	-	-	-	-
C202.5	3	2	-	-	-	-	-	-	-	-	-	-
C202	3	2	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 4

UNIT I VECTOR CALCULUS **12**

Gradient, divergence, curl – Solenoidal and irrotational fields – Vector identities– Directional derivatives – Line, surface and volume integrals –Green's, Gauss divergence and Stoke's theorems (without proof) .

UNIT II ANALYTIC FUNCTIONS **12**

Limit of a complex functions-Derivative of f(z)-Definition of Analytic Function – Cauchy Riemann equations – Properties of analytic functions - Determination of harmonic conjugate – Milne-Thomson's method – Conformal mappings: 1/z, az , az+b and bilinear transformation.

UNIT III COMPLEX INTEGRATION **12**

Line integral – Cauchy's integral theorem (statements only) – Cauchy's integral formulae and its applications – Taylor's and Laurent's expansions (statements only) – Singularities – Poles and Residues – Cauchy's residue theorem (statement only) – Contour integration – Unit circle and semicircular contour.

UNIT IV MULTIPLE INTEGRALS **12**

Double integration in Cartesian and polar coordinates – Change of order of integration – Area as double integral – Triple integration in Cartesian coordinates – Conversion from Cartesian to polar – Volume as a double and Triple Integral.

UNIT V LAPLACE TRANSFORMS **12**

Definition-Conditions for existence- Transforms of elementary functions – Properties of Laplace Transform-Transforms of periodic functions – Transforms of derivatives and integrals– Inverse transforms – Convolution theorem– Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficients only- Unit step function and Unit impulse function [simple problems only]

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. B. S. Grewal, Higher **Engineering Mathematics**, Khanna Publishers, New Delhi, 42nd Edition, 2012.

REFERENCES:

1. E. Kreyszig, **Advanced Engineering Mathematics**, John Wiley & Sons. Singapore, 10thEdition, 2012.
2. M.K. Venkataraman, Engineering **Mathematics: Vol I and II**, National Publishing., Chennai 2001.
3. T. Veerarajan, **Engineering Mathematics**, Tata McGraw Hill Publishing Co, New Delhi, 2004.

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Course code	21BT23T	Semester	II			
Category	BASIC SCIENCE COURSE (BSC)		L	T	P	C
Course Title	ANATOMY AND HUMAN PHYSIOLOGY		3	0	0	3

COURSE OBJECTIVES:

- To define the basic concepts relating to cell, blood components and joints
- To understand the structure and functions of the various types of systems in the human body.
- To demonstrate the importance of anatomical features and physiology of human systems

PREREQUISITE:

- Fundamentals of the Chemistry and Biology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C203.1	Comprehend the basic concepts in human anatomy and physiology along with body fluids	K2
C203.2	Recognize the breathing mechanism, human body mechanics, bones and joints involved in movement	K2
C203.3	Perceive the concepts about circulatory pathways	K2
C203.4	Ability to understand the basic physiology of endocrine, human neural system and its conduction of nerve impulse	K2
C203.5	Conceive the mechanism about kidney function	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C203.1	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C203.2	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C203.3	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C203.4	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C203.5	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C203	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT-I BASICS OF ANATOMY AND PHYSIOLOGY 9

Introduction to Human anatomy and physiology, Structure of human cell – Four primary tissues, organs and organ systems – Physiology of homeostasis. Osteology and joints- Muscles, Body fluids- Composition and functions of blood - Plasma proteins- Red blood cells, White blood cells and platelets - Blood groups and blood clotting.

UNIT-II SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS 9

Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton – Types of joints and function – Types of cartilage and function. Muscular: Parts of Muscle – Movements. Respiratory: Parts of Respiratory Systems – Types of respiration - Mechanisms of Breathing – Regulation of Respiration

UNIT- III CARDIOVASCULAR AND LYMPHATIC SYSTEMS 9

Cardiovascular: Components of Blood and functions.- Blood Groups and importance – Structure of Heart – Conducting System of Heart – Properties of Cardiac Muscle - Cardiac Cycle - Heart Beat – Types of Blood vessel – Regulation of Heart rate and Blood pressure. Lymphatic: Parts and Functions of Lymphatic systems – Types of Lymphatic organs and vessels

UNIT-IV NERVOUS AND ENDOCRINE SYSTEMS 9

Nervous: Cells of Nervous systems – Types of Neuron and Synapses – Mechanisms of Nerve impulse – Brain: Parts of Brain – Spinal Cord – Tract and Pathways of Spines – Reflex Mechanism – Classification of Nerves - Autonomic Nervous systems and its functions. Endocrine - Pituitary and thyroid gland.

UNIT-V DIGESTIVE AND URINARY SYSTEMS 9

Digestive: Organs of Digestive system – Digestion and Absorption. Urinary: Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulation of Blood pressure by Urinary System – Urinary reflex

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Prabhjot Kaur. Text Book of Anatomy and Physiology. Lotus Publishers. 2014
2. Elaine.N. Marieb, “Essential of Human Anatomy and Physiology”, Eight Edition, Pearson Education, New Delhi, 2007

REFERENCES:

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. Pearson Publishers, 2014
2. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2013.

Course code	**21EE24T**	**Semester**	**II**			
Category	**ENGINEERING SCIENCE COURSE (ESC)**		**L**	**T**	**P**	**C**
Course Title	**BASIC ELECTRICAL, ELECRONICS AND INSTRUMENTATION ENGINEERING (COMMON FOR CSE, IT, AI&DS, BIOTECH, CIVIL, MECH, CSE(AI&ML))**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- The course is intended to introduce the students to basic theorems and laws in DC and AC circuits.
- This course aims at giving adequate exposure to students on the principles of electrical machines.
- The course will enable the students to acquire knowledge on fundamentals and applications of various electronic devices and measuring instruments.

PREREQUISITE:

- Engineering Physics, Mathematics

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C204.1	***Impart*** knowledge on electrical circuit components, laws and theorems.	K2
C204.2	***Analyze*** the behavior of ac circuits components in power system	K3
C204.3	***Illustrate*** the working of various ac machines, dc machines and special machines along with its characteristics.	K2
C204.4	***Infer*** and ***relate*** the working and applications of various electronics devices and circuits.	K2
C204.5	***Categorize*** the specific instruments for electrical measurements.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
C204.1	3	2	-	-	-	-	-	-	2	-	1	1
C204.2	3	2	-	-	-	-	-	-	2	-	1	1
C204.3	3	2	-	-	-	-	-	-	2	-	1	1
C204.4	3	2	-	-	-	-	-	-	-	-	1	1
C204.5	3	2	-	-	-	-	-	-	2	-	1	1
C204	3	2	-	-	-	-	-	-	2	-	1	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I DC CIRCUITS 9

Basic circuit components (R, L & C) - Ohms Law - Kirchoff's Law – voltage and current division -source transformation-steady state solution of DC circuits - Nodal analysis, Mesh analysis- Thevenin's Theorem, Norton's Theorem, Maximum Power transfer -Superposition Theorem.

UNIT II AC CIRCUITS 9

Introduction to AC circuits – waveforms and RMS value – power and power factor, Analysis of single-phase ac circuits consisting of RL and RLC combinations -Resonance- Balanced and Unbalanced three-phase circuits-Star and Delta connections.

UNIT III ELECTRICAL MACHINES 9

Principles of operation and characteristics of DC machines, Construction and operation of Single-Phase transformer – Three phase transformer connections – Autotransformer. Construction and types of Single phase and Three phase Induction motor, Construction and working principle of Alternator, Stepper motors – Brushless DC Motors.

UNIT IV ELECTRONIC DEVICES & CIRCUITS 9

Types of Materials – Silicon & Germanium - PN Junction diodes – Structure, Operation and Characteristics – Display devices-LED, Laser diodes – Zener diode - Bipolar Junction Transistor – Characteristics and applications –Amplifiers - Basics, types and applications, Oscillators-Basics, types and its applications—D/A and A/D converters.

UNIT V MEASUREMENTS & INSTRUMENTATION 9

Introduction to transducers - Classification of Transducers: Resistive, Inductive, Capacitive Thermoelectric, piezoelectric, photoelectric, Hall effect. Types and principle of indicating Instruments – Multimeters, Wattmeter, instrument transformers (CT and PT), Oscilloscopes.

TOTAL: 45 PERIODS

LEARNING RESOURCES:

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, ―Basic Electrical and Electronics Engineering, McGraw Hill Education (India) Private Limited, Third Reprint ,2016
2. Leonard S Bobrow, "Foundations of Electrical Engineering", Oxford University Press, 2013
3. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2007.

REFERENCES:

1. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007
2. John Bird, "Electrical Circuit Theory and Technology", Elsevier, First Indian Edition, 2006
3. N K De, Dipu Sarkar, "Basic Electrical Engineering", Universities Press (India)Private Limited 2016
4. David A. Bell, "Electronic devices and circuits", Oxford University higher education,5th edition2008.
5. Allan S Moris, "Measurement and Instrumentation Principles", Elseveir, First Indian Edition, 2006.

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Course code	**21BT25T**	**Semester**	**II**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**CHEMISTRY OF BIOMOLECULES**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To comprehend the fundamental chemical principles that govern biological systems
- To Understand the regulation of biological/biochemical processes
- To Relate biomolecules and their metabolic pathways with metabolic disorders

PREREQUISITE:

- Fundamentals of the Chemistry and Biology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C205.1	***Understand*** the role of chemical and biological basis in life	K2
C205.2	***Explain*** the core concepts in biological metabolism and enzymatic structure and function.	K2
C205.3	***Illustrate*** the role of Biomolecules in Homeostasis	K2
C205.4	***Relate*** the structure, function and reactions of Biomolecules	K3
C205.5	***Analyze*** complications related to Metabolic disorders	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C205.1	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C205.2	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C205.3	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C205.4	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C205.5	3	2	1	-	-	-	-	-	-	-	-	-	2	-	-	-
C205	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 3**

UNIT-I INTRODUCTION TO BIOMOLECULES 05

Role of carbon, Types of functional groups, Chemical nature of water, pH and biological buffers, Biomolecules

UNIT-II CARBOHYDRATES 12

Introduction: Monosaccharides: Structure, Function, and its Reaction, Polysaccharides: Structure and Function; Homopolysaccharides – Sucrose, Lactose, Maltose, Heteropolysaccharides – Glycoprotein, Proteoglycans and Glycolipids, Glycosaminoglycans. **Metabolism, Regulation and Bioenergetics**: Glucose Metabolism – (Glycolysis, TCA cycle, Oxidative Phosphorylation), Gluconeogenesis, Glycogenesis, Glycogenolysis, Hexose Mono-Phosphate and Glyoxalate Shunt, Calculation of ATP – Glucose, **Biochemical Diseases**: Diabetes and Hunter syndrome

UNIT- III LIPIDS 12

Introduction: Classification, Structure, Function and its Reaction; Saponifiable Lipids – Fats and Waxes, Phospholipids, Sphingolipids and Glycolipids; Non Saponifiable Lipids – Steroids, Cholesterol and Eicosanoids. **Metabolism, Regulation and Bioenergetics**: Oxidation of Fatty Acids – Palmitic Acid and Propionic Acid, Alpha and Omega Oxidations, Fatty Acid Synthesis, Calculation of ATP – Palmitic Acid and Stearic Acid, **Biochemical Diseases**: Hypercholesterolemia and Tay-Sachs disease

UNIT-IV PROTEINS 09

Introduction: Amino Acids, Peptides, Proteins, measurement, Protein structure Hierarchy, Protein Folding, glycoproteins, lipoproteins. **Metabolism, Regulation and Bioenergetics**: Synthesis of Amino Acids – Glutamate, Serine, Aspartate, Alanine, Tryptophan, Thyrosine, Phenyl Alanine and Histidine, Urea Cycle. **Biochemical Diseases**: Maple syrup urine disease and Phenylketonuria

UNIT-V NUCLEIC ACIDS 07

Introduction: Purine and Pyrimidine, RNA and its types, DNA and its types, Watson and Crick Model, Chargaff's Rule. **Metabolism and Regulation**: Synthesis of Nucleic Acid (Denovo and Salvage Pathway), Degradation using Exo and Endonucleases. **Biochemical Diseases**: Hyperuricemia and Gout

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Lehninger A.L., Nelson D.L. and Cox M.M. Principles of Biochemistry. CBS publishers and distributors.
2. Victor W.R., David A.B., Botham K.M., Kennelly P.J., Weil P.A., Harper's illustrated biochemistry, 31st edition, New York: Mcgraw-Hill Education, 2018.
3. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.

REFERENCES:

1. Voet and Voet, Biochemistry, 2nd Edition, John Wiley & Sons Inc., 1995.
2. Lubert Stryer, Biochemistry, 4th Edition, WH Freeman & Co., 2000.

Course code	**21IT26T**	**Semester**	**II**			
Category	**ENGINEERING SCIENCE COURSE(ESC)**		**L**	**T**	**P**	**C**
Course Title	**PROGRAMMING IN C (COMMON FOR CSE, IT, ECE, BIOTECH, CHEM, CSE (AI&ML))**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn Introduction of Algorithm and Basic Structure of C Programming.
- To gain knowledge on Implementation of Arrays and Strings concept in C Programming.
- To understand the Basic functions and Pointer declaration in C Programming.
- To apply the concepts of Structures and Unions in an example program.
- To write a sample C program to implement file handling and accessing Graphic Library function.

PREREQUISITE:

- Basic Mathematics Skills

COURSE OUTCOMES:

CO. No.	**Course Outcome**	**Blooms level**
On successful completion of this Course, students will be able to		
C206.1	***Explain*** the data types, syntax and control structures for solving different problems.	K2
C206.2	***Apply*** the concepts of Arrays, Strings in 'C' language for user defined problems	K3
C206.3	***Make use of*** functions and concepts of pointers in 'C' language	K3
C206.4	***Organize*** data using structures and unions in 'C' Programs.	K3
C206. 5	***Develop*** and implement applications using File handling Process and Graphics.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C206.1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-
C206.2	3	2	1	-	-	-	-	-	-	-	-	-	3	2	-	-
C206.3	3	2	1	-	-	-	-	-	-	-	-	-	3	2	-	-
C206.4	3	2	1	-	-	-	-	-	-	-	-	-	3	2	-	-
C206. 5	3	2	1	-	-	-	-	-	-	-	-	-	3	2	-	-
C206	3	2	1	-	-	-	-	-	-	-	-	-	3	2	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS	No. of Credits: 3

UNIT-I INTRODUCTION TO PROGRAMMING 9

Basic Organization of a Computer - Introduction to Algorithm, Pseudo code, Flow Chart. Structure of 'C' program, compilation and linking processes - C Tokens: Keywords, Data Types, Constants, Variables - Declaration –Operator: precedence and associativity -Expressions - Input/Output statements -Assignment statements – Decision making statements Switch statement - Looping Statements-Bitwise operations- pre-processor-Syntax and Logical Errors in compilation solving simple scientific and statistical problems.

UNIT-II ARRAYS AND STRINGS 9

Arrays: Declaration, Initialization - One dimensional array: Assigning an array to another array – Equating an array with another array –Two dimensional Arrays: Declaration – usage of two-dimensional arrays – reading, storing and accessing elements in two dimensional arrays –String operations: Initialization of Strings – string library functions - command line arguments – Searching and Sorting of Strings.

UNIT-III FUNCTIONS AND POINTERS 9

Introduction to functions: Classification of functions – function definition – function call –function with inputs and outputs - recursive function –example programs: copy one string to another string using recursion, binary search using recursion -Pointer Fundamentals: Pointer Declaration – Passing Pointers to a Function- Operations on pointers: Pointer Arithmetic - Pointer comparisons -Array of pointer: Pointers and one-dimensional arrays- Pointers and multi-dimensional arrays.

UNIT-IV STRUCTURES AND UNIONS 9

Introduction to Structures: Defining structures - initializing structures -Array of Structures – Nested structures - Introduction to union Creating and using union variables - memory allocation of union – example programs: Store and display N employees information using Union- Dynamic memory allocation: Allocating and freeing memory, Allocating memory for arrays.

UNIT-V FILE HANDLING AND GRAPHICS 9

Files: Introductions - Data hierarchy - Types of file processing- Sequential access: Reading data from sequential access file - Updating sequential access file - Random access: Reading data from random access file - Writing data randomly to random access file –C Graphics: libraries and functions – 2D shapes – 3D shapes – Examples.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Sumitabha Das, "Computer Fundamentals & C Programming", McGraw Hill, 2018.
2. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
3. Yashavant Kanetkar" Let usC", 15thedition.

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REFERENCES:

1. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. Byron S Gottfried and Jitendar Kumar Chhabra, "Programming with C", Tata McGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
3. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006.
4. Ashok N. Kamthane, "Computer programming", Pearson Education, 2007.

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Course code	**21MC05T**	**Semester**	**II**			
Category	**MANDATORY COURSE (MC)**		**L**	**T**	**P**	**C**
Course Title	***தமிழரும் தொழில்நுட்பமும்***		**1**	**0**	**0**	**1**

SYLLABUS: **No. of Credits: 1**

அலகு 1 நெசவு மற்றும் பானை தொழில்நுட்பம்: 3

சங்க காலத்தில் நெசவு தொழில் – பாண்டங்களின் கீறல் குறியீடுகள்

அலகு 2 வடிவமைப்பு மற்றும் கட்டிட தொழில்நுட்பம்: 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள். சோழர் காலக் கட்டிடக்கலை, மாமல்லபுரம் சிற்பங்களும், கோவில்களும்

அலகு 3 உற்பத்தி தொழில் நுட்பம்: 3

கப்பல் கட்டும் கலை – இரும்பு தொழிற்சாலை – இரும்பை உருக்குதல் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்

அலகு 4 வேளாண்மை மற்றும் நீர்ப்பாசன தொழில் நுட்பம்: 3

கடல் சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துகுளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு

அலகு 5 அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்: 3

தமிழின் வளர்ச்சி – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் மின் நூலகம்

Total: 15 Periods

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அடிக்குறிப்பு

1) தமிழக வரலாறு – மக்களும் பண்பாடும் – கே . கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்

2) கணினி தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)

3) கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்

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Course code	**21MC05T**	**Semester**	**II**			
Category	**MANDATORY COURSE (MC)**		**L**	**T**	**P**	**C**
Course Title	**TAMILS AND TECHNOLOGY**		**1**	**0**	**0**	**1**

SYLLABUS: **No. of Credits: 1**

UNIT 1 WEAVING AND CERAMIC TECHNOLOGY: **3**

Weaving Industry During Sangam Age - Graffiti on Potteries.

UNIT 2 DESIGN AND CONSTRUCTION TECHNOLOGY: **3**

Dravidian Architecture; Contemporary Architecture; Cholar kala kattida kalai, Pallava Architecture; Motifs; Temple Architecture.

UNIT 3 MANUFACTURING TECHNOLOGY: **3**

Metallurgical Studies- Iron Industry Steel; Beads Making Industry.

UNIT 4 AGRICULTURE AND IRRIGATION TECHNOLOGY: **3**

Agriculture in Ancient Tamil Era; Land Classification; Crops; Irrigation; Crop Rotation; Marketing; Agriculture in Tamil Literature.

UNIT 5 SCIENTIFIC TAMIL & TAMIL COMPUTING: **3**

Digitalization of Tamil Books

Total: 15 Periods

REFERENCES

1) Historical Heritage of the Tamils (Dr. S. Subatamanian, Dr. K. D Thirunavukkarasu) (Published By: International of Tamil Studies)
2) The Contributions of Tamil to Indian Culture (Dr. M. Valarmathi) (Published By: International Institute of Tamil Studies.)
3) 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)

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Course code	**21BT27P**	**Semester**	**II**		
Category	**PROFESSIONAL CORE COURSE (PCC)**	**L**	**T**	**P**	**C**
Course Title	**BIOCHEMISTRY LABORATORY**	**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To carry out qualitative and quantitative estimation of biomolecules.
- To relate the laboratory analysis with biological fluids.
- To understand the regulation of biochemical processes.

PREREQUISITE:

- Fundamentals of the Chemistry and Biology Laboratory

COURSE OUTCOMES:

CO. No.	Course Outcome	Blooms level
On successful completion of this Course, students will be able to		
C208.1	***Outline the*** awareness of the hazardous chemicals and safety precautions in case of emergency.	K2
C208.2	***Experiment with*** the principles behind the qualitative and Quantitative estimation of biomolecules.	K3
C208.3	Analyze the biomolecules in the body fluids.	K4
C208.4	***Examine*** the various biomolecules to relate the biochemical parameters with clinical aspects	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C208.1	2	1	-	-	-	-	-	-	1	-	-	-	2	-	-	-
C208.2	3	1	-	-	-	-	-	-	1	-	-	-	2	-	-	-
C208.3	3	3	2	-	-	-	-	-	1	-	-	-	2	-	-	-
C208.4	3	3	2	-	-	-	-	-	1	-	-	-	2	-	-	-
C208	3	2	1	-	-	-	-	-	1	-	-	-	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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List of Experiment **No. of Credits: 2**

1. Guidelines and Safety Awareness in Life Science Laboratories
2. Unit Conversions and Buffer Preparation
3. Study of Colorimeter and Beer's-Lambert's Law
4. Qualitative Estimation of Carbohydrates
5. Quantitative Estimation of Total Sugar by Anthrone Method
6. Quantitative Estimation of Reducing Sugar by DNSA Method
7. Extraction of Lipids and analysis by TLC
8. Qualitative Estimation of Proteins and Nucleic Acid
9. Quantitative Estimation of Protein by Biuret and Lowry's Methods
10. Estimation of Creatinine from Urine
11. Acid hydrolysis and action of salivary amylase on starch
12. Hydrolysis of Starch and Estimation of Glucose and Glucose Oxidase and Peroxidase (God- Pod) Method

LEARNING RESOURCES:

TEXT BOOKS:

1. Jayaraman J., Laboratory Manual in Biochemistry, 2nd Edition, New Age International Private Limited, January 2011.
2. Gupta R.C and Bhargavan S, "Practical Biochemistry", CBS Publishers and Distributors, 1985.

REFERENCES:

1. Hofmann, A., & Clokie, S. (Eds.). (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge: Cambridge University Press. doi:10.1017/9781316677056

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Course code	**21IT28P**	**Semester**	**II**			
Category	**ENGINEERING SCIENCE COURSE (ESC)**		**L**	**T**	**P**	**C**
Course Title	**PROGRAMMING IN C LABORATORY (COMMON FOR CSE, IT, ECE, BIOTECH, CHEM, CSE(AI&ML))**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To develop programs in C using basic constructs.
- To develop applications in C using strings, pointers, functions, structures
- To develop applications in C using file processing, Graphics

PREREQUISITE:

- Basic Mathematics Skills

COURSE OUTCOMES:

CO. No.	**Course Outcome**	**Blooms level**
On successful completion of this Course, students will be able to		
C209.1	***Utilize*** decision making and looping statements for problem solving.	K3
C209.2	***Apply*** the concepts of Arrays and String to solve problem statements.	K3
C209.3	***Examine*** the dynamic behaviour of memory by the use of pointers.	K4
C209.4	***Develop*** simple applications using Structures and unions.	K3
C209.5	***Design*** and develop simple applications using File Processing and Graphics.	K6

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
C209.1	3	2	1	-	-	1	-	-	1	-	1	1	1	2
C209.2	3	2	1	-	-	1	-	-	1	-	1	1	2	1
C209.3	3	3	2	1	-	1	-	-	1	-	1	1	2	1
C209.4	3	2	1	-	-	1	-	-	1	-	1	1	2	1
C209.5	3	3	3	3	2	1	-	-	1	-	1	1	2	1
C209	3	2	2	3	2	1	-	-	1	-	1	1	2	1

Note: 1: Slight, 2: Moderate, 3: Substantial

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LIST OF EXPERIMENT	No. of Credits: 4

1. a) Write a C program to perform input / output of all basic data types.

   b) Write a C program using decision making construct.

   c) Write a program that finds if a given number, is a prime number.

2. a) Write a program to find whether the given year is a leap year or not?
   (Hint: not every Centurion year is a leap. For example, 1700, 1800 and 1900 is not a leap year)

   b) Write a program using looping statements.

   c) Write a program to use swapping operations.

3. a) Write a C program for print pyramids and patterns.

   b) Write a C program to generate Fibonacci series.

4. a) Write a C program to shut down or turn off the computer.

   b) Write a C program to perform sorting operations.

5. Write a program using one dimensional and two-dimensional arrays.

6. From a given paragraph perform the following using built-in functions:
   a) Count total number of vowels and consonants.
   b) Capitalize the first word of each sentence.
   c) Replace a given word with another word.

7. Write a program using user defined functions and recursive functions.

8. Write a C program using pointers functions.

9. Write a program using structures and unions.

10. Write a program using text files and binary files.

11. Write a program using string functions.

12. Write a program using dynamic memory allocation.

Total: 60 Periods

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LEARNING RESOURCES:

TEXT BOOKS:

1. Sumitabha Das, “Computer Fundamentals & C Programming”, McGraw Hill, 2018.
2. ReemaThareja, “Programming in c”, Oxford University Press, Second Edition, 2016
3. Yashavant P. Kanetkar, “Let Us C”, Sixteenth Edition, BPB Publications, 2018.

REFERENCES:

1. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. Byron S Gottfried and Jitendar Kumar Chhabra, “Programming with C”, Tata McGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
3. Kernighan,B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2006
4. Ashok N. Kamthane, “Computer programming”, Pearson Education, 2007.

III SEMESTER

SEMESTER III										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21BT31T	Applied Microbiology	PCC	40	60	100	3	0	0	3
2	21BT32T	Process Calculations for Biotechnologist	PCC	40	60	100	3	0	0	3
3	21BT33T	Bioorganic chemistry	PCC	40	60	100	3	0	0	3
4	21MA34T	Series, Transforms and Partial Differential Equations	BSC	40	60	100	3	1	0	4
5	21BT35T	Cell Biology	PCC	40	60	100	3	0	0	3
6	21MC01T	Constitution of India	MC	40	60	100	2	0	0	0
PRACTICAL										
7	21BT37P	Applied Microbiology Laboratory	PCC	60	40	100	0	0	4	2
8	21BT38P	Cell Biology Laboratory	PCC	60	40	100	0	0	4	2
TOTAL										**20**

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Course code	21BT31T	Semester	III			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	APPLIED MICROBIOLOGY		3	0	0	3

COURSE OBJECTIVES:

- To Build knowledge in isolation, identification, cultivation, multiplication and preservation of microorganisms
- To demonstrate the expertise in handling and controlling of microorganisms in labs as well as in various industries
- To illustrate the microbial knowledge in day to day life

PREREQUISITE:

- Fundamentals of Biology and Biochemistry

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C301.1	***Understand*** the chronology and types of microorganisms	K2
C301.2	***Outline*** the basics of culturing and isolation techniques	K2
C301.3	***Summarize*** the various types of microorganisms and its controls	K2
C301.4	***Relate*** between microorganisms and humans, their basic applications	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C301.1	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
C301.2	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
C301.3	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
C301.4	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS	No. of Credits: 3

UNIT I MICROBIAL EVOLUTION AND IDENTIFICATIONS 9

History and evolution of microbiology (classification and nomenclature of Microorganisms), Structural organization and multiplication – Eukaryotes and Prokaryotes, Microscopic Techniques-light and electron microscopy; Microbial staining techniques gram staining, acid fast, capsular staining, flagellar staining.

UNIT II GROWTH AND METABOLISM 12

Microbes growth Environment; Basic requirements for growth- Natural- In laboratory; Methods to cultivate and isolate microorganism; growth phases and growth curves - Chemostat, Turbidostat; Techniques for measurements of growth and enumeration, Batch culture, continuous culture and synchronous growth; factors affecting growth, Filamentous growth and measurement., Mathematics of growth-generation time; Respiratory metabolisms of microorganism – aerobic and anaerobic paths of energy production, specific growth rate Microbial metabolism: Entner–Doudoroff pathway. Fermentative pathways – organisms, substrates, intermediates and end products.

UNIT III CONFORMATION AND INHABITATION OF MICROBES 9

Biochemical test for identification (citrate utilization, catalase, coagulase, IMViC), Physical and chemical control of microorganisms; Disinfection, antiseptics and fumigation; Determination of phenol coefficient of disinfectant. Sources of microorganisms - Microbial Type Collection Centres in India and abroad, clinically important microorganisms.

UNIT IV MICROORGANISMS IN HEALTH AND DISEASE 6

Beneficiary Microorganisms- Probiotics and Prebiotics, Gut microorganism, Disease causing Microorganisms- Bacteria, Virus, Fungi, Protozoa. Therapeutic microorganisms.

UNIT V MICROORGANISM AND THE WORLD 9

Metabolites Types; **Food Microbiology**- Beneficiary- Preservatives; **Agriculture Microbiology**- beneficiary microbes, biogas; **Industry related**- Antibiotics and Commercial products; Aquatic microorganisms, bioremediation, **Energy Microbiology** - MFC, Biosensors.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition 1993, Fifth Edition New Delhi, India.

2. Talaron K, Talaron A, Casita, PelczarAnd Reid. Foundations In Microbiology, W.C.Brown Publishers, 1993.

3. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

REFERENCES:

1. Dr.R.C.Dubey and Dr.D.K.Maheshwari A Textbook of Microbiology,S. Chand. S.Chand and company 2010.

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Course code	**21BT32T**	**Semester**	**III**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PROCESS CALCULATIONS FOR BIOTECHNOLOGIST**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To imbibe the knowledge to the students in the area of Bio-Chemical Engineering with emphasis in process calculations
- To deal with laws of conservation of mass and energy
- To perform calculations pertaining to processes and operations associated with Biotechnology

PREREQUISITE:

- Fundamentals of Physics, Chemistry and Mathematics

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C302. 1	***Solve*** the basic chemical and biochemical engineering problems	K3
C302. 2	***Analyze*** the importance of ideal and actual gas equations in various industrial processes	K4
C302. 3	***Apply*** the material balance concepts in various industrial processes	K3
C302. 4	***Make use of*** the energy balance concepts in various industrial processes	K3
C302. 5	***Develop*** different combustion equation and solve using basic principles of thermochemistry	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C302. 1	3	1	-	-	-	-	-	-	-	-	-	-	1	2	-	-
C302. 2	3	3	2	-	-	-	-	-	-	-	-	-	1	2	-	-
C302. 3	3	1	-	-	-	-	-	-	-	-	-	-	1	2	-	-
C302. 4	3	1	-	-	-	-	-	-	-	-	-	-	1	2	-	-
C302. 5	3	1	-	-	-	-	-	-	-	-	-	-	1	2	-	1

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 3**

UNIT I BASIC CHEMICAL CALCULATIONS 9

Systems of units – fundamental and derived quantities, Dimension, Dimensional Homogeneity and Dimensional Analysis, limitations and significance, unit conversion from one system to the other – composition of mixtures and solutions –Basic Calculations: mass fraction, mass %, mole fraction, mole %, mass ratios, molarity, molality, normality, ppm, composition by density.

UNIT II IDEAL AND ACTUAL GAS EQUATIONS 9

Ideal and actual gas equations, Vander Waals, compressibility factor equations, gas mixtures – vapour pressure, partial pressures, partial volumes – Air-water vapour systems, Humidification and dehumidification, Humidity chart, pH of solutions, Vapour pressure and applications of psychrometric chart.

UNIT III MATERIAL BALANCE 9

Basics of unit operations and unit processes involved in biotechnology industries and its applications. Material balance concept – overall & component – material balance equation for Evaporation, Absorber without reaction, Distillation (Binary system), Extraction, Drying, Crystallization, Mixing and Fermentation, Recycle, Purge and Bypass illustration.

UNIT IV ENERGY BALANCE 9

Fundamentals of energy balance calculations–Concepts of heat capacity, latent heat, sensible heat, vapour pressure and internal energy – energy balance with and without phase change in heat exchanger, Application of energy balance in Bioprocesses.

UNIT V FUELS AND COMBUSTION 9

Types of biofuels – solid, liquid & gaseous fuels – Ultimate and proximate analysis, Calculation of calorific value of fuels, Determination of composition by or sat analysis of products of combustion of solid, liquid and gas fuels – calculations of excess air from or sat techniques – problems on combustion process.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Bhatt B.I & SB Thakore, Stoichiometry - Fifth edition Tata McGraw Hill 2012.
2. K V Narayanan and B Lakshmi kutty, Stoichiometry and Process calculations –PHI 2015.
3. Geankoplis C.J. “Transport process & Separation process Principles 4th edition-PHI 2006.

REFERENCES:

1. McCabe W.L & J.C.Sonith & P.Harriot “Unit operations of chemical Engineering” 6thEdn McGraw Hill2001

2. Robert W.Fox, Alan T.McDonald & Philip J.Pritchard “Introduction to Fluid Mechanics” 6thedn John Wiley & Sons2003.

3. Himmelblau D.M “Basic principles & Calculations in Chemical Engineering” 6thedn PHI 2006.

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Course code	**21BT33T**	**Semester**	**III**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**BIOORGANIC CHEMISTRY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To describe in detail about the elements of atom, charges and their bonding rule.
- To know the various kinetic properties and types of reaction mechanisms.
- To understand the possible bio-organic reactions involved in biosynthesis.

PREREQUISITE:

- Fundamentals of Physics, Chemistry and Biochemistry

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C303. 1	***Understand*** the elements of atom, charges and their bonding rule in detail.	K2
C303. 2	***Summarize*** the possible bio-organic reactions involved in biosynthesis.	K2
C303. 3	***Relate*** the various kinetic properties, types of reaction mechanisms and role of catalyst.	K2
C303. 4	***Apply*** the bioorganic reactions for profiling DNA and Protein.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
C303. 1	2	-	-	-	-	-	1	-	-	-	-	2	2	2	-	-
C303. 2	2	1	-	-	-	-	1	-	-	-	-	2	2	2	-	-
C303. 3	2	1	-	-	-	-	-	-	-	-	-	2	2	-	-	-
C303. 4	3	2	1	-	-	-	-	-	-	-	-	2	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION TO BONDING, ISOMERISIM AND STEREOCHEMISTRY 12

Atoms, Electrons and orbitals, Covalent Bonds, Octet rule, Polar covalant Bonds, Electronegativity, Isomerism –Types, Fischer, Sawhorse and Newmann projection, E and Z nomenclature.cis and trans isomerism, IUPAC nomenclature, sp^3 hybridization, optical activity, D-L and R-S notations, conformational analysis of ethane, butane, cyclohexane and peptide bond, Resonance effects, S_N1 and S_N2 reactions, E1 and E2 reaction.

UNIT II ENZYMES: STRUCTURE, STEREOCHEMISTRY AND MECHANISM 6

Enzymes and its classification, Stereospecific enzymatic reactions - fumarase catalysed reactions - NAD dependent oxidation and reduction reactions - chiral methyl group. The dehydrogenases - the proteases - lysozyme-ribonucleases.

UNIT III CATALYSIS 9

Reactivity – Coenzymes – Proton transfer – metal ions – Intra molecular reactions – Covalent catalysis– Catalysis by organized aggregates and phases. Inclusion complexation.

UNIT IV KINETICS AND MECHANISM 9

Kinetic method – Rate law and mechanism – Transition states- Intermediates – Trapping of intermediates – Microscopic reversibility – Kinetic and thermodynamic reversibility – Isotopes for detecting intermediates. Primary and secondary isotopes – the Arrhenius equation Eyring equation - ΔG, ΔS, ΔH, Thermodynamics of coupled reactions.

UNIT V BIOORGANIC REACTIONS 9

Timing of Bond formation and fission – Acyl group transfer – C-C bond formation and fission – Catalysis of proton transfer reactions – Transfer of hydride ion – Alkyl group. Transfer – Terpenebiosynthesis– Merrifield state peptide synthesis – Sanger method for peptide and DNA sequencing.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Carey, Francis A.” Organic Chemistry”. VIIth Edition, Tata MCGraw Hill, 2009.
2. Page, M.I. and Andrew Williams “Organic and Bio-organic Mechanisms”. Pearson, 2010.

REFERENCES:

1. Morrison R. T., and Boyd R. N., “Organic Chemistry”, Pearson Education (Singapore) Pvt Ltd., New Delhi, 2002.
2. Michael B. Smith, “March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure”, Wiley, 8th Edition, 2020.

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Course code	21MA34T	Semester	III			
Category	BASIC SCIENCE COURSE(BSC)		L	T	P	C
CourseTitle	SERIES,TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS (COMMON TO MECH, CIVIL, CHEM & BIOTECH)		3	1	0	4

COURSE OBJECTIVES:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To develop Z transform techniques for discrete time systems.

PREREQUISITE:

- Mathematics skills at Sem-II level

COURSE OUTCOMES:

CO. No	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C304.1	***Understand*** how to solve the given standard partial differential equations.	K2
C304.2	***Solve*** differential equations using Fourier series analysis which plays a vital role in engineering applications.	K3
C304.3	***Appreciate*** the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.	K2
C304.4	***Understand*** the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.	K2
C304.5	***Use*** the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C304.1	3	3	-	-	-	-	-	-	-	-	-	-
C304.2	3	2	-	-	-	-	-	-	-	-	-	-
C304.3	3	2	-	-	-	-	-	-	-	-	-	-
C304.4	3	2	-	-	-	-	-	-	-	-	-	-
C304.5	3	3	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS	No. of Credits: 4

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Introduction-Formation of partial differential equations Solutions of a partial differential equation-Linear Equations of the first order– Nonlinear equations of the first order Charpit's method Linear partial Differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES 12

Introduction - Euler's Formulae - Conditions for a Fourier Expansion-Functions having points of discontinuity-Change of interval – Odd and even functions–Half range sine series–Half range cosine series–Parseval's Formula-Complex form of Fourier series–Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Introduction - Method of separation of variables–Vibrations of a stretched string-Wave equation [Fourier Series Method Only]– One dimensional equation of heat conduction–Steady state solution of two-dimensional equation of heat conduction - Laplace's equation in polar coordinates.

UNIT IV FOURIER TRANSFORMS 12

Introduction-Statement of Fourier integral theorem–Fourier transforms – Properties of Fourier transforms–Convolution theorem–Parseval's identity for Fourier transform-Relation between Fourier and Laplace transforms.

UNIT V TRANSFORMS AND DIFFERENCE EQUATIONS 12

Introduction – Definition of Z-transforms – Some standard Z-transforms–Damping rule-Some standard results-Shifting to the right and left – Multiplication by n-Initial and Final value theorem –Inverse Z-transform (using partial fraction and residues) – Convolution theorem–Convergence of Z-transforms-Evaluation of inverse Z-transforms [using partial and residue method only]-Application of difference equations.

Total:60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. B. S. Grewal, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, New Delhi, 2014.

2. Narayanan S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCES:

1. Erwin Kreyszig,"Advanced Engineering Mathematics ",10th Edition, John Wiley, India, 2016.

2. B.V.Ramana, "Higher Engineering Mathematics", McGrawHill Education Pvt. Ltd, New Delhi, 2016.

3. Wylie, R.C.and Barrett,L.C.,"Advanced Engineering Mathematics",Tata McGraw Hill

   Education Pvt. Ltd, 6th Edition, NewDelhi, 2012.

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Course code	**21BT35T**	**Semester**	**III**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**CELL BIOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To acquire fundamental knowledge and perform translational research in cell biology
- To understand the cellular communication and signaling mechanisms
- To learn the cellular transport mechanisms and analytical techniques

PREREQUISITE:

- Biochemistry

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C305. 1	***Understand*** the structural and functional units of a cell	K2
C305. 2	***Describe*** the various transport phenomena in cells	K2
C305. 3	***Explain*** the molecular interactions between the cells.	K2
C305. 4	***Relate*** the receptor and ligand interaction to aid cellular transduction	K2
C305. 5	***Analyze*** the cellular mechanisms using various techniques involved in Cell Biology	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C305. 1	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C305. 2	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C305. 3	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C305. 4	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C305. 5	3	2	1	-	-	-	-	-	-	-	-	-	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS	No. of Credits: 3

UNIT I CELL MEMBRANE, ORGANELLES AND MEMBRANE PROTEIN 10

Prokaryotic and Eukaryotic cells - Overview. Lipid bilayer: Composition, structure and properties of membrane lipids. Significance of membrane fluidity and asymmetry. Lipid rafts and its significance. Structure and functions of cell organelles, Cytoskeleton. Membrane proteins: Peripheral and Transmembrane proteins. Membrane dynamics: flip-flop, rotational and lateral diffusion. Techniques to assess membrane dynamics: Hybrid cells, FRAP and FLIP techniques. Cell-Cell junctions.

UNIT II CELL CYCLE AND REGULATION 7

Cell cycle, Cell Division - Mitosis, Meiosis, Molecules controlling cell cycle, Role of Ras and Raf in oncogenesis and apoptosis.

UNIT III MEMBRANE TRANSPORT 10

Basics of membrane transport: Size, solubility and electrochemical gradient of solutes across membrane. Kinetics of passive vs. facilitated diffusion. Transport proteins: Uniporters, Symporters, Antiporters, Aquaporins, ATP driven pumps and its types, Ion-channels – voltage and ligand gated. Role of ion-channels and ATP pumps in nerve conduction. Principles of Patch-Clamp experiment to study ion-channels activity.

UNIT IV CELL SIGNALLING 8

Extracellular Cell Signalling, Cell Signalling Types - Autocrine, paracrine and endocrine, Receptor Mediated Cell Signalling – Types and Classes, Secondary Messengers - cAMP, cGMP, IP_3, DAG and Ca^{2+}

UNIT V TECHNIQUES IN CELL BIOLOGY 10

Cell fractionation: Extraction, Homogenization and Centrifugation techniques. Microscopy and cell architecture: Fixation, sectioning and staining techniques for microscopic studies – Light microsope, fluorescent/confocal microscope, Electron microscopes – SEM, TEM and cryo EM. Cell isolation: Fluorescence Activated Cell Sorter (FACS) and Magnetic separation/MACS. Cell viability studies: Using tetrazolium salts, LDH release, Tryphan blue exclusion.

otal: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Lodish H, BerkA,MatsudairaP,Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J., Molecular Cell Biology, 8th Edition, 2016.

2. Arnold Berk , Chris A. Kaiser , Harvey Lodish , Angelika Amon, HiddePloegh, Anthony Bretscher, Monty Krieger, Kelsey C. Martin. 2016. Molecular Cell Biology, 8th edition, W.H. Freeman. USA.

3. Rastogi, S.C. “Cell Biology” IIndEdition, New Age International, 2002.

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REFERENCES:

1. Anthony J.F. Griffiths, Susan R. Wessler, Sean B. Carroll and John Doebley. 2010.Introduction to Genetic Analysis. 10th edition. W.H. Freeman. USAVoet and Voet, Biochemistry, 2nd Edition, John Wiley & Sons Inc., 1995.

2. Campbell, N.A., J.B. Recee and E.J. Simon "Essential Biology", VIIrd Edition, Pearson International, 2007.

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Course code	**21MC01T**	**Semester**	**III**			
Category	**MANDATORY COURSE (MC)**		**L**	**T**	**P**	**C**
Course Title	**CONSTITUTION OF INDIA**		**2**	**0**	**0**	**0**

COURSE OBJECTIVES:

- To understand the importance of constitution.
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court, controller and auditor general of India and election commission of India.

PREREQUISITE:

- Civic Knowledge.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C306.1	***Understand*** historical background of the constitutional making and its importance for building a democratic India, the structure of Indian government, the structure of state government, the local Administration	K2
C306.2	***Understand*** the directive principle of state policy, and strengthening of the constitutional institutions.	K2
C306.3	***Analyze*** the role of Governor and Chief Minister, role of state election commission, the decentralization of powers.	K2
C306.4	***Understand*** the Public Election Process.	K2
C306.5	***Know*** the Special Provisions for Various category of People.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C306.1	-	-	-	-	-	3	-	2	-	-	-	1	-	-	-
C306.2	-	-	-	-	-	2	-	2	-	-	-	1	-	-	-
C306.3	-	-	-	-	-	2	-	2	-	-	-	1	-	-	-
C306.4	-	-	-	-	-	1	-	2	-	-	-	1	-	-	-
C306.5	-	-	-	-	-	1	-	2	-	-	-	1	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 0**

UNIT I INTRODUCTION TO INDIAN CONSTITUTION 6

The Necessity of the Constitution, The Societies before and after the Constitution adoption. **Introduction to the Indian constitution,** The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India.

UNIT II FUNDAMENTAL RIGHTS AND DIRECTIVE PRINCIPLES 6

Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building. Directive Principles of State Policy (Art. 36-51).

UNIT III UNION EXECUTIVE AND STATE EXECUTIVE 6

Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Parliamentary Terminologies**.** Supreme Court of India, State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts.

UNIT IV ELECTIONS, AMENDMENTS AND EMERGENCY PROVISIONS 6

Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments Important Constitutional Amendments. Emergency Provisions, types of Emergencies and its consequences.

UNIT V DIRECTIVE PRINCIPLES & FUNDAMENTAL DUTIES 6

Fundamental Duties (Art. 51A), Basic Features of Constitution & Constitutional **special provisions:** Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

Total: 30 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. N. Shukla, Constitution of India, Eastern Book Agency, 2014.
2. P. Jain, Indian Constitutional Law, Lexis Nexis, 2013.
3. M. Seervai, Constitutional Law of India, Universal Law Publishing Co., Reprint 2013.

REFERENCES:

1. Glanville Austin, Indian Constitution – cornerstone of the Nations, Oxford University Press, 1999.
2. M. Bakshi, The Constitution of India, Universal Law Publishing Co., 2014.
3. D. Basu, Shorter Constitution of India (14^{th} Ed. 2008, reprint 2010).

Course code	21BT37P	Semester	III			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	APPLIED MICROBIOLOGY LABORATORY		0	0	4	2

COURSE OBJECTIVES:

- To learn and experiment various culturing techniques and microbial growth estimation

PREREQUISITE:

- Fundamentals of Biology and chemistry

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C307.1	***Understand*** about basic lab techniques and culture medium	K2
C307.2	***Experiment with*** Culturing of microorganisms and ***Build*** Medium Preparation.	K3
C307.3	***Examine*** the microorganisms by ***v***arious Staining Procedure and ***Classify*** them through biochemical test.	K4
C307.4	***Inference*** the growth of microorganisms in various conditions	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C307.1	2	1	-	-	-	-	-	-	1	-	-	-	1	-	-	-
C307.2	3	2	1	-	-	-	-	-	1	-	-	-	1	-	-	-
C307.3	3	3	1	-	-	-	-	-	1	-	-	-	1	-	-	-
C307.4	3	3	-	-	-	-	-	-	1	-	-	-	1	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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List of Experiment **No. of Credits: 2**

1. Sterilization Techniques
2. Preparation of Broth and agar
3. Microbial Culture Techniques
4. Preservation techniques
5. Microscopy and Staining
6. Microorganism Growth Curve
7. Enumeration of microorganisms
8. Effect of different environmental condition on microorganisms
9. Antibiotic Sensitive Assay
10. Effect of disinfectants on microorganisms
11. Biochemical methods to identify Microorganism
12. Isolation of microorganisms from waste water

LEARNING RESOURCES:

TEXT BOOKS:

1. Cappuccino, J.G. and N. Sherman "Microbiology: A Laboratory Manual, 4th Edition, Addison-Wesley, 1999.
2. Collee, J.G. etal., "Mackie & McCartney Practical Medical Microbiology 4thEdition, Churchill Livingstone, 1996.

REFERENCES:

1. R.C. Dubey and D. K. Maheshwari, "Practical Microbiology", SChand (India), 2002.

Course code	**21BT38P**	**Semester**	**III**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**CELL BIOLOGY LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To learn the various techniques for morphology, identification and propagation of cells

PREREQUISITE:

- Biochemistry Laboratory

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C308.1	***Outline the*** awareness on the sterilization techniques and microscopy handling	K2
C308.2	***Experiment with*** differential staining in order to understand the internal components of a cell	K3
C308.3	***Demonstrate*** the ability to propagate cells and perform cell division	K2
C308.4	***Distinguish*** the viable cells from dead cells using cell viability assays.	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C308.1	2	1	-	-	-	-	-	-	1	-	-	-	2	-	-	-
C308.2	3	2	1	-	-	-	-	-	1	-	-	-	2	-	-	-
C308.3	2	1	-	-	-	-	-	-	1	-	-	-	2	-	-	-
C308.4	3	3	1	-	-	-	-	-	1	-	-	-	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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LIST OF EXPERIMENT **NO OF CREDITS: 2**

1. Principles of sterilization and handling of microscopes.
2. Studying the diversity of cells using permanent slides.
3. Differentiate plant cells from animal cells using a staining procedure.
4. Stain and differentiate gram positive and gram negative bacteria.
5. Stain and differentiate nucleated and non-nucleated blood cells.
6. Staining method to identify blood parasites.
7. Cell lysis through Osmosis and Tonicity.
8. Peripheral Blood Mononuclear Cell Separation from Blood.
9. Growing root tips of *Allium cepa* and study different stages of Mitosis.
10. Study of Meiotic Cell Division using permanent slides.
11. Thin Layer Chromatography.
12. Cell Viability: Tryphan Blue Assay.

LEARNING RESOURCES:

TEXT BOOKS:

1. Rickwood, D. and J.R. Harris "Cell Biology: Essential Techniques", Johnwiley,1996.
2. Davis, J.M. "Basic Cell Culture: A Practical Approach", IRL,1994.

REFERENCES:

1. Roitt, I., Brostoff, J. and Male, D. "Immunology", 6th Edition, Mosby, 2001.

IV SEMESTER

SEMESTER IV											
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21BT41T	Research Methodology and Biostatistics	BSC	40	60	100	3	1	0	4
2	21BT42T	Fluid Mechanics and Heat Transfer Operations for Biotechnologist	PCC	40	60	100	3	0	0	3
3	21BT43T	Applied Thermodynamics for Biotechnologists	PCC	40	60	100	3	0	0	3
4	21BT44T	Principles and Techniques of Molecular Biology	PCC	40	60	100	3	0	0	3
5	21BT45T	Basics of Industrial Biotechnology	PCC	40	60	100	3	0	0	3
6	21MC02T	Environmental Sciences	MC	40	60	100	2	0	0	0
PRACTICAL										
7	21BT47P	Chemical Engineering Laboratory for Biotechnologists	PCC	40	60	100	0	0	4	2
8	21BT48P	Molecular Biology Laboratory	PCC	40	60	100	0	0	4	2
9	21EE01P	Mini Project – I	EEC	40	60	100	0	0	2	1
TOTAL										**21**

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Course code	21BT41T	Semester	IV			
Category	BASIC SCIENCE COURSE (BSC)		L	T	P	C
Course Title	RESEARCH METHODOLOGY AND BIOSTATISTICS		3	1	0	4

COURSE OBJECTIVES:

- To create an awareness on research methods and data collection techniques.
- To prepare the students to present their research in journals and periodicals.
- To understand the basic concepts of biostatistics and its role in research.
- To implement the statistical tools in research.

PREREQUISITE:

- Mathematics

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C401.1	***Document*** and present research findings in various scientific forums	K3
C401.2	***Analyze*** and present the research data.	K3
C401.3	***Interpret*** research findings using various statistical tools and techniques	K3
C401.4	***Define*** and apply a research problem statement	K3
C401.5	***Identify*** research gaps through literature survey	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C401.1	3	2	1	-	-	-	-	-	-	-	-	-	1	1	1	1
C401.2	3	2	1	-	-	-	-	-	-	-	-	-	1	1	1	1
C401.3	3	2	1	-	-	-	-	-	-	-	-	-	1	1	1	1
C401.4	3	2	1	-	-	-	-	-	-	-	-	-	1	1	1	1
C401.5	3	2	1	-	-	-	-	-	-	-	-	-	1	1	1	1

Note: - 1: Slight; 2: Moderate; 3: Substantial

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SYLLABUS	No. of Credits: 4

UNIT I CLASSIFICATION AND PRESENTATION OF DATA 9+3

Biostatistics – Definition and Scope – Collection of Data (Primary and Secondary). Variable – Discrete and Continuous. Presentation of Data – Classification and Types of Classification, Tabulation - Types of Tables. Diagrams and Graphs – Bar Diagram (Simple and Multiple), Pie Diagram , Frequency Diagram : Histograms , Frequency Polygon, Frequency Curve , Ogives, Line Graphs, Characteristics of Frequency Distribution.

UNIT II STATISTICAL RESEARCH TOOLS AND TECHNIQUES 9+3

Measures of Central Tendency – Mean, Median, Mode – Weighted Arithmetic Mean (Individual, Discrete, and Continuous) - Measures of Dispersion – Range , Mean Deviation, Standard Deviation and Standard Error-Correlation and Its Types, Regression and Regression Equations and Regression Lines. Samples – Principle and Sampling Methods. Test of Significance – Large and Small Sample Test – Test for Proportions – ANOVA, Student's T Test, F Test and Chi Square Test.

UNIT III RESEARCH PROBLEM AND EXPERIMENTATION 9+3

Types of Research (Descriptive/Analytical, Applied /Fundamental, Qualitative/Quantitative, Conceptual / Empirical)-Defining a Research Problem statement– Development of Research Plan -Basic Principles – Informal and Formal Experimental Design -Data Collection Techniques - Hypothesis – Null and Alternate Hypothesis, Testing the Hypothesis

UNIT IV LITERATURE REVIEW AND INFORMATION RESOURCES 9+3

Literature Review- Importance in Defining a Problem, Identifying gap- Sources of Information – Primary and Secondary Sources. Library Books, Journals, Periodicals, Reference Sources, Abstracting and Indexing Sources, Reviews, Monographs- Internet – Search Engines, Online Libraries (Scopus, Medline, PubMed, Science Directs), E-Books, E-Encyclopedia, Institutional Websites.

UNIT V SCIENTIFIC DOCUMENTATION AND PRESENTATION 9+3

Scientific Writing – Characteristics. Logical Format for Writing Thesis and Papers. Essential Features of Abstract, Introduction, Review of Literature, Materials, Methods and Discussion. Effective Illustration – Table and Figures. Reference Styles – Project Proposal Writing, ResearchReport Writing (Research Articles, Oral Communications)- Presentation Techniques – Assignment, Seminar, Debate, Workshop, Colloquium, Conference-Computer Aided Techniquesfor Data Presentation, Data Analysis, And Statistical Techniques

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Biostatistical Analysis 5th Edition (2008), J.H. Zar. Publisher – Pearson Education Inc. and Dorling Kindersley Publishing Inc.
2. Research Methodology Methods and Statistical Techniques (2018), Santhosh Gupta. PublisherDD.

REFERENCES:

1. Research Methodology for Biological Sciences (2006), N. Gurumani. MJP Publishers-TamilNadu Book House.
2. Introduction to Biostatistics (2004), N. Gurumani. MJP Publishers Research
3. Methodology: Methods and Techniques (2004), C.R. Kothari. Publisher – New Age International

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Course code	21BT42T	Semester	IV			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	FLUID MECHANICS AND HEAT TRANSFER OPERATIONS FOR BIOTECHNOLOGIST		3	0	0	3

COURSE OBJECTIVES:

- To enable the students to understand the fundamental principles and concepts of fluidmechanics in fluid flow and fluid flowing over immersed solids
- Learn the concepts involved in heat transfer by conduction, convection and radiation heattransfer.

PREREQUISITE:

- Basics of Stoichiometry.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C402.1	***Explain*** the theoretical concepts of Fluid Properties & Fluid Mechanics	K3
C402.2	***Demonstrate*** the capability to analyse the Flow of Fluid through Packing and its industrial applications.	K4
C402.3	***Understand*** the concept of Conduction Heat Transfer in various heat exchange process in the industry.	K3
C402.4	***Learn*** basic Convection Heat Transfer and condensation process	K3
C402.5	***Correlate*** Radiation Heat Transfer & Heat Transfer Equipment in biotechnology	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C402.1	3	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
C402.2	3	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
C402.3	3	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
C402.4	3	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
C402.5	3	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-

Note: - 1: Slight; 2: Moderate; 3: Substantial

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SYLLABUS	No. of Credits: 3

UNIT I FLUID PROPERTIES AND FLUID MECHANICS **9**

Fluid definition- compressible, in compressible fluids – coefficient of isothermal compressibility, Density, specific gravity, specific weight, surface tension, vapour pressure, viscosity. Rheology of fluids. Newtonian and Non-newtonian fluids. Fluid statics – Barometric equation – application for incompressible and compressible fluids. Types of Pressure measurement devices, Fluid Dynamics – equation of continuity – Bernoulli's equation – Flow Measurement Device Types.

UNIT II FLOW OF FLUID THROUGH PACKINGS **9**

Fluidization, Fluid transport Industrial application of fluid flow through packing-characterise of packed bed-Bed surface area-void fraction-Laminar flow through packed bed and turbulent flow pressure drop experienced by the fluid-equations and application problems. Heat Transfer from wall surfaces, Fluidization Phenomena-Industrial application - minimum fluidization velocities. Industrial pipes and fittings- Fluid moving machinery-pumps centrifugal, Reciprocating-gear, Peristaltic pumps, Introduction togas moving machinery-Fans, blowers, compressors. Dimensional analysis for flow parameters by Rayleigh's method, Buckingham Pi theorem.

UNIT III CONDUCTION HEAT TRANSFER **9**

Heat transfer phenomena-thermodynamics & heat transfer. Heat conduction – Fourier's Law – steady state conduction in plexor and radial systems – Resistance concept – series and resistance in conduction –and parallel resistance in conduction – unsteady state conduction – lumped capacity model – extended surfaces (Fins) –combined conduction & convection – 2-dimensional conduction.

UNIT IV CONVECTION HEAT TRANSFER **8**

Forced and natural convection – Dimensional analysis, Dimensional numbers, Convection heat transfer coefficient, LMTD for parallel and counter flow exchanger. Correlations for flow over plate, through tubes, over spheres and cylinders. Agitated systems, Packed columns, condensation phenomena, Film and drop wise condensation over tubes. Boiling phenomena, and overall heat transfer coefficients and solving related problems.

UNIT V RADIATION HEAT TRANSFER AND EQUIPMENTS **10**

Electromagnetic waves, energy of radiation, Planck's Equation-Blackbody, Radiation exchange. Kirchhoff's law, Stefen-Boltemann equation of radiant energy – Wien's law, Radiation exchange between surfaces – black, gray bodies, view factors-sample problems. Concept of overall heat transfer coefficient by radiation. Types of Heat Exchangers, LMTD Concepts and Design of heat exchangers. Types of Evaporators, Design of Evaporators, Application of Heat exchangers and Evaporators in Biotechnology Industries.

Total: 45 Periods

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LEARNING RESOURCES:

TEXT BOOKS:

1. Bansal RK. A Textbook of Fluid Mechanics and Hydraulic Machines (in SI Units). Laxmi Publications, Ltd.; 2005.
2. Geankoplis. C.J ”Transport Process & separation Process Principles” IV edition PrenticeHall of India 2015.
3. P. K. Nag “Heat & Mass Transfer”, Tata McGraw Hill III Edition 2011.

REFERENCES:

1. Frank Kreith, Raj M. Manglik and Mark S. Bohn “Principles of Heat Transfer” VIIedition Cenage Learning Inc 2018.
2. Mc Cabe, W.L., Smith, J.C. and Harriot, P., ‘Unit Operations in Chemical Engineering’,VII edition., McGraw-Hill, 2017.

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Course code	**21BT43T**	**Semester**	**IV**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**APPLIED THERMODYNAMICS FOR BIOTECHNOLOGISTS**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To enable the students to learn about basic concepts of classical and statistical thermodynamics

PREREQUISITE:

- Fundamentals of Physics, Chemistry and Mathematics

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C403.1	***Explain*** the theoretical concepts of thermodynamics and how it applies to energy conversion in technological applications and biological systems.	K3
C403.2	***Demonstrate*** the capability to analyse the energy conversion performance in a variety of modern applications in biological systems.	K4
C403.3	***Design*** and carry out bioprocess engineering experiments, and analyseand interpret fundamental data to do the design and operation of bioprocesses.	K3
C403.4	***Describe*** the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations microbial growth and product formation.	K3
C403.5	***Apply*** their knowledge in the field of biochemical engineering from the principles of thermodynamics.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C403.1	3	2	2	1	-	-	-	-	-	-	-	-	1	1	-	-
C403.2	3	2	2	1	-	-	-	-	-	-	-	-	1	-	-	-
C403.3	3	2	2	1	-	-	-	-	-	-	-	-	1	2	-	-
C403.4	3	2	2	1	-	-	-		-	-	-	-	1	2	-	-
C403.5	3	2	2	1	1	-	-		-	-	-	-	-	1	2	-

Note: - 1: Slight; 2: Moderate; 3: Substantial

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SYLLABUS **No. of Credits: 3**

UNIT I THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS 9

First Law of thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non ideal behavior; residual properties;estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications. Application of thermodynamics concepts – Calorimeter, refrigerator, compressor and nozzles.

UNIT II SOLUTION THERMODYNAMICS 9

Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation.

UNIT III PHASE EQUILIBRIA 9

Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria. Phase diagrams for binary solutions.

UNIT IV CHEMICAL REACTION EQUILIBRIA 9

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversionand yields for single.

UNIT V BIOCHEMICAL THERMODYNAMICS 9

Thermodynamics of open system – biological system. Concept of pH and ionization. Ligand binding. Membrane transport (Gibbs Donnan equation). Energy coupling reactions (ATP and NADH). Energetic of metabolic pathways (Glucose metabolism, Photosynthesis). Thermodynamic feasibility analysis of metabolic pathways. Protein stability

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Smith J.M., Van Ness H.C., and Abbot M.M. "Introduction to Chemical Engineering Thermodynamics", VI Edition. Tata McGraw-Hill, 2003.
2. Narayanan K.V. "A Text Book of Chemical Engineering Thermodynamics", PHI, 2003.
3. Christiana D. Smolke, "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.

REFERENCES:

1. Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley, 1989.
2. Donald T Hayne, "Biological Thermodynamics", Cambridge University press, New York, 2001.

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Course code	**21BT44T**	**Semester**	**IV**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PRINCIPLES AND TECHNIQUES OF MOLECULAR BIOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To familiarize with the cell and molecular biology of both Prokaryotes and Eukaryotes.
- To Acquire basic fundamental knowledge and explore skills in molecular biology
- To emphasize the molecular mechanism of DNA replication, repair, transcription,protein synthesis and gene regulation in various organisms.

PREREQUISITE:

- Fundamentals of Biochemistry and Cell Biology

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C404.1	***Describe*** the basic structure and biochemistry of nucleic acids and protein	K2
C404.2	***State*** the principle of central dogma and DNA replication in prokaryotes and eukaryotes	K2
C404.3	***Infer*** the various types of RNA and explain the DNA transcription and the posttranscriptional modification.	K2
C404.4	***Outline*** the genetic code and prokaryotic and eukaryotic protein synthesis	K2
C404.5	***Understand*** about the gene organization in prokaryotes and eukaryotes and related mechanisms	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C404.1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-
C404.2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-
C404.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-
C404.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-
C404.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	3	3

Note: - 1: Slight; 2: Moderate; 3: Substantial

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SYLLABUS	No. of Credits: 3

UNIT I GENETIC MATERIAL **9**

Introduction to nucleic acids: Nucleic acids as genetic material, Primary and secondary structure of DNA: Conformational variants of double helical DNA, Tertiary structure of DNA: DNA supercoiling, Hogsteen base pairing, Triple helix, Quadruple helix, X–ray diffraction analysis of DNA, Forces stabilizes DNA structure, Reversible denaturation and hyperchromic effect.

UNIT II DNA REPLICATION AND REPAIR **9**

Overview of Central dogma. Organization of prokaryotic and eukaryotic chromosomes. DNA replication: Meselson& Stahl experiment, bi–directional DNA replication, Geometry of replication, Okazaki fragments, Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication, Telomere replication in eukaryotes. θ replication, D-loop and rolling circle mode of replication. Mutagens, DNA mutations and their mechanism, various types of repair mechanisms.

UNIT III TRANSCRIPTION **9**

Structure and function of mRNA, rRNA and tRNA. Characteristics of promoter and enhancer sequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteins of RNA synthesis, Fidelity of RNA synthesis, Inhibitors of transcription, Differences in prokaryotic and eukaryotic transcription. Basic concepts in RNA world: Ribozymes, RNA processing: 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.

UNIT IV TRANSLATION **9**

Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis. Inhibitors of protein synthesis. Posttranslational modifications and its importance.

UNIT V REGULATION OF GENE EXPRESSION **9**

Organization of genes in prokaryotic and eukaryotic chromosomes, Hierarchical levels of gene regulation, Prokaryotic gene regulation –lac and trp operon, Regulation of gene expression with reference to λ phage life cycle.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Friefelder, David. "Molecular Biology." Narosa Publications, 1999
2. Weaver, Robert F. "Molecular Biology" IInd Edition, Tata McGraw-Hill, 2003.
3. Karp, Gerald "Cell and Molecular Biology: Concepts and Experiments" IVth Edition, JohnWiley, 2005.
4. Friefelder, David and George M. Malacinski "Essentials of Molecular Biology" IInd Edition,Panima Publishing, 1993.

REFERENCES:

1. Tropp, Burton E. "Molecular Biology: Genes to Proteins". IIIrd Edition. Jones and Bartlett, 2008.
2. Glick , B.R. and J.J. Pasternak. "Molecular Biotechnology: Principles and Applications ofRecombinant DNA" 4th Edition. ASM, 2010.

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VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

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Course code	21BT45T	Semester	IV			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	BASICS OF INDUSTRIAL BIOTECHNOLOGY		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on industrial fermentation technology.
- To make the students aware of the overall industrial bioprocess that helps them tomanipulate the process to the requirement of industrial needs.
- To prepare students for the bulk production of commercially important primary, secondary metabolites and biotechnological products.

PREREQUISITE:

- Microbiology and Biochemistry

COURSE OUTCOMES:

CO. No.	Course Outcome	Blooms level
On successful completion of this Course, students will be able to		
C405.1	***Understand*** the fundamentals of fermentation technology	K2
C405.2	***Interpret*** the techniques for the production of primary metabolites	K2
C405.3	***Illustrate*** the techniques for the production of secondary metabolites	K2
C405.4	***Summarize*** the production of enzymes and other bio products	K2
C405.5	***Outline*** the process for the production of modern biotechnological products	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C405.1	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-	1
C405.2	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-	1
C405.3	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-	1
C405.4	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-	1
C405.5	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-	1

Note: - 1: Slight; 2: Moderate; 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION TO INDUSTRIAL BIOPROCESS 9

Fermentation- Fermentation principles & Product recovery for Bacterial, fungal and yeast; Biochemistryof fermentation; Types of media Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting- block diagrams, pictorial representation.

UNIT II PRODUCTION OF PRIMARY METABOLITES 9

Primary Metabolites- Production of commercially important primary metabolites like organic acids- (Citric acid, Lactic acid, Acetic acid, Itaconic acid), amino acids (Glutamic acid, Phenyalanine, Asparticacid) and alcohols; Biosynthetic pathways and Feedback Mechanisms.

UNIT III PRODUCTION OF SECONDARY METABOLITES 9

Fermentation Design, Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics (Penicillin, Cephalosporin, Erythromycin), Vitamins (Vit B12, Riboflavin) ,β- Carotene, Alkaloids and Steroids; Biosynthetic Pathways and Feedback Mechanisms.

UNIT IV PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 9

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Bio preservatives, Biopolymers, Biofuel, Biogas. Cheese, Beer, SCP & Mushroom culture, Bioremediation, Economic Aspects.

UNIT V PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS 9

Production of recombinant proteins : Monoclonal antibodies, Human Growth Factor, Insulin, Tumor Suppressor Proteins - therapeutic and diagnostic applications; vaccines.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Patel, AH- Industrial Microbiology. 2nd edition, Trinity press Lakshmi publication (P) Ltd., 2017.
2. Satyanarayana, U. ―Biotechnology‖ Books & Allied (P) Ltd., 2005.
3. Ratledge, Colin and Bjorn Kristiansen ―Basic Biotechnology‖ IInd Edition Cambridge University Press, 2001
4. Dubey, R.C. ―A Textbook of Biotechnology‖ S.Chand& Co. Ltd., 2006.

REFERENCES:

1. Casida, L.E. ―Industrial Microbiology‖, New Age International (P) Ltd, 1968.
2. Presscott, S.C. and Cecil G. Dunn, ―Industrial Microbiology‖, Agrobios (India), 2005.
3. Cruger,Wulf and Anneliese Crueger, ―Biotechnology: A Textbook of Industrial Microbiology‖, IInd Edition, Panima Publishing, 2000.
4. Moo-Young, Murrey, ―Comprehensive Biotechnology‖, 4 Vols. Pergamon Press, (An Imprint of Elsevier) 2004.
5. Stanbury, P.F., A. Whitaker and S.J. Hall ―Principles of Fermentation Technology‖, IInd Edition, Butterworth –Heinemann (an imprint of Elsevier), 1995.

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Course code	21MC02T	Semester	IV			
Category	MANDATORY COURSE (MC)		L	T	P	C
Course Title	ENVIRONMENTAL SCIENCES (Common for All Branches except Chemical)		2	0	0	0

COURSE OBJECTIVES:

- To study the nature, interrelationship between living organism and environment, biodiversity, natural resources, pollution control and waste management.
- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To appreciate the importance of environment by assessing its impact on the human world.

PREREQUISITE:

- Basic awareness on environment.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C406.1	***Illustrate*** the interrelationship between living organism and environment.	K2
C406.2	***Relate*** Public awareness, environmental pollution and its problem.	K2
C406.3	***Classify*** the dynamic processes and the features of natural resources.	K2
C406.4	***Measure*** the development and improvement in standard of living.	K2
C406.5	***Summarize*** the knowledge about human health and welfare.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C406.1	1	-	-	-	-	-	1	-	-	-	-	-
C406.2	2	-	-	-	-	-	1	-	-	-	-	-
C406.3	1	-	-	-	-	-	1	-	-	-	-	-
C406.4	1	-	-	-	-	-	2	1	-	-	-	1
C406.5	1	-	-	-	-	-	1	1	-	-	-	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 0

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) –Introduction to biodiversity definition: genetic, species and ecosystem diversity –biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity –threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts –endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds, etc., Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II NATURAL RESOURCES 6

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources. Field study of local area to document environmental assets – river / forest / grassland /
hill / mountain.

UNIT III ENVIRONMENTAL POLLUTION AND DISASTER MANAGEMENT 6

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution(c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards, accidents and holocaust – solid waste management: causes, effects and control measures of municipal solid wastes- E waste and Scrap tyres – Recycling of Plastic, Glass and Paper wastes- role of an individual in prevention of pollution – pollution case studies –disaster management: floods, earthquake, cyclone and landslides- case studies. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 6

From unsustainable to sustainable development- Equitable use of resources for sustainable lifestyles – urban problems related to energy –water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of nongovernmental organization- environmental ethics: Issues and possible solutions – principles of green chemistry–climate change, global warming, acid rain, ozone layer depletion, case studies. – wasteland reclamation – consumerism and waste products –environment protection act – Air (Prevention and Control of Pollution) act – Water(Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – environmental impact assessmentenforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – women and child welfare – HIV/AIDS –SARS- Covid-19- role of information technology in environment and human health – Case studies.

Total: 30 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill, New Delhi, 2014.
2. Anubha Kaushik, and Kaushik, C. P., Environmental Science and Engineering, New Age International Publishers, 6thEdition, 2019.

REFERENCES:

1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2nd Edition, University Grants Commission, Universities Press, 2013.
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Pearson Education, 2004.
3. Tyler Miller, G., and Scott E. Spoolman, Environmental Science, Cengage Learning India Pvt, Ltd, Delhi, 2014.

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Course code	21BT47P	Semester	IV			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	CHEMICAL ENGINEERING LABORATORY FOR BIOTECHNOLOGISTS		0	0	4	2

COURSE OBJECTIVES:

- To provide basic understanding of chemical engineering principles and operations
- Course will enable the students to apply the principles in other chemical engineering andbiotechnology subjects offered in higher semesters.

PREREQUISITE:

- Chemistry and Process Calculation

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C407.1	***Apply*** the basic principles of chemical engineering	K3
C407.2	***Relate*** the material balance and energy balance in unit operations, unit process of chemical engineering and biotechnology	K3
C407.3	***Analyze*** the principles of chemical engineering and its applicationsin chemical, mechanical and biological perspectives	K3
C407.4	***Explore*** the design and working principles of fluid moving machinery and transport phenomena	K3
C407.5	***Investigate*** the design and working principles of mass transfer and heat transfer	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C407.1	3	2	2	1	-	-	-	-	-	-	-	-	2	1	-	-
C407.2	3	2	2	1	-	-	-	-	-	-	-	-	2	1	-	-
C407.3	3	2	2	1	-	-	-	-	-	-	-	-	2	1	-	-
C407.4	3	2	2	1	-	-	-	-	-	-	-	-	2	1	-	-
C407.5	3	2	2	1	-	-	-	-	-	-	-	-	2	1	-	-

Note: 1: Slight; 2: Moderate; 3: Substantial

List of Experiment **No. of Credits: 2**

1. Flow measurement in Orifice meter
2. Flow measurement in Venturimeter
3. Flow measurement in Rotameter
4. Pressure drop in flow through pipes
5. Pressure drop in flow through packed column
6. Pressure drop in flow through fluidized beds
7. Characteristics of centrifugal pump
8. Filtration through plate and frame filter press
9. Filtration in leaf filter
10. Heat transfer characteristics in heat exchanger
11. Simple and Steam distillation
12. Leaching

LEARNING RESOURCES:

TEXT BOOKS:

1. McCabe W.L., Smith J.C. Unit Operations In Chemical Engineering.5th Edition. McGraw Hill. 1993.
2. Binay K.Dutta, Heat transfer: Principles and applications, PHI learning Pvt. Ltd., New Delhi,1st edition, 2006.

REFERENCES:

1. Geankoplis C.J. Transport Processes and Unit Operations. Prentice Hall India.2002.
2. Perry's Chemical Engineers' Handbook, 9th Edition, Kindle Edition by Don W. Green,Marylee Z. Southard, Imprint: McGraw-Hill Education.

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Course code	21BT48P	Semester	IV			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	MOLECULAR BIOLOGY LABORATORY		0	0	4	2

COURSE OBJECTIVES:

- Provide hands-on experience in performing basic molecular biology techniques.
- Introduce students to the theory behind in each technique and to describe common applications of each methodology in biological research. This will facilitate the students to take up specialized project in Molecular biology and will be a pre-requisite for research work.

PREREQUISITE:

- Fundamentals of the Biochemistry and Biology Laboratory

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C408.1	***Demonstrate*** the principles under pinning important techniques in molecular biology.	K3
C408.2	***Isolate*** DNA from prokaryotic and eukaryotic organisms	K3
C408.3	***Apply*** the principles in transformation of genetic material	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C408.1	3	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-
C408.2	3	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-
C408.3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-

Note: 1: Slight; 2: Moderate; 3: Substantial

List of Experiment **No. of Credits: 2**

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1. Agarose Gel Electrophoresis
2. Isolation of microbial DNA
3. Isolation of DNA from Banana/Strawberry using Household Chemicals
4. Isolation of genomic DNA from plant cell
5. Isolation of genomic DNA from Animal cell
6. Isolation of RNA
7. Quantification of DNA (UV/ Vis) and analysis of purity
8. Restriction enzyme digestion and Ligation
9. competent cells preparation
10. Transformation
11. Selection of recombinants – Antibiotic sensitivity assay
12. Plating of λ phage

LEARNING RESOURCES:

TEXT BOOKS:

1. Robert J. Slater., Experiments in Molecular Biology, Springer Nature, 1986.

REFERENCES:

1. Sambrook, Joseph and David W. Russell "The Condensed Protocols: From Molecular Cloning: A Laboratory Manual" Cold Spring Harbor, 2006.

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Course code	21EE01P	Semester	IV			
Category	EMPLOYABILITY ENHANCEMENT COURSE (EEC)		L	T	P	C
Course Title	MINI PROJECT – I		0	0	2	1

COURSE OBJECTIVE:

- To introduce project-based learning

PREREQUISITE:

- All Core Courses

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C409.1	***Evaluate*** specific problem statements for ill-defined real-life problems with reasonable assumptions and constraints.	K5
C409.2	***Perform*** literature search and / or patent search in the area of interest	K3
C409.3	***Conduct*** experiments / design and analysis / solution iterations anddocument the results/ Perform error analysis	K4
C409.4	***Synthesize*** the results and arrive at scientific conclusions / products / solution	K4
C409.5	***Document*** the results in the form of technical report / presentation	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C409.1	3	3	2	2	2	1	1	1	3	2	2	2	2	2	2	2
C409.2	3	3	2	2	2	1	1	1	3	2	2	2	2	2	2	2
C409.3	3	3	2	2	2	1	1	1	3	2	2	2	2	2	2	2
C409.4	3	3	2	2	2	1	1	1	3	2	2	2	2	2	2	2
C409.5	3	3	2	2	2	1	1	1	3	2	2	2	2	2	2	2

Note: 1: Slight; 2: Moderate; 3: Substantial

DOMAINS

Students are advised to carryout the projects in the following domains, but not limited with

- Biochemistry
- Bio-organic Chemistry
- Cell Biology
- Microbiology
- Marine Biology
- Industrial Biotechnology
- Plant Science
- System Biology
- Natural Products

Total: 30 Periods

ONLINE RESOURCES:

1. https://swayam.gov.in/nc_details/NPTEL
2. https://www.sciencedirect.com/
3. https://www.ncbi.nlm.nih.gov/
4. https://www.ncbi.nlm.nih.gov/pmc/
5. https://mtccindia.res.in/
6. https://www.atcc.org/

V SEMESTER

SEMESTER V										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21BT51T	Bioprocess Engineering	PCC	40	60	100	3	0	0	3
2	21BT52T	Mass Transfer Operations	ESC	40	60	100	3	0	0	3
3	21BT53IT	Analytical Techniques in Biotechnology	PCC	40	60	100	2	0	4	4
4	21BT54T	Principles of Genetic Engineering	PCC	40	60	100	3	1	0	4
5	-	Professional Elective - I	PEC	40	60	100	3	0	0	3
6	-	Open Elective - I	OEC	40	60	100	3	0	0	3
PRACTICAL										
7	21BT57P	Bioprocess Laboratory	PCC	40	60	100	0	0	4	2
8	21BT58P	Genetic Engineering Laboratory	PCC	40	60	100	0	0	4	2
TOTAL										**24**

Course code	21BT51T	Semester	V			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	BIOPROCESS ENGINEERING		3	0	0	3

COURSE OBJECTIVES:

- To provide the students with the basics of bioreactor engineering.
- To develop bioengineering skills for production of biochemical products using biochemical processes.

PREREQUISITE:

- Microbiology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C501.1	***Select*** appropriate bioreactor configurations and operation modes based on nature of bioproducts and other process criteria	K3
C501.2	***Illustrate*** the design of a bioreactor and scale-up process.	K3
C501.3	***Integrate*** research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology	K3
C501.4	***Use*** the modeling and simulation of bioprocesses in reducingthe cost and to enhance the quality of products and systems.	K3
C501.5	***Apply*** bioprocess technology in recombinant cell cultivation	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C501.1	3	2	1	-	-	-	-	-	-	-	-	-	-	3	-	-
C501.2	3	2	1	-	-	-	-	-	-	-	-	-	-	3	-	-
C501.3	3	2	1	-	-	-	-	-	-	-	-	-	3	3	-	-
C501.4	3	2	1	-	-	-	-	-	-	-	-	-	3	3	1	1
C501.5	3	2	1	-	-	-	-	-	-	-	-	-	3	3	1	1

Note: - 1: Slight; 2: Moderate; 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I CONFIGURATION OF BIOREACTORS 9

Introduction – Ideal Reactor, Chemostat, Fed batch cultivation – Fixed Volume and Quasi- Steady State, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, Packed bed reactor, Airlift reactor, Fluidized bed reactor, Bubble column reactors

UNIT II BIOREACTOR SCALE – UP 9

Oxygen mass transfer in bioreactors – microbial oxygen demands, Methods for the determination of mass transfer coefficients, Factors affecting kLa, Mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impellertip speed.

UNIT III BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS 9

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors.

UNIT IV MODELLING AND SIMULATION IN BIOPROCESSES 9

Structured models – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism using ISIM.

UNIT V RECOMBINANT CELL CULTIVATION 9

Different host vector system for recombinant cell cultivation, strategies and advantages, E. coli, yeast Pichiapastoris / Saccharomyces cereviseae, Insect cell cultivation, Animal cell cultivation, Plant cell cultivation, Reactor considerations in the above system

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Michael L. Shuler and FikretKargi, Bioprocess Engineering, Basic Concept, 2nd Edition Prentice Hall PTR, 2002
2. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications
3. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.

REFERENCES:

1. Anton Moser, “Bioprocess Technology, Kinetics and Reactors”, Springer Verlag.
2. James M. Lee, Biochemical Engineering, PHI, USA.

Course code	21BT52T	Semester	V			
Category	ENGINEERING SCIENCE COURSE (ESC)		L	T	P	C
Course Title	MASS TRANSFER OPERATIONS		3	0	0	3

COURSE OBJECTIVES:

- The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in phase changes for product separation
- To define the principles of adsorption, absorption, leaching and drying extraction, distillation crystallization operations.
- To begin the concept of bio separation process and develop skills of the students in the area of mass transfer operations with emphasis on separation and purification of bioproducts.

PREREQUISITE:

- Basic Physics, Chemistry, Process Calculation and Mathematics Skills

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C502.1	***Classify*** and use the accurate engineering correlations of diffusion and mass transfer coefficients to model a separation process	K3
C502.2	***Analyze*** the importance of gas – liquid operations (absorbers and strippers) in various industrial processes	K3
C502.3	***Investigate*** the simultaneous phase equilibrium material balance concepts in various industrial separation (distillation) processes	K3
C502.4	***Make*** use of the mechanism behinds for liquid–liquid (extraction) and solid–liquid (leaching) separation process for bioproduct purification	K3
C502.5	***Design*** and construction with operating principles for drying and adsorption process for bioproduct purification with industrial applications	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C502.1	3	2	2	1	-	-	-	-	-	-	-	-	1	2	-	-
C502.2	3	2	2	1	-	-	-	-	-	-	-	-	1	2	-	-
C502.3	3	2	2	1	-	-	-	-	-	-	-	-	1	2	-	-
C502.4	3	2	2	1	-	-	-	-	-	-	-	-	1	2	-	-
C502.5	3	2	2	1	-	-	-	-	-	-	-	-	1	2	-	-

Note: - 1: Slight; 2: Moderate; 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I DIFFUSION AND MASS TRANSFER 9

Molecular diffusion in fluids and solids, Inter-phase Mass Transfer, Mass Transfer coefficients, analogies in transport phenomenon, Application of Mass Transfer operation in biotechnology industry.

UNIT II GAS LIQUID OPERATIONS 9

Principles of gas-liquid absorption, single component absorption, types of absorption and its packing, design of absorption column, HTU, NTU concepts.

UNIT III VAPOUR LIQUID OPERATIONS 9

Vapor-Liquid equilibria, types of distillation process – Simple, Steam, Azeotropic, Extractive, batch and continuous distillation, McCABE THIELE & PONCHON-SAVARIT Principles, HETP, HTU and NTU concepts, Basic Calculation.

UNIT IV EXTRACTION OPERATIONS 9

Liquid-Liquid equilibria, extraction Principles, various stages of extraction process, types of extraction, Industrial extraction equipments. Solid-liquid equilibria, Leaching Principles, Industrial leaching equipments, Basic Calculation.

UNIT V SOLID FLUID OPERATIONS 9

Adsorption equilibria – Batch, fixed and Moving bed adsorption; Drying-Mechanism-Drying curves- Time of Drying; types of drying process, Industrial drying equipments, Basic Calculation.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Treybal R.E. Mass Transfer Operations. IIIrd edition. Mcgraw Hill, 1981.
2. Geankoplis C.J. Transport Processes and Unit Operations. IIIrd edition, Prentice Hall of India, 2002.

REFERENCES:

1. McCabe W.L & J.C.Sonith &P. Harriot "Unit operations of chemical Engineering" 6thEdn McGrawHill2001.
2. Coulson and Richardson's Chemical Engineering. Vol I & II, Asian Books Pvt Ltd, 1998.

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Course code	21BT53IT	Semester	V			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY		2	0	4	4

COURSE OBJECTIVES:
- To have a fundamental knowledge about the Light spectrum, Absorption, Fluorescence,NMR, Mass spectroscopy
- To acquire knowledge on the different chromatographic methods for separation of biologicalproducts.
- To have practical hands on experience on analytical instruments

PREREQUISITE:
- Fundamentals of Physics, Chemistry and Biology.

COURSE OUTCOMES:

CO.NO	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C503.1	***Understand*** fundamental knowledge about spectrometry, Properties of electromagnetic radiation and components of optical instruments	K2
C503.2	***Interpret*** the theory of absorbance, molecular spectroscopy and its application	K2
C503.3	***Discuss*** about Mass spectrometer and the environmental impacts of NMR	K2
C503.4	***Characterize*** and separate different biological samples using basic chromatographic methods	K3
C503.5	***Demonstrate*** the mechanism of electrochemical cells, surfacemicroscopy, and acquire knowledge about Instrument for potentiometric studies and its application	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Co. No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C503.1	2	1	-	-	-	-	-	-	-	-	-	-	2	2	1	-
C503.2	2	1	-	-	-	-	-	-	-	-	-	-	2	2	1	-
C503.3	2	1	-	-	-	-	-	-	-	-	-	-	2	2	1	-
C503.4	3	2	1	1	-	-	-	-	-	-	-	-	2	2	1	-
C503.5	3	2	1	1	-	-	-	-	-	-	-	-	2	2	1	-

Note:- 1: Slight; 2: Moderate; 3 Substantial

SYLLABUS **No. of Credits: 4**

UNIT I INTRODUCTION TO SPECTROMETRY 6

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements.

UNIT II MOLECULAR SPECTROSCOPY 6

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law –Instrumentation - Applications -Theory of fluorescence and Phosphorescence – Instrumentation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications

UNIT III MAGNETIC RESONANCE SPECTROSCOPY & MASS SPECTROMETRY 6

Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR-spectrometers – applications of 1H and 13C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values –instrumentation.

UNIT IV SEPARATION METHODS 6

General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography- principlesof GC and applications – HPLC- Capillary electrophoresis – Applications.

UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY 6

Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

Total: 30 Periods

List of Experiment

1. Precision and validity in an experiment using absorption spectroscopy .
2. Validating Lambert-Beer's law using $KMnO_4$
3. Finding the molar absorbtivity and stoichiometry of the using absorption spectrometry.
4. Finding the pKa of 4-nitrophenol using absorption spectroscopy.
5. UV spectra of nucleic acids using varied concentration.
6. Chemical actinometry using potassium ferrioxolate.
7. Estimation of SO4-- by Nephelometry.
8. Estimation of Al3+ by Flourimetry.
9. Limits of detection using aluminium alizarin complex.
10. Chromatography analysis using TLC.
11. Chromatography analysis using Column Chromatography.
12. Chromatography analysis using Size Exclusion Chromatography.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch "Instrumental Methods of Analysis".CengageLearning , 2007.
2. Fifield F.W.,Principles and Practice of Analytical Chemistry. Blackwell, Scientific Publishers,2016
3. Ewubg G. W. "Instrumental Methods of Chemical Analysis" 5^{th} Edition, Mc Graw Hill 1985

REFERENCES:

1. Sharma, B.K. "Instrumental Methods of Chemical Analysis: Analytical Chemistry", KrishnaPrakashan Media (P) Ltd, 2014
2. Haven, Mary C., etal., "Laboratory Instrumentation ". 4th Edition, Wiley India Pvt Ltd, 2010
3. Philopose P.M.Analytical Biotechnology. Domihant Publishers & distributors, New Delhi,2016.

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Course code	21BT54T	Semester	V			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	PRINCIPLES OF GENETIC ENGINEERING		4	0	0	4

COURSE OBJECTIVES:

- To explain the techniques involved in cloning genes for the production of recombinant proteins
- To explicate the fundamentals of r DNA technology on construction of vectors and DNA libraries
- To describe the principle involved in whole genome sequencing and mapping.
- To make students understand the application of genetic engineering in various fields.

PREREQUISITE:

- Molecular biology and Biochemistry

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C504.1	***Understand*** the cloning of commercially important genes and production of recombinant proteins	K2
C504.2	***Construct*** and screening of DNA libraries	K3
C504.3	***Learn*** to design DNA sequence using amplification techniques	K3
C504.4	***Evaluate*** the methods for sequencing genomic materials	K3
C504.5	***Infer*** the applications of genetic engineering in biotechnology	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C504.1	2	1	-	-	-	-	-	-	-	-	-	-	3	2	-	1
C504.2	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-	1
C504.3	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-	1
C504.4	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-	1
C504.5	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-	1

Note: - 1: Slight; 2: Moderate; 3: Substantial

SYLLABUS **No. of Credits: 4**

UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY **12**

Overview of recombinant DNA technology. Manipulation of DNA – Restriction and Modification enzymes, DNA polymerase, DNA ligase, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for yeast, insect and mammalian systems, Prokaryotic and eukaryotic expression host systems, Introduction of recombinant DNA into host cells and selection methods.

UNIT II Construction of DNA Libraries **12**

Construction of genomic and cDNA libraries- hairpin and loop strategies, Limitations in cDNA library constructions Artificial chromosomes– BACs and YACs, Chromosome walking, Screening of DNA libraries using nucleic acid probes and antibodies.

UNIT III SEQUENCING AND AMPLIFICATION OF DNA **12**

Maxam Gilbert's and Sanger Coulson's and automated methods of DNA sequencing, Polymerase chain reaction: Principle and steps in PCR, Types of PCR- Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR–SYBR green assay, Taqman assay, Molecular beacons, Site directed mutagenesis.

UNIT IV ORGANIZATION AND STRUCTURE OF GENOMES **12**

Organization and structure of genomes, Genome sequencing methods, Conventional and shotgun genome sequencing methods, Next generation sequencing technologies, Ordering the genome sequence, Genetic maps and Physical maps, STS content based mapping, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Opticalmapping. ORF finding and functional annotation.

UNIT V APPLICATIONS OF GENETIC ENGINEERING **12**

Gene therapy- ex vivo and in vivo, Microarrays, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, DIGE, TOGA, Yeast Two hybrid System, CRISPR-Cas. Genetic engineering in medicine - recombinant therapeutics, antibiotics and vaccines, Genetic engineering in agriculture – bio pesticides and herbicides.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Primrose SB and R. Twyman "Principles of Gene Manipulation & Geneomics BlackwellScience Publications, 2006.
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, Third Edition (Blackwell Publishing), 2003.

REFERENCES:

1. Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology "Greene Publishing Associates, NY, 1988.
2. Genomes 3 by T A Brown Third Edition (Garland Science Publishing), 2007.

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Engineering Stream Courses
PROFESSIONAL ELECTIVE I		
1	21BT551PT	Frontiers in Biomedicine
2	21BT552PT	Fundamentals of Nano Science
3	21BT553PT	Green and Renewable energy
4	21BT554PT	Bioethics and IPR
5	21BT555PT	Enzyme Technology

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Course code	21BT551PT	Semester	V			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	FRONTIERS OF BIOMEDICINE		3	0	0	3

COURSE OBJECTIVES:

- To provide students with sound foundation in the mathematical, scientific andengineering fundamentals necessary
- To formulate, analyze and solve engineering problems and to prepare them for graduate studies and for successful careers in healthcare sector

PREREQUISITE:

- Biochemistry, Microbiology and Cell Biology

COURSEOUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C551.1	***Understand*** the fundamental concepts of bio medicine	K2
C551.2	***Comprehend*** the methods, technologies utilized in the field of immunology	K2
C551.3	***Define*** the concept of biomaterials and the techniques used	K2
C551.4	***Learn*** the various tools and techniques used in biomedical field	K2
C551.5	***Explain*** the various sources of biomedicine and study the role of nano technology.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C551.1	2	1	-	1	-	-	-	-	-	-	-	-	-	2	-	-
C551.2	2	1	-	1	-	-	-	-	-	-	-	-	-	2	-	-
C551.3	2	1	-	1	-	-	-	-	-	-	-	-	-	2	-	-
C551.4	2	1	-	1	-	-	-	-	-	-	-	-	-	2	-	-
C551.5	2	1	-	1	-	-	-	-	-	-	-	-	-	2	-	-

Note:- 1: Slight; 2: Moderate; 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION TO BIOMEDICINE **9**

Biomedical science – Early development of biomedical system – Development of the biomedical science as profession – Role of IBMS in 21st century – Education and training for Biomedical scientist – Professional societies.

UNIT II TECHNIQUES USED IN IMMUNOLOGY **9**

Haematology and Transfusion science - Clinical biochemistry - Histopathology and Cytopathology - Medical microbial - Evaluation of a new diagnostic test - Sensitivity and specificity of an assay.

UNIT III BIOMATERIALS **9**

Materials in Medicine: From Prosthetics to regeneration - Biomaterials: Types, properties and their Applications - Tissue/ Biomaterial Interactions - Techniques for Guiding Tissue Repair & Regeneration.

UNIT IV BIOMEDICAL SYSTEMS **9**

Foundations for Systems Biomedicine - Genomic Technologies - Proteomic Technologies - Software Tools - Challenges - Applications of Immunologic Modeling to Drug Discovery.

UNIT V SOURCES OF BIOMEDICINE **9**

Medicines derived through Food, Terrestrial and Marine Sources, Role of Nano-Technology in drug deliver, Probiotics and Prebiotics Future of Biomedicine

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Pitt, S. J., & Cunningham, J. (2009). An introduction to biomedical science in professional and clinical practice. John Wiley & Sons.
2. Enderle, J., & Bronzino, J. (Eds.). (2012). Introduction to biomedical engineering. Academic press.
3. Biomedical Engineering: Concepts, Methodologies, Tools, andApplications. (2017). United States: IGI Global.

REFERENCES:

1. Liu, E. T., & Lauffenburger, D. A. (Eds.). (2009). Systems biomedicine: Concepts andperspectives. Academic Press.
2. Baker, B. J. (Ed.). (2015). Marine biomedicine: from beach to bedside. CRC Press.
3. Pokorski, M. (Ed.). (2015). Environmental Biomedicine. Springer InternationalPublishing.

Course code	21BT552PT		Semester	V			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)			L	T	P	C
Course Title	FUNDAMENTALS OF NANO SCIENCE			3	0	0	3

COURSE OBJECTIVES:

- To learn about basics of nanomaterial science, preparation method, types and applications.

PREREQUISITE:

- Physics and Chemistry

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C552.1	***Understand*** the basics of nanomaterials	K2
C552.2	***Describe*** the preparation of nanomaterials	K2
C552.3	***Explain*** the various techniques involved in the preparation of Nano-materials	K2
C552.4	***Comprehend*** the different techniques involved in the characterization of nano-materials	K2
C552.5	***Learn*** the diversified applications of Nano-materials	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C552.1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-
C552.2	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-
C552.3	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-
C552.4	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-
C552.5	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-
C552	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-

Note: - 1: Slight; 2: Moderate; 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION 8

Nanoscale Science and Technology-Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires ultra-thin films-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS 12

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays functionalization and applications-Quantum wires, Quantum dots- preparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES 9

X- ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques-AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT V APPLICATIONS 7

NanoInfoTech: Information storage- nano computer, molecular switch, super chip, nanocrystal, Nanobiotechnology: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targeted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nano sensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sun barrier products - In Photostat, printing, solar cell, battery.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, “Nanoscale Charecterisation of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCES:

1. G Timp, “Nanotechnology”, AIP press/Springer, 1999.
2. Akhlesh Lakhtakia,“The Hand Book of Nano Technology, Nanometer Structure, Theory,Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.

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Course code	**21BT553PT**	**Semester**	**V**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**GREEN AND RENEWABLE ENERGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To get exposure on solar radiation and its environmental impact to power.
- To know about the various collectors used for storing solar energy.
- To know about the various applications in solar energy.
- To learn about the wind energy and biomass and its economic aspects.
- To know about geothermal energy with other energy sources.

PREREQUISITE:

- Environmental Sciences

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C553.1	***Understand*** the physics of solar radiation	K2
C553.2	***Classify*** the solar energy collectors and methodologies of storing solar energy	K2
C553.3	***Acquire*** knowledge in applying solar energy in a useful way	K2
C553.4	***Explain*** wind energy and biomass with its economic aspects	K2
C553.5	***Learn*** the various types of green energy sources like biogas and other biofuels	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C553.1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
C553.2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
C553.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
C553.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
C553.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Note: - 1: Slight; 2: Moderate; 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I PRINCIPLES OF SOLAR RADIATION 10

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT II SOLAR ENERGY COLLECTION 8

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT III SOLAR ENERGY STORAGE AND APPLICATIONS 8

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applicationssolar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT IV WIND ENERGY AND GEOTHERMAL 10

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria; Geo-thermal Resources, types of wells, methods of harnessing the energy, potential in India.

UNIT V BIO-ENERGY 9

Bio resources – Biomass direct combustion – thermochemical conversion – biochemical conversion-mechanical conversion – Biomass gasifier – Types of biomass gasifiers – Cogeneration – Carbonization – Pyrolysis – Biodiesel production – Ethanol production – Biogas and Bio-hydrogen Production.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Rai G.D. , “Non-Conventional Energy Sources”, Khanna Publishers, 2011.
2. Twidell & Wier, “Renewable Energy Resources”, CRC Press (Taylor & Francis), 2011.

REFERENCES:

1. Tiwari and Ghosal, “Renewable energy resources”, Narosa Publishing House, 2007
2. Ramesh R & Kumar K.U , “Renewable Energy Technologies”,Narosa Publishing House,2004
3. Mittal K M, “Non-Conventional Energy Systems”, Wheeler Publishing Co. Ltd, New Delhi,2003
4. Kothari D.P, Singhal ., K.C., “Renewable energy sources and emerging technologies”, P.H.I,New Delhi, 2010

Course code	21BT554PT	Semester	V			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	BIOETHICS AND IPR		3	0	0	3

COURSE OBJECTIVES:

- To provide fundamental ethical in advanced clinical trial management
- To understand about project management in clinical trials
- To manage quality assurance and governance
- To create awareness about Intellectual Property Rights and engineering ethics

PREREQUISITE:

- Basic sciences and Environmental sciences

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C554.1	***Acquire*** knowledge in all aspect of clinical trials	K2
C554.2	***Learn*** the regulations pertaining to clinical trials	K2
C554.3	***Explain*** project management and ethics in clinical trials	K2
C554.4	***Understand*** the data protection and management	K2
C554.5	***Comprehend*** the importance of intellectual property rights	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C554.1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
C554.2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
C554.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
C554.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
C554.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Note: - 1: Slight; 2: Moderate; 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION TO CLINICAL TRIALS 9

Fundamentals of clinical trials; Basic statistics for clinical trials; Clinical trials in practice; Reporting and reviewing clinical trials; Legislation and good clinical practice - overview of the European directives and legislation governing clinical trials in the 21stcentury; International perspectives; Principles of the International Committee on Harmonization (ICH)-GCP.

UNIT II REGULATIONS OF CLINICAL TRIALS 9

Drug development and trial planning - pre-study requirements for clinical trials; Regulatory approvals for clinical trials; Consort statement; Trial responsibilities and protocols - roles and responsibilities of investigators, sponsors and others; Requirements of clinical trials protocols; Legislative requirements for investigational medicinal products.

UNIT III MANAGEMENT AND ETHICS OF CLINICAL TRIALS 9

Project management in clinical trials - principles of project management; Application in clinical trial management; Risk assessment; Research ethics and Bioethics - Principles of research ethics; Ethical issues in clinical trials; Use of humans in Scientific Experiments; Ethical committee system including ahistorical overview; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology; Introduction to laws and regulation regarding use of animals in research.

UNIT IV INFORMED CONSENT 9

Consent and data protection- the principles of informed consent; Consent processes; Data protection; Legislation and its application; Data management – Introduction to trial master files and essential documents; Data management.

UNIT V INTELLECTUAL PROPERTY RIGHTS 9

Intellectual Property Rights (IPR) – Discrimination. Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology, Case studies on basmati rice, turmeric and neem.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, NewYork, 2005.
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Thompson Learning, Wadworth Publisher & co, 2013.
3. Matthews D and Zech H, "Research Handbook on Intellectual Property and the LifeSciences", Edward Elgar Publishing, 2017.

REFERENCES:

1. Charles D Fleddermann, “Engineering Ethics”, Prentice Hall, New Mexico, 4th Edition,2011.
2. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, 7th Edition, 2011.

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Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

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Course code	21BT555PT	Semester	V			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	ENZYME TECHNOLOGY		3	0	0	3

COURSE OBJECTIVES:

- To learn enzyme reactions and its characteristics along with the production and purification process
- To give the student a basic knowledge concerning kinetics with the usage of enzymes

PREREQUISITE:

- Basic Industrial Biotechnology, Bioprocess Principles

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C555.1	***Explain*** the concept of enzymatic reactions in biological systems.	K2
C555.2	***Identify*** the theoretical and practical aspects of enzyme kinetics in bioprocess applications.	K2
C555.3	***Learn*** the various immobilization techniques to improve enzyme stability.	K2
C555.4	***Understand*** suitable techniques for production and purification of enzymes.	K2
C555.5	***Describe*** the enzymatic reaction mechanism and design artificial enzymes.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C555.1	2	1	-	-	-	-	-	-	-	-	-	-	3	2	1	-
C555.2	2	1	-	-	-	-	-	-	-	-	-	-	3	2	1	-
C555.3	2	1	-	-	-	-	-	-	-	-	-	-	3	2	1	-
C555.4	2	1	-	-	-	-	-	-	-	-	-	-	3	2	1	-
C555.5	2	1	-	-	-	-	-	-	-	-	-	-	3	2	1	-

Note: - 1: Slight; 2: Moderate; 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION TO ENZYMES **9**

Classification of enzymes - Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases, Ligases, Nomenclature of enzyme, Mechanisms of enzyme action – Specificity, Factors affecting enzyme activity, Concept of active site, Enzyme substrate complex formation, Lock and Key Hypothesis - Induced Fit Hypothesis, Non Productive Hypothesis, Substrate strained Hypothesis, Collision theory and Transition state theory.

UNIT II KINETICS OF ENZYME ACTION **13**

Kinetics of single substrate reactions- Michelis-Menten Equation, Briggs- Haldmann Equation, Estimation of Michelis-Menten parameters, Reciprocal plot, Eadie-Hofstee plot, Hans Wolf Plot, Eisenthal Carnish Bowdan Plot, Multi-substrate reactions - Mechanisms and kinetics , Turnover number Integral form of Michelis-Menten Equation, Types of inhibition – Reversible and Irreversible Inhibitors, Competitive, Uncompetitive and Non Competitive Inhibitions, Models for substrate and product inhibition, Allosteric regulation of enzyme, Monod Changeux Wyman model, pH and Temperature effect on enzymes

UNIT III ENZYME IMMOBILIZATION AND BIOSENSORS **7**

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors

UNIT IV PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES **8**

Methods of Enzyme Production, Extraction and Purification of Enzymes, Methods of characterization of enzymes, Development of enzymatic assays – Enzyme units, Enzyme activity, Specific activity, Rate of a reaction, Percentage of purity, Continuous and Discontinuous assay, Factors to control in assay.

UNIT V BIOTRANSFORMATION **8**

Hydrolytic- Ester bond, Amide, Epoxides, Nitriles, Reduction reactions – Aldehydes, Ketones, C=C, Oxidation reactions – Alkanes, Aromatic, Baeyer-Villiger – Enzymes in organic synthesis – esters, amide, peptide – Modified and Artificial Enzymes – Catalytic antibodies.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Jens. N, John. V and Gunnar. L, “Bioreaction engineering principles”, 2nd Edition, KulwerAcademic, 2002
2. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, 2nd Edition, Marcel DekkerInc. 2002.
3. Shuler. M, Kargi. M., and Delisa. M, “Bioprocess Engineering: Basic Concepts”, 3rd revised, Pearson Education, 2017

REFERENCES:

1. Anton Moser, “Bioprocess Technology: Kinetics and Reactors”, Springer Verlag 2011.
2. Tapobrate Panda, “Bioreactors: Analysis and Design”, Tata McGraw Hill, 2011.

Course code	21BT57P	Semester	V			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	BIOPROCESS LABORATORY		0	0	4	2

COURSE OBJECTIVES:

- To educate the students on the effect of various parameters on enzyme activity.
- To impart the knowledge on enzyme inhibition kinetics.
- To apply the concept of various enzyme immobilization techniques.

PREREQUISITE:

- Fundamentals of the microbiology, biochemistry and process calculation.

COURSE OUTCOMES:

CO. No.	Course Outcome	Blooms level
On successful completion of this Course, students will be able to		
C507.1	***Demonstrate*** the parameters involved in enzyme kinetic.	K3
C507.2	***Evaluate*** the various parameters involved in growth kinetics.	K3
C507.3	***Apply*** the principles for the growth of microorganisms.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C507.1	3	3	2	1	-	-	-	-	-	-	-	-	3	2	-	-
C507.2	3	3	2	1	-	-	-	-	-	-	-	-	3	2	-	-
C507.3	3	3	2	1	-	-	-	-	-	-	-	-	3	2	-	-

Note: 1: Slight; 2: Moderate; 3: Substantial

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List of Experiment **No. of Credits: 2**

1. Enzyme kinetics – Determination of Michaelis Menten parameters.
2. Enzyme activity – Effect of Temperature and Deactivation Kinetics.
3. Enzyme activity – Effect of pH.
4. Enzyme inhibition kinetics.
5. Enzyme immobilization – Gel entrapment.
6. Enzyme immobilization – Crosslinking.
7. Enzymatic conversion in Packed bed Column/Fluidized bed Column.
8. Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate, YieldCoefficient.
9. Growth of yeast – Estimation of Biomass, Calculation of Specific Growth Rate, YieldCoefficient.
10. Medium optimization – Plackett Burman Design.
11. Estimation of kLa – Dynamic Gassing-out method.
12. Estimation of kLa – Sulphite Oxidation Method.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. RBailey and Ollis, — Biochemical Engineering Fundamentals‖, McGraw Hill (2nd Ed.),1986.
2. Shuler and Kargi, — Bioprocess Engineering —, Prentice Hall,1992.
3. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.

REFERENCES:

1. Anton Moser, —Bioprocess Technology, Kinetics and Reactors, Springer Verlag.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGrawHill.
3. James M. Lee, Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors, Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Decker Inc.

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`Course code	21BT58P	Semester	V			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**GENETIC ENGINEERING LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To provide hands-on experience in performing basic recombinant DNA techniques
- To learn about the identification and characterization of gene and protein
- To introduce students to the theory behind each techniques of Genetic engineering

PREREQUISITE:

- Molecular biology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C508.1	***Experiment*** the basic techniques of DNA isolation and manipulation	K3
C508.2	***Demonstrate*** clearly about the gene amplification and methods foranalysis of DNA	K3
C508.3	***Apply*** the principles of Genetic engineering in analysis of gene expression	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C508.1	3	2	1	-	-	-	-	-	-	-	-	-	-	3	3	-
C508.2	3	2	1	-	-	-	-	-	-	-	-	-	-	3	3	-
C508.3	3	2	1	-	-	-	-	-	-	-	-	-	-	3	3	-

Note: 1: Slight; 2: Moderate; 3: Substantial

List of Experiment **No. of Credits: 2**

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1. Preparation of plasmid DNA
2. Elution of DNA from agarose gels
3. Restriction Digestion
4. Ligation of DNA in to expression vectors
5. Transformation & Selection of recombinants- Blue white screening assay
6. Optimization of time of inducer for recombinant protein expression
7. Protein profiling by SDS- PAGE
8. Western blotting
9. Southern blotting
10. Hybridization with anti-sera
11. PCR amplification of genes
12. Colony lysate PCR.

LEARNING RESOURCES:

TEXT BOOKS:

1. Primrose SB and R. Twyman "Principles of Gene Manipulation & Geneomics BlackwellScience Publications, 2006.
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, ThirdEdition (Blackwell Publishing), 2003.

REFERENCES:

1. Old RW, Primrose SB, "Principles of Gene Manipulation, An Introduction toGenetic Engineering ", Blackwell Science Publications, 1993.
2. Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols in Molecular Biology", Greene Publishing Associates, NY, 1988.
3. Berger Sl, Kimmer AR, "Methods in Enzymology", Vol 152, Academic Press, 1987.

VI SEMESTER

SEMESTER VI										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21BT61T	Protein Engineering	PCC	40	60	100	3	1	0	4
2	21BT62T	Applied Chemical Reaction Engineering	PCC	40	60	100	3	0	0	3
3	21BT63T	Principles of Immunology	PCC	40	60	100	3	0	0	3
4	-	Professional Elective - II	PEC	40	60	100	3	0	0	3
5	-	Open Elective - II	OEC	40	60	100	3	0	0	3
PRACTICAL										
6	21BT66P	Principles of Immunology Laboratory	PCC	60	40	100	0	0	4	2
7	21EE04P	Internship	EEC	100	-	100	0	0	0	1
8	21EE02P	Mini Project - II	EEC	60	40	100	0	0	2	1
TOTAL										**20**

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Course code	**21BT61T**	**Semester**	**VI**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PROTEIN ENGINEERING**		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

- To understand the importance of protein biomolecules.
- To realize the structure-function relationships in proteins

PREREQUISITE:

- Biochemistry and Microbiology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C601. 1	***Differentiate*** the various interactions in protein makeup.	K2
C601. 2	***Understand*** the architecture of protein structure.	K2
C601. 3	***Discuss*** with different level of protein structure.	K2
C601. 4	***Elaborate*** the role of functional proteins in various field of study	K2
C601. 5	***Apply*** the latest application of protein science in their research.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C601. 1	3	-	-	-	-	-	-	-	-	2	-	-	3	-
C601. 2	3	-	2	-	-	-	-	1	-	-	-	-	3	-
C601. 3	3	-	-	2	-	-	-	-	-	-	-	-	3	-
C601. 4	3	-	2	2	-	-	-	1	-	2	-	-	3	-
C601. 5	3	-	2	2	-	-	-	1	-	2	-	2	3	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 4**

UNIT I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS 09 + 03

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, Xray) and elucidation of protein structure. Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

UNIT II PROTEIN ARCHITECTURE 09 + 03

Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass spec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turn beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites.

UNIT III TERTIARY & QUATERNARY STRUCTURE 09 + 03

Tertiary structure: Domains, folding, denaturation and , overview of methods to determine 3D structures. Quaternary structure of protein: Modular nature, formation of complexes. Computer exercise on the above aspects

UNIT IV STRUCTURE-FUNCTION RELATIONSHIP 09 + 03

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp Repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers. Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding 62 catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications. Computer exercise on the above aspects.

UNIT V PROTEOMICS 09 + 03

Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein-protein interactions and methods to study it: protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. Application of Proteomics in drug discovery.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Branden C. and Tooze J., Introduction to Protein Structured 2nd Edition, Garland Publishing, 1999.
2. Creighton T.E. “Proteins” 2nd Edition. W.H. Freeman, 1993.
3. Pennington, S.R and M.J. Dunn, “Proteomics: Protein Sequence to Function”. Viva Books, 2002.

REFERENCES:

1. Voet D. and Voet G., “Biochemistry”. 3rd Edition. John Wiley and Sons, 2008.
2. Haggerty, Lauren M. “Protein Structure: Protein Science and Engineering”. Nova Science Publications, 2011.

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Course code	**21BT62T**	**Semester**	**VI**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**APPLIED CHEMICAL REACTION ENGINEERING**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide the basic concepts of types of reactions, variable affecting the rate of reaction, predicting the rate equations for different types of reactions.
- To provide the information about different reactor systems, deriving the performance equations and predicting the rate equations in chemical reaction engineering system.

PREREQUISITE:

- Process Calculations for Biotechnologists

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C602.1	***Develop*** different rate equation for various chemical reactions	K2
C602.2	***Apply*** the material balance concepts in various industrial reactors	K2
C602.3	***Make*** use of the RTD studies for non-ideal flow reactors	K2
C602.4	***Construct*** the rate equation for various Gas, solid, liquid reactions	K2
C602.5	***Solve*** the rate equation for the fixed and fluidized bed reactors used in process industries	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C602.1	3	2	1	-	-	-	-	-	-	-	-	-	1	2
C602.2	3	2	1	-	-	-	-	-	-	-	-	-	1	2
C602.3	3	1	-	-	-	-	-	-	-	-	-	-	1	2
C602.4	3	1	-	-	-	-	-	-	-	-	-	-	1	2
C602.5	3	2	1	-	-	-	-	-	-	-	-	-	1	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I SCOPE OF CHEMICAL REACTION ENGINEERING 08

Broad outline of chemical reactors; Rate equations; Concentration - dependent term of a rate equation; Single and Multiple Reactions; Elementary and Nonelementary Reactions; Molecularity and Order of Reaction; Temperature - dependent term of a rate equation; Searching for a mechanism and develop a rate equation for different homogeneous reactions.

UNIT II HOMOGENEOUS REACTIONS AND IDEAL REACTORS 12

Industrial scale reactors; Interpretation of batch reactor data; Constant-volume batch reactor; Differential method of analysis of data; Integral method of analysis of data; Irreversible Unimolecular-type first-order reactions; Irreversible bimolecular-type second-order reactions; Homogeneous catalyzed reactions; Autocatalytic reactions; Irreversible Reactions in Series.; First-Order Reversible Reactions; Ideal Reactors for a Single Reaction; Performance equations for ideal batch reactor, Space-Time and Space-Velocity; Performanceequations for steady-state mixed flow reactor; Performance equations for steady-state plug
flow reactor; Semi-batch reactors; multiple

UNIT III IDEAL FLOW AND NON IDEAL FLOW REACTORS 09

Basics of Non-Ideal Flow; The Residence Time Distribution (RTD); State of Aggregation of the Flowing Stream; Role of RTD, State of Aggregation, and Earliness of Mixing in Determining Reactor Behavior; Exit age distribution of fluid; Experimental Methods for Finding E; Relationship between the F and E Curves; Non-ideal flow models; Dispersion Model; Tanks-In-Series Model; reactor performance with non-ideal flow.

UNIT IV GAS-SOLID AND GAS-LIQUID REACTIONS 08

Heterogeneous reactions-introduction; Contacting Patterns for Two-Phase Systems; Solid Catalyzed Reactions; The rate equation for surface kinetics; Pore diffusion resistance combined with surface kinetics; Porous catalyst particles; Performance equations for reactors containing porous catalyst particles.

UNIT V THREE PHASE REACTORS 08

Packed Bed Catalytic Reactor, Reactors with Suspended Solid Catalyst, Fluidized Reactors of Various Types; Deactivating Catalysts; G/L reactions on solid catalysis; Trickle bed, Slurry reactors; The general rate equation; performance equations for an excess of B; reactors for fluid - fluid reactions; Rate equation for straight mass transfer (absorption) of A;
Fluid-Fluid Reactors: Design; mass transfer in a tower reactor; Tank reactors.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Levenspiel O. Chemical Reaction Engineering.3rd Edition. John Wiley.1999.
2. Fogler H.S. Elements of Chemical Reaction Engineering. Prentice Hall India.2002
3. Dawande, S.D., "Principles of Reaction Engineering", 1st Edition, Central Techno, 2001

REFERENCES:

1. Missen R.W., Mims C.A., Saville B.A. Introduction To Chemical Reaction Engineering and Kinetics. John Wiley.1999.
2. Richardson, J.F. and Peacock, D.G., "Coulson Richardson - Chemical Engineering", Vol. III, 3rd Edition, Butterworth- Heinemann - Elsevier, 2006.

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Course code	**21BT63T**	**Semester**	**VI**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PRINCIPLES OF IMMUNOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To discuss the structure, functions and integration of immune system.
- To explain the antigen-antibody interactions and how the immune system is protecting thebody from foreign pathogens/germs.
- To explain various techniques of monoclonal and engineered antibodies (importanttherapeutic molecules) production, for treating most of the human diseases.

PREREQUISITE:

- Fundamentals of Biochemistry and Cell Biology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C603. 1	Understand the concepts of immune system and immune responses.	K2
C603. 2	State the structure and functions of antibodies.	K2
C603. 3	Infer the immunity to various pathogens.	K2
C603. 4	Outline the transplantation and tumor immunology	K2
C603. 5	Discuss the therapeutic/diagnostic molecules.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C603. 1	3	1	-	-	-	-	-	-	-	-	-	-	3	1
C603. 2	3	1	-	-	-	-	-	-	-	-	-	-	3	1
C603. 3	3	1	-	-	-	-	-	-	-	-	-	-	3	1
C603. 4	3	1	-	-	-	-	-	-	-	-	-	-	3	1
C603. 5	3	1	-	-	-	-	-	-	-	-	-	-	3	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS		No. of Credits: 03
UNIT I	**INTRODUCTION TO IMMUNE SYSTEM**	**11**

Introduction, Haematopoiesis, Immune cells; primary, secondary and tertiary immune organs; innate and acquired immunity; Toll receptors and responses, Antigens and its characterization; haptens and adjuvants; cytokines; complement pathway, antigen presenting cells; major histocompatibility complex

UNIT II HUMORAL AND CELLULAR IMMUNITY 12

Development, maturation, activation, regulation, differentiation and classification of T-cells and B-cells, antigen processing and presentation, theory of clonal selection, TCR; antibodies: structure and functions; antigen-antibody reactions: Immuno precipitation- immune diffusion (ODD, SRID and Rocket immune electrophoresis), agglutination reaction
– Blood grouping, comb and Widal reaction. ELISA, Immuno Histochemistry, Complement fixation test and cell sorting technique)

UNIT III IMMUNITY AGAINST PATHOGENS, HYPERSENSITIVITY AND AUTOIMMUNITY 08

Inflammation; protective immune responses to virus, bacteria, fungi and parasites; Allergy and hypersensitivity – Types of hypersensitivity; Autoimmunity, Autoimmune disorders and diagnosis immunosuppression and tolerance – AIDS and immunodeficiency diseases

UNIT IV IMMUNE TOLERANCE, TRANSPLANTATION AND TUMOR IMMUNOLOGY 07

Immune tolerance, Immunosuppression; Immuno deficiencies; Transplantation – genetics of transplantation; laws of transplantation; tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy

UNIT V APPLIED IMMUNOLOGY 07

Monoclonal and polyclonal antibodies, engineering of antibodies; Classification and methods in vaccine development, recent advancement in vaccine development, revolution in vaccine research by SARS CoV2, immune modulatory drugs

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Peter J. Delves, Seamus J Martin, Dennis R Burtn and Ivan M. Roitt., Roitts Essential Immunology, 13th Edition, Wiley –Blackwell, 2016.
2. Judith a Owen, Jenni Punt and Sharon A Stranford, Kuby Immunology, Macmillan International, 7th Edition, 2012
3. Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 2006.

REFERENCES:

1. Coico, Richard "Immunology: A Short Course" 6th Edition. John Wiley, 2008.
2. Khan, Fahim Halim "Elements of Immunology" Pearson Education, 2009.
3. R. R. Rich, T. A. Fleisher, W. T. Shearer, H. Schroeder, Anthony J. Frew, and Cornelia M Weyand, Clinical Immunology – Principles and Practice, Elsevier, 4th Edition, 2013.

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Engineering Stream Courses
PROFESSIONAL ELECTIVE II		
1	21BT641PT	Molecular Pathogenesis of Infectious Diseases
2	21BT642PT	Bio-inspired AI
3	21BT643PT	Principles of Food Processing
4	21BT644PT	Creativity, Innovation and New Product Development
5	21BT645PT	Animal Biotechnology

Course code	21BT641PT	Semester	VI			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	MOLECULAR PATHOGENESIS OF INFECTIOUS DISEASES		3	0	0	3

COURSE OBJECTIVES:

- To provide the knowledge on basics of molecular pathogenesis, concept of infectious diseases and to understand various host defence mechanisms
- To know about the host-pathogen interaction and identify virulence factors
- To control pathogens by modern approaches

PREREQUISITE:

- Microbiology, Cell Biology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C641.1	***Understand*** the principle and causes of infectious diseases	K2
C641.2	***Differentiate*** various host defense mechanisms	K2
C641.3	***Illustrate*** the concept behind molecular pathogenesis	K2
C641.4	***Learn*** the characterization tools to study host pathogen interactions	K2
C641.5	***Explain*** the best approaches to control pathogens.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C641.1	2	2	2	-	-	-	-	-	-	-	-	-	2	-
C641.2	2	2	2	-	-	-	-	-	-	-	-	-	2	-
C641.3	2	2	2	2	-	-	-	-	-	-	-	-	2	-
C641.4	2	2	2	3	3	-	-	-	-	-	-	-	2	-
C641.5	2	2	3	2	2	-	-	-	-	-	-	-	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS		No. of Credits: 03

UNIT I **OVERVIEW OF MOLECULAR PATHOGENESIS** **09**

Historical perspective – the discovery of microscope, Louis Pasteur's contributions, Robert Koch's postulates, early discoveries of microbial toxins, Principles of Infectious diseases- pathogenicity- pathogen types and modes of entry, causes of infectious disease, mechanisms of pathogenesis.

UNIT II **HOST-DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES** **09**

Attributes & components of microbial pathogenesis, Host defence: skin, mucosa, cilia, secretions, physical movements, limitation of free iron, antimicrobial compounds, mechanism of killing by humoral and cellular defence mechanisms, complements, inflammation process, general disease symptoms, Pathogenic adaptations to overcome the above defences.

UNIT III **MOLECULAR PATHOGENESIS** **09**

Virulence, virulence factors, virulence-associated factors and virulence lifestyle factors, molecular genetics and gene regulation in virulence of pathogens, *Vibrio cholerae*- Cholera toxin, co-regulated pili, filamentous phage, survival *E. coli* pathogens - Enterotoxigenic *E. coli* (ETEC), labile & stable toxins, Enteropathogenic *E. coli* (EPEC), type III secretion, cytoskeletal changes, intimate attachment, Influenza virus- Intracellular stages, Neuraminidase & Haem-agglutinin in entry, M1 & M2 proteins in assembly and disassembly, the action of amantadine.

UNIT IV **EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS** **09**

Virulence assays: adherence, invasion, cytopathic, cytotoxic effects. criteria & tests in identifying virulence factors, attenuated mutants, molecular characterization of virulence factors, signal transduction & host responses.

UNIT V **APPROACHES TO CONTROL PATHOGENS** **09**

Classical approaches based on serotyping. Modern diagnosis based on highly conserved virulence factors, immuno & DNA-based techniques. New therapeutic strategies based on recent findings on molecular pathogenesis of a variety of pathogens, Vaccines - DNA, subunit and cocktail vaccines.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Brenda B. Wilson., Malcolm E. Winkler. Brian T. Ho. "Bacterial Pathogenesis", 4th Ed, ASM press, Washington DC, USA, 2019.
2. Iglewski B.H., Clark V.L. "Molecular basis of Bacterial Pathogenesis", Academic Press, USA, 1990

REFERENCES:

1. Peter Williams, Julian Ketley & George Salmond, "Methods in Microbiology: Bacteria Pathogenesis", 1st Ed, Academic Press, USA, 1998.

VEL TECH HIGH TECH

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Course code	**21BT642PT**	**Semester**	**VI**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**BIO-INSPIRED AI**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn bio-inspired theorem and algorithms
- To understand random walk and simulated annealing
- To learn genetic algorithm and differential evolution
- To learn swarm optimization and ant colony for feature selection

PREREQUISITE:

- Mathematics, Algorithm and Data Structure

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this course, students will be able to		
C642.1	***Understand*** bio-inspired algorithms	K2
C642.2	***Explain*** random walk and simulated annealing	K2
C642.3	***Learn*** genetic algorithms and differential evolution	K2
C642.4	***Explain*** swarm intelligence and ant colony for feature selection	K2
C642.5	***Apply*** bio-inspired techniques in various fields	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
C642.1	2	2	2	3	3	-	-	-	-	-	-	-	2	-
C642.2	2	2	2	3	3	-	-	-	-	-	-	-	2	-
C642.3	2	2	2	3	3	-	-	-	-	-	-	-	2	-
C642.4	2	2	2	3	3	-	-	-	-	-	-	-	2	-
C642.5	2	2	2	3	3	-	-	-	-	-	-	-	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	**No. of Credits: 03**

UNIT I INTRODUCTION 09

Introduction to algorithm - Newton ' s method - optimization algorithm - No-Free-Lunch Theorems - Nature-Inspired Mata-heuristics - Analysis of Algorithms -Nature Inspires Algorithms -Parameter tuning and parameter control.

UNIT II RANDOM WALK AND ANNEALING 09

Random variables - Isotropic random walks - Levy distribution and flights - Markov chains - step sizes and search efficiency - Modality and intermittent search strategy - importance of randomization- Eagle strategy-Annealing and Boltzmann Distribution - parameters -SA algorithm - Stochastic Tunneling

UNIT III GENETIC ALGORITHMS AND DIFFERENTIAL EVOLUTION 09

Introduction to genetic algorithms and - role of genetic operators - choice of parameters - GA variants - schema theorem - convergence analysis - introduction to differential evolution - variants -choice of parameters - convergence analysis - implementation

UNIT IV SWARM OPTIMIZATION AND FIREFLY ALGORITHM 09

Swarm intelligence - PSO algorithm - accelerated PSO - implementation - convergence analysis - binary PSO - The Firefly algorithm - algorithm analysis - implementation - variants- Ant colony optimization toward feature selection

UNIT V APPLICATIONS OF BIO INSPIRED COMPUTING 09

Improved Weighted Threshold Histogram Equalization Algorithm for Digital Image Contrast Enhancement Using Bat Algorithm - Ground Glass Opacity Nodules Detection and Segmentation using Snake Model - Mobile Object Tracking Using Cuckoo Search- Bio inspired algorithms in cloud computing- Wireless Sensor Networks using Bio inspired Algorithms.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1 Eiben, A.E. Smith, James E, "Introduction to Evolutionary Computing" Springer

2 Helio J.C. Barbosa, "Ant Colony Optimization-Techniques and Applications",

REFERENCES:

1 Xin-She Yang , Joao Paulo papa, "Bio-Inspired Computing and Applications in Image Processing", Elsevier First Edition, 2016

2 Yang ,Cui, XIao, Gandomi, Karamanoglu,"Swarm Intelligence and Bio-Inspired Computing",Elsevier First Edition 2013

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Course code	**21BT643PT**	**Semester**	**VI**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**PRINCIPLES OF FOOD PROCESSING**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms which spoil food and food borne diseases.
- To know different techniques used for the preservation of foods.

PREREQUISITE:

- Fundamentals of Biochemistry and Microbiology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C643.1	***Describe*** about various constituents present in food and their roles in food processing.	K2
C643.2	***Understand*** the different kinds of food additives and preservation techniques in food processing.	K2
C643.3	***Define*** about the importance of microorganisms involved in processing of food materials	K2
C643.4	***Elaborate*** the various food borne diseases caused by pathogens and toxins.	K2
C643.5	***State*** the principles of unit operations in modern food processing and impact on food quality to control the gene expression in variousorganisms	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C643.1	3	-	-	-	-	2	2	-	-	-	-	2	2	-
C643.2	3	-	-	-	-	2	2	-	-	-	-	2	2	-
C643.3	2	-	-	-	-	1	2	-	-	-	-	2	1	-
C643.4	2	-	-	-	-	2	2	-	-	-	-	2	-	-
C643.5	3	-	-	-	-	2	1	-	-	-	-	2	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS		No. of Credits: 03
UNIT I	**CONSTITUENTS OF FOOD**	**09**

Carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics, principles of Nutrigenetics and Nutrigenomics, immune boosting food.

UNIT II FOOD ADDITIVES 09

Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids, introduction to food safety

UNIT III MICROORGANISMS ASSOCIATED WITH FOOD 09

Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; Pre and Probiotic foods and its importance, fermented foods and food chemicals, single cell protein

UNIT IV FOOD BORNE DISEASES AND FOOD SPOILAGE 09

Classification – food infections – bacterial and other types; food intoxications and poisonings –bacterial and non-bacterial; food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products

UNIT V FOOD PROCESSING AND PRESERVATION 09

Various methods of food preservation, Preservation by high temperature- sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning; Preservation by low temperature- frozen storage, freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; Irradiation method of foods preservation, non-thermal processing of food.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. T.P. Coultate – Food – The Chemistry of Its Components, 2nd Edn. Royal Society, London, 1992.
2. B. Sivasanker – Food Processing and Preservation, Prentice-Hall of India Pvt. Ltd. New Delhi 2002.

REFERENCES:

1. W.C. Frazier And D.C. Westhoff – Food Microbiology, 4th Ed., Mcgraw-Hill Book Co., New York 1988.
2. J.M. Jay – Modern Food Microbiology, Cbs Pub. New Delhi, 1987.

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Course code	21BT644PT	Semester	VI			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	CREATIVITY, INNOVATION AND NEW PRODUCT DEVELOPMENT		3	0	0	3

COURSE OBJECTIVES:

- To learn knowledge about various aspects of Creativity and Innovation.
- To understand about Project selection and screening techniques.
- To analyze the concepts of new product development, patent and IPR.
- To design prototype and understand the marketing research process.
- To acquire knowledge about model preparation and evaluation.

PREREQUISITE:

- Basic Sciences

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C644.1	***Acquire*** knowledge in all aspect of Creativity	K2
C644.2	***Learn*** the regulations pertaining to Innovation	K2
C644.3	***Explain*** the aspects of New Product Development	K2
C644.4	***Understand*** the huddles New Product Planning and Evaluation	K2
C644.5	***Comprehend*** the importance of intellectual property rights	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C644.1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
C644.2	2	-	-	-	-	1	-	2	2	-	2	-	-	-
C644.3	2	-	-	-	-	2	2	2	2	-	2	-	-	-
C644.4	2	2	2	2	-	2	2	3	3	1	2	-	-	-
C644.5	2	3	2	2	-	2	2	3	3	1	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS		No. of Credits: 03
UNIT I	**INTRODUCTION**	**09**

The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - creativity and problem solving - brain storming - different techniques.

UNIT II PROJECT SELECTION AND EVALUATION 09

Definition, Importance and Steps –- Collection of ideas and purpose of the project – Identification – Prioritization – Initiation– Constrained Optimization Methods for Project Selection-Benefit Measurement Methods for Project Selection Review - Selection criteria - screening ideas for new products (evaluation techniques) - Pre-project evaluation-ongoing evaluation – post project evaluation.

UNIT III NEW PRODUCT PLANNING 09

Idea generation (Idea Formulation)- Screening of ideas (Evaluation)- Concept Testing- Business analysis- Test marketing - Commercialization (Market Introduction) Product development Design of prototype - testing - quality standards - marketing research - introducing new products

UNIT IV NEW PRODUCT DEVELOPMENT 09

Research and new product development - Patents - Patent search - Patent laws - International code for patents - Intellectual property rights (IPR) – The use of patents in innovation management - Patenting of Life- Exclusions from patents – Alternatives to patenting.

UNIT V MODEL PREPARATION & EVALUATION 09

Creative design - Model Preparation - The Scorecard-Markov model - The IDEO Process - The Booz, Allen, and Hamilton (BAH) model - The Stage-Gate model -Testing - Cost evaluation - Patent application

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Twiss, Brian. “Managing Technological Innovation”, Pitman Publishing Ltd., 1992.
2. Watton, Harry B. “New Product Planning”, Prentice Hall Inc., 1992.

REFERENCES:

1. Nystrom, Harry “Creativity and Innovation”, John Wiley & Sons, 1979.
2. Khandwalla, N. – “Fourth Eye (Excellence through Creativity) - Wheeler Publishing”, 1992.

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Course code	**21BT645PT**	**Semester**	**VI**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**ANIMAL BIOTECHNOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide the fundamentals of animal cell culture, details of the diseases and therapy
- To offer the knowledge on micromanipulation and transgenic animal technologies

PREREQUISITE:

- Principles and Techniques of Molecular biology and Genetic Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C645.1	***Infer*** about the animal diseases and its diagnosis.	K2
C645.2	***Extend*** therapeutic knowledge to treat animal infections	K2
C645.3	***Understand*** the fundamentals of animal cell culture	K2
C645.4	***Make use of*** the micromanipulation technology to improve animal breeding.	K2
C645.5	***Apply*** the principles of biotechnology for the production of transgenic animals.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C645.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C645.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C645.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C645.4	3	2		-	-	-	-	-	-	-	-	-	-	-
C645.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 03**

UNIT I ANIMAL PHYSIOLOGY AND CELL CULTURE TECHNIQUES 09

Animals Tissues: Epithelial Tissue, connective Tissue, Muscle Tissue, Neural Tissue. Culturing of cells, primary and secondary cell lines, Cell culture-Scaling up of animal cell culture-monolayer culture, suspension culture, organ culture.

UNIT II ANIMAL HEALTH AND THERAPEUTICS 09

Bacterial and viral diseases in animals like rat, Mice, guinea pigs, cattle and horse-Type of diseases, Symptoms, causative agent, colonization and disease transmission. Therapeutic animal vaccines.

UNIT III EXPERIMENTAL ANIMALS USED IN PHARMACOLOGY 09

Common laboratory animals: Description, handling and applications of different species and strains of animals. Preclinical screening of new substances for the pharmacological activity using in vivo, in vitro, and other possible animal alternative models.

UNIT IV MICROMANIPULATION OF EMBRYOS 09

Micromanipulation technology; equipment used in micromanipulation; enrichment of x andy bearing sperms from semen samples of animals; artificial insemination; in vitro fertilization and embryo transfer; Micro-manipulated breeding of farm animal

UNIT V TRANSGENIC ANIMALS 09

Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2013
2. Ramadass P, Meera Rani S. Text Book of Animal Biotechnology. Akshara Printers, 1997.

REFERENCES:

1. Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford UniversityPress.2000

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Course code	**21BT66P**	**Semester**	**VI**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PRINCIPLES OF IMMUNOLOGY LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To give practical training in the functioning of immune system.
- To give laboratory training in different immunological and immunotechnological techniques.

PREREQUISITE:

- Fundamentals of the Biochemistry, Microbiology and Molecular Biology Laboratory

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C606.1	***Identify*** the immune system cells and tissues.	K2
C606.2	***Perform*** on the immunological /clinical tests	K3
C606.3	***Isolate*** lymphocytes and monocytes.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
C606.1	3	1	-	-	-	-	-	-	-	-	-	-	-	-
C606.2	3	1	-	-	-	-	-	-	-	-	-	-	-	-
C606.3	3	1	-	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

List of Experiment	No. of Credits: 2

1. Identification of immune cells in a blood smear
2. Identification of blood group
3. Testing for typhoid antigens by Widal test
4. Immunodiffusion – Single Diffusion
5. Immunodiffusion – Double Diffusion
6. Immunoelectrophoresis – Rocket immunoelectrophoresis
7. Immunoelectrophoresis – Counter Current immunoelectrophoresis
8. Enzyme Linked Immuno Sorbent Assay (ELISA)
9. Isolation of peripheral blood mononuclear cells
10. Isolation of monocytes from blood
11. Immunofluorescence
12. Identification of t cells by T-cell rossetting using sheep RBC.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Roitt I, Male, Brostoff. Immunology, Mosby Publ., 2002.

REFERENCES:

1. Kuby J, Immunology, WH Freeman & Co., 2000.
2. Ashim K. Chakravarthy, Immunology, TataMcGraw-Hill, 1998

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Course code	21EE04P	Semester	VI			
Category	EMPLOYABILITY ENHANCEMENT COURSE (EEC)		L	T	P	C
Course Title	INTERNSHIP		0	0	2	1

COURSE OBJECTIVES:

- Make use of the knowledge gained by the student at various stages of the degree course in industries to acquire the practical knowledge and experience.

PREREQUISITE:

- Fundamentals Courses in Biotechnology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C607.1	***Provides*** real work experience	K4
C607.2	***Opportunity*** to explore students' interest	K4
C607.3	***Students*** will ***be able*** to integrate classroom knowledge and theory with practical application	K4
C607.4	***Develops*** professional skills and competencies	K4
C607.5	***Assists*** in building up the career of students	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C607.1	3	2	1	1	1	1	1	1	1	1	1	1	1	1
C607.2	3	2	1	1	1	1	1	1	1	1	1	1	1	1
C607.3	3	2	1	1	1	1	1	1	1	1	1	1	1	1
C607.4	3	2	1	1	1	1	1	1	1	1	1	1	1	1
C607.5	3	2	1	1	1	1	1	1	1	1	1	1	1	1

Note: 1: Slight, 2: Moderate, 3: Substantial

DOMAINS	No. of Credits: 1

Students are advised to carry out the projects in the following domains, but not limited with

1. Biochemistry
2. Bio-organic Chemistry
3. Cell Biology
4. Microbiology
5. Marine Biology
6. Industrial Biotechnology
7. Plant Science
8. Bioinformatics
9. Natural Products

Duration: 2 Weeks

ONLINE RESOURCES:

1. https://swayam.gov.in/nc_details/NPTEL
2. https://www.sciencedirect.com/
3. https://www.ncbi.nlm.nih.gov/
4. https://www.ncbi.nlm.nih.gov/pmc/
5. https://mtccindia.res.in/
6. https://www.atcc.org/

Course code	21EE02P	Semester	VI			
Category	EMPLOYABILITY ENHANCEMENT COURSE (EEC)		L	T	P	C
Course Title	MINI PROJECT – II		0	0	2	1

COURSE OBJECTIVES:

- To inculcate the project based learning

PREREQUISITE:

- Mini-project I

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C608.1	***Evaluate*** specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.	K5
C608.2	***Perform*** literature search and / or patent search in the area of interest	K3
C608.3	***Conduct*** experiments / design and analysis / solution iterations and document the results/ Perform error analysis	K4
C608.4	***Synthesize*** the results and arrive at scientific conclusions / products / solution	K4
C608.5	***Document*** the results in the form of technical report / presentation	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES:

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C608.1	3	3	2	2	2	1	1	1	3	2	2	2	2	2
C608.2	3	3	2	2	2	1	1	1	3	2	2	2	2	2
C608.3	3	3	2	2	2	1	1	1	3	2	2	2	2	2
C608.4	3	3	2	2	2	1	1	1	3	2	2	2	2	2
C608.5	3	3	2	2	2	1	1	1	3	2	2	2	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

DOMAINS	No. of Credits: 2

Students are advised to carry out the projects in the following domains, but not limited with

1. Biochemistry
2. Bio-organic Chemistry
3. Cell Biology
4. Microbiology
5. Marine Biology
6. Industrial Biotechnology
7. Plant Science
8. System Biology
9. Natural Products10. Bioinformatics

Total: 30 Periods

ONLINE RESOURCES:

1. https://swayam.gov.in/nc_details/NPTEL
2. https://www.sciencedirect.com/
3. https://www.ncbi.nlm.nih.gov/
4. https://www.ncbi.nlm.nih.gov/pmc/
5. https://mtccindia.res.in/
6. https://www.atcc.org/

VII SEMESTER

SEMESTER VII										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21HM812PT	Total Quality Management	HSMC	40	60	100	3	0	0	3
2	21BT72T	Principles of Bioseparation Processes	PCC	40	60	100	3	0	0	3
3	21BT73IT	Computational Biology	PCC	50	50	100	2	0	4	4
4	-	Professional Elective - III	PEC	40	60	100	3	0	0	3
5	-	Professional Elective - IV	PEC	40	60	100	3	0	0	3
PRACTICAL										
6	21BT76P	Principles of Bioseparation Processes Laboratory	PCC	60	40	100	0	0	4	2
7	21EE05P	Project Phase - I	PROJ	60	40	100	0	0	4	2
8	21EE03P	Technical Seminar	EEC	100	-	100	0	0	2	1
TOTAL										**21**

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Course code	21HM812PT	Semester	VII			
Category	HUMANITIES & SOCIAL SCIENCE INCLUDING MANAGEMENT COURSES (HSMC)		L	T	P	C
Course Title	TOTAL QUALITY MANAGEMENT (COMMON FOR MECHANICAL, BIOTECH, CHEMICAL, ECE, IT)		3	0	0	3

COURSE OBJECTIVES:

- To facilitate the understanding of Quality Management principles and process.

PREREQUISITE:

- Basic Engineering Knowledge

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C701.1	***Understand*** quality concepts and philosophies of TQM	K2
C701.2	***Apply*** TQM principles and concepts of continuous improvement	K3
C701.3	***Apply*** and analyze the quality tools, management tools and statistical fundamentals to improve quality	K3
C701.4	***Understand*** the TQM tools as a means to improve quality	K2
C701.5	***Remember*** and understand the quality systems and procedures adopted	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C701.1	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-
C701.2	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-
C701.3	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-
C701.4	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-
C701.5	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II TQM PRINCIPLES 9

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS 9

Introduction- Benefits of ISO Registration- ISO 9000 Series of Standards- Sector-Specific Standards- AS 9100, TS16949 and TL 9000- ISO 9001 Requirements- Implementation- Documentation- Internal Audits- Registration- ISO 14000 Series Standard- Concepts of ISO 14001- Requirements of ISO 14001- Benefits of EMS. Case studies of TQM implementation in manufacturing and service sectors including IT.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Poornima M Charantimath, “Total Quality Management”, Pearson Education, Fourth Edition, 2022.
2. Dale H.Besterfiled, Carol B.Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCES:

1. Joel.E. Ross, “Total Quality Management – Text and Cases”, Routledge, 2017.
2. Kiran.D.R, “Total Quality Management: Key concepts and case studies”, Butterworth – Heinemann Ltd, 2016.
3. Itay Abuhav, “ISO 9001: 2015 - A Complete Guide to Quality Management Systems”, CRC press, 2017.
4. https://archive.nptel.ac.in/courses/110/104/110104080/

Course code	21BT72T		Semester	VII		
Category	PROFESSIONAL CORE COURSE (PCC)	L	T	P	C	
Course Title	PRINCIPLES OF BIOSEPARATION PROCESSES	3	0	0	3	

COURSE OBJECTIVES:

- To comprehend the methods for obtaining pure proteins, enzymes and in general about product development R & D
- To educate the principle involved in membrane separations and enrichment operations.
- To promote the applicability of chromatographic techniques in biological products separation

PREREQUISITE:

- Chemistry of Biomolecules, Bioprocess Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C702.1	***Learn*** the advanced bio-separation methods for product purification	K2
C702.2	***Explore*** the components of downstream equipment and to understand the requirements for successful operations.	K2
C702.3	***Enhance*** the problem-solving techniques required in a multi-factorialmanufacturing environment.	K3
C702.4	***Apply*** various cell disruption techniques for intracellular and extracellular products.	K3
C702.5	***Identify*** the different separating techniques and adopt it in large scale operations.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO 2	PSO3	PSO4
C702.1	1	-	-	-	1	-	-	-	-	1	-	-	-	3	-	-
C702.2	2	2	1	-	-	-	1	-	-	1	-	-	-	2	-	-
C702.3	-	3	3	3	2	2	2	-	3	-	2	-	-	1	-	2
C702.4	-	3	2	3	1	-	-	-	3	2	-	-	-	1	-	-
C702.5	-	-	2	2	1	-	-	-	2	2	3	2	2	2	-	2

Note:1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION TO BIOSEPARATION PROCESS 9

Role and importance of Bioseparation process in biotechnological processes– Problems and requirements of bioproduct purification – Economics of downstream processing in Biotechnology, cost-cutting strategies – Separation characteristics of proteins and enzymes – size, stability, properties – Process of Classification of Bioproducts – Upstream production methods affect downstream purification strategies- Cell disruption methods for intracellular products – Physical, chemical, mechanical – Removal of insoluble, biomass and particulate debris separation techniques-RIPP scheme.

UNIT II BASICS OF BIO-SEPARATION PROCESSES 9

Filtration - Filtration at constant pressure and at constant rate – Empirical equations for batch and continuous filtration – Types of filtrations - Centrifugal and cross – flow filtration – Types of filtration equipment's – Centrifugation – Basic principles, design characteristics – Types of centrifuges and applications – Sedimentation- Ultrafiltration-Clarifier and classifier, Flocculation and conditioning of broth, Miscellaneous bioseparation processes – Electrophoresis, Field-flow fractionation.

UNIT III ENRICHMENT OPERATIONS FOR BIO-SEPARATION PROCESSES 9

Theory, Design consideration and configuration of membrane separation processes – Reverse osmosis, microfiltration, nanofiltration, ultrafiltration, dialysis and pervaporation – Structure and characteristics of membranes – Membrane modules – Enrichment Operations – Extraction– equipment for extraction – Aqueous two-phase extraction process – Evaporators – Types of evaporators– Electro dialysis – Adsorption isotherms and techniques – Protein precipitation – Methods of precipitation–Applications of the different types of membrane separation processes.

UNIT IV BIO-SEPARATION PROCESSES USING CHROMATOGRAPHY 9

Chromatography – Classification of chromatographic techniques – General description and principles of column chromatography – Chromatographic terms and parameters – Practice of chromatography – Partition, normal-phase, displacement, reversed-phase, size exclusion, ion exchange, Binary chromatography, hydrophobic, affinity chromatography- hybrid separation technologies-membrane chromatography – Scale-up of chromatography – Process considerations in Preparative liquid chromatography and HPLC, Hydrodynamic chromatography.

UNIT V COMPLETING OPERATIONS AND FORMULATIONS 9

Drying – Mechanism, methods and applications, Types of dryers – Tray, spray, rotary, belt, disc – Crystallization – Nucleation, growth – Types of crystallizers – Tank, scraped surface, Oslo, - Process crystallizers of proteins- Circulating-magma evaporator – Freeze drying – tunnel dryer, Spray dryer- Principle, process, applications – Case studies-Citric acid, Penicillin, Cephalosporin, Recombinant Streptokinase, Interferon.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Belter, P.A., Gussler, E.L. and Hu, W.S., "Bioseparation: Downstream Processing for Biotechnology", John Wiley and Sons, 2011.
2. Roger, H., "Bioseparations Science and Engineering", Oxford University Press, 2015.ISBN: 9780190213749.

REFERENCES:

1. Forciniti, D., “Industrial Bioseparation: Principles & Practice”, Blackwell, 2008.
2. Ladisch, M.R., “Bioseparations Engineering: Principles, Practice, and Economics”, John Wiley& Sons, 2014, ISBN 978-8126549078

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Course code	21BT73IT	Semester	VII			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	COMPUTATIONAL BIOLOGY		2	0	4	4

COURSE OBJECTIVES:

- To provide knowledge on biological databases and applications of Bioinformatics.
- To enhance students about recent advancement in drug delivery systems.
- To use biological databases to understand and solve complex research problems.

PREREQUISITE:

- Chemistry of Biomolecules, Protein Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C703.1	***Outline*** the bioinformatics tools with programming skills	K2
C703.2	***Compare*** the evolutionary relationship between the organisms	K2
C703.3	***Identify and utilize*** the macromolecules’ structure prediction methods	K3
C703.4	***Summarize*** various bioinformatics methods that are used in sequence to structure and function analysis.	K3
C703.5	***Apply*** computational based solutions for biological perspectives	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C703.1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C703.2	-	2	-	-	1	-	-	1	-	3	1	-	-	-	-	-
C703.3	2	1	-	1	2	1	-	-	-	1	-	-	-	-	-	-
C703.4	2	2	-	2	3	1	2	2	2	3	1	-	-	-	-	1
C703.5	3	-	2	3	3	3	3	3	2	1	2	-	3	-	-	2

Note:1:Slight,2: Moderate,3:Substantial

SYLLABUS	No. of Credits: 4

UNIT I BIOLOGICAL DATABASES 6

Introduction to Bioinformatics and Computational Biology-Biological sequences, Classification of biological databases - Sequence Databases, Structure Databases, Genome specific databases, Special, Data file formats, Basics of Structured Query Language.

UNIT II SEQUENCE ANALYSIS AND SCORING MATRICES 6

Sequence Alignment- Homology vs Similarity, Similarity vs Identity. Types of Sequence alignment - Pairwise and Multiple sequence alignment and Applications, Global alignment, Local alignment-PILEUP- Dot plot, Alignment algorithms and types- Substitution matrices- Dayhoff mutation matrix- Dot matrix sequence comparison.

UNIT III MOLECULAR PHYLOGENY 6

Phylogenetics Basics, Molecular clock theory, Ultra metric trees, Clustering: Hierarchical Clustering, k-Means Clustering- Distance matrix methods-UPGMA, NJ, Character based methods-Maximum Parsimony. Hidden Markov Model, Methods of evaluating phylogenetic methods-Bootstrapping, jack-knifing.

UNIT IV MACROMOLECULAR STRUCTURE ANALYSIS 6

Gene prediction, Conserved domain analysis, Protein structure visualization, Prediction of protein secondary structure, Tertiary structure prediction- Homology modelling, Threading, Ab-initio Prediction, AI based tool for macromolecular analysis, Validation of the predicted structure using Ramachandran plot-case study.

UNIT V APPLICATIONS 6

Introduction to Systems Biology and Synthetic Biology. Microarray data analysis, DNA computing, Drug designing, objectives, types, Basics of molecular docking- modern tools usage, Applications of Bioinformatics in genomics and proteomics- Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting, Miscellaneous applications.

S. No	List of Experiments
1.	1.a Unix/Linux – basic operations and working with terminal 1.b Basics of SQL Queries
2.	Accession and retrieval of data from various biological databases
3.	Pairwise alignment using Needleman-Wunch Algorithm& Smith watermanAlgorithm
4.	Database Sequence Analysis Tools- BLAST, FASTA and Clustal W
5.	Multiple sequence alignment
6.	Gene prediction –ORF finder
7.	Protein Secondary structure prediction
8.	Homology modelling
9.	Molecular Visualization and 3D structural studies using Rasmol - Commands,Domain identification
10.	Molecular Visualization and 3D structural studies using Chimera
11.	Phylogenetic Analysis -Use of PHYLIP
12.	Small molecule building, using ISIS Draw and CHEM SKETCH –Tutorial.

No of Periods: 60

LEARNING RESOURCES:

TEXT BOOKS:

1. Arthur Lesk, Introduction to Bioinformatics, 2014, 4thEdition, Oxford University Press, UK.
2. Jamil Momand, Concepts in Bioinformatics and Genomics, 2016, 1st Edition, Oxford University Press, UK.

TEXT BOOKS:

1. Higgs, Paul G.., Attwood, Teresa K. Bioinformatics and Molecular Evolution. Germany: Wiley,2013.
2. Harisha, S. Fundamentals of Bioinformatics. India: I.K. International Publishing House Pvt. Limited, 2013.

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE
PROFESSIONAL ELECTIVE - III		
1	21BT741PT	Bioprocess Instrumentation Dynamics and control
2	21BT742PT	Cancer Biology
3	21BT743PT	Stem Cell Technology
4	21BT744PT	Medical Biotechnology
5	21BT745PT	Bio-business Startup Policy and Human Rights

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Course code	21BT741PT	Semester	VII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	BIOPROCESS INSTRUMENTATION DYNAMICS AND CONTROL		3	0	0	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding of process instrumentation, dynamics and control
- To learn about various models of open and closed loop systems for bioprocess instrumentation, dynamics and control

PREREQUISITE:

- Bioprocess Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C741.1	***Understand*** the principles, types and applications of process instruments in various industries.	K2
C741.2	***Develop*** transient models for processes using material or energy balance equations with Laplace Transforms.	K3
C741.3	***Outline*** the controller principles and closed-loop control systems for transient response, offset and stability.	K2
C741.4	***Understand*** frequency response of control systems and tune the PID controllers.	K2
C741.5	***Identify*** the performance of various advanced control strategies.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C741.1	3	3	1	-	-	-	-	-	-	-	-	-	-	3	-	-
C741.2	3	3	1	1	-	-	-	-	-	-	-	-	-	3	-	-
C741.3	3	3	2	2	-	-	-	-	-	-	-	-	-	3	-	-
C741.4	3	3	2	2	-	-	-	-	-	-	-	-	-	3	-	-
C741.5	3	3	2		2	-	-	-	-	-	-	-	-	3	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I PROCESS INSTRUMENTATION **9**

Principles of measurements - classification of process control instruments - measurements of temperature, pressure, fluid flow, liquid level, liquid weight and mass flow rate, viscosity and consistency, pH, concentration, electrical and thermal conductivity, humidity of gases - composition by physical and chemical properties.

UNIT II OPEN LOOP SYSTEMS **9**

Laplace transformation and its application in process control - Open-loop systems, first order systems and their transient response for standard input functions - first order systems in series, linearization and its application in process control - second order systems and their dynamics,transportation lag.

UNIT III CLOSED LOOP SYSTEMS **9**

Closed loop control systems - development of block diagram for feed-back control systems - servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE **9**

Introduction to frequency response of closed-loop systems - P,PI,PID, controller mechanism - control system design by frequency response techniques - Bode diagram, stability criterion, tuning of controllers: Z-N tuning rules, C-C tuning rules.

UNIT V ADVANCED CONTROL SYSTEMS **9**

Feedback control of systems with dead time and inverse response -Control systems with multiple loops - analog and digital, Advanced Control Schemes, Feed forward, ratio control -control of distillation towers and heat exchangers- Super computers.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. GeorgeStephanopolous, “Chemical Process Control”, Prentice - Hall of India Pvt. Ltd., New Delhi,1990.
2. Coughanowr and LeBlanc, “Process Systems Analysis and Control”, 3rd Edition, McGraw-Hill, NewYork, 2017.

REFERENCES:

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, “Process dynamics and control I”, 2ndEdition, John Wiley & Sons, Inc.
2. Marlin, T. E., “Process Control”, 2nd Edition, McGraw Hill, New York, 2000.
3. Smith, C. A. and Corripio, A. B., “Principles and Practice of Automatic Process Control”, 2ndEdition, John Wiley, New York, 1997.

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Course code	**21BT742PT**	**Semester**	**VII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**CANCER BIOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To develop comprehensive knowledge on the basic principles of cancer biology.
- To learn about the relevance of different therapeutic, diagnostic approaches and emerging technologies in cancer research and treatment.

PREREQUISITE:

- Chemistry of Biomolecules, Cell Biology

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C742.1	***Understand*** *the* basics of cell cycle, screening and detection of cancer.	K2
C742.2	***Explain*** different types of carcinogenesis and its mechanisms	K3
C742.3	***Acquire*** knowledge about oncogene identification and detection	K2
C742.4	***Understand*** the principles of cancer metastasis	K2
C742.5	***Discuss*** the different therapeutic procedures in cancer	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C742.1	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C742.2	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C742.3	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C742.4	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C742.5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I FUNDAMENTALS OF CANCER BIOLOGY 9

Regulation of cell cycle - mutations that cause changes in signal molecules - effects on receptor - signal switches - tumour suppressor genes - modulation of cell cycle in cancer - different forms of cancers - diet and cancer - Cancer screening and early detection - Detection using biochemical assays - tumor markers – Immunodiagonisis.

UNIT II PRINCIPLES OF CARCINOGENESIS 9

Theory of carcinogenesis: types - Chemical carcinogenesis - metabolism of carcinogenesis - principles of physical carcinogenesis - x-ray radiation-mechanisms of radiation carcinogenesis, viral carcinogenesis.

UNIT III PRINCIPLES OF MOLECULAR CELL BIOLOGY IN CANCER 9

Signal targets and cancer - activation of kinases – Oncogenes - identification of oncogenes - retroviruses and oncogenes - detection of oncogenes - Oncogenes/proto-oncogene activity - Growth factors related to transformation – Tumorigenesis.

UNIT IV CANCER METASTASIS 9

Clinical significances of invasion - heterogeneity of metastatic phenotype - metastatic cascade -basement membrane disruption - three step theory of invasion - proteinases and tumour cell invasion- multistage invasion.

UNIT V NEW MOLECULES FOR CANCER THERAPY 9

Different forms of therapy – chemotherapy - radiation therapy – hormone therapy, prediction of aggressiveness of cancer - advances in cancer detection - Use of signal targets towards therapy of cancer–tumor immunology.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Weinberg, R.A. “The Biology of Cancer” Garland Science, 2007.
2. Pecorino, “Molecular Biology of Cancer”, 3rd Edition, Oxford University Press, 2014.

REFERENCES:

1. Dr. Pradeep Kumar. “The Textbook of Cancer Biology”, Prachi Digital Publication, 2022.
2. Ruddon, Raymond W. “Cancer Biology”, IV Edition. Oxford University Press, 2007.

Course code	21BT743PT	Semester	VII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	STEM CELL TECHNOLOGY		3	0	0	3

COURSE OBJECTIVES:

- To impart the basic knowledge of stem cell, culturing and its clinical applications.
- To demonstrate the role of stem cell in regenerative medicine.

PREREQUISITE:

- Cell Biology, Principles and Techniques of Molecular Biology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C743.1	***Differentiate*** different types of stem cells and to characterize them.	K2
C743.2	***Gain*** knowledge on animal and plant stem cells.	K2
C743.3	***Develop*** techniques to program stem cells into specific cell types.	K2
C743.4	***Determine*** the factors affecting stem cell differentiation.	K2
C743.5	***Understand*** the role of stem cells in tissue engineering and regenerative medicine.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C743.1	2	1	1	2	-	-	-	1	-	-	-	-	-	-	2	2
C743.2	1	-	2	3	-	-	-	2	-	-	-	-	-	-	2	2
C743.3	1	-	1	-	-	-	-	3	-	-	-	-	-	-	2	2
C743.4	-	-	3	2	-	-	-	3	-	-	-	-	-	-	2	2
C743.5	1	1	2	-	-	-	-	2	-	-	-	-	-	-	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION TO STEM CELLS **9**

Stem cells: Definition, Classification, Sources and Properties –Types of stem cells: methods of Isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. Preservations of Stem cell.

UNIT II STEM CELLS IN PLANTS AND ANIMALS **9**

Stem cell and founder zones in plants –particularly their roots – stem cells of shoot meristems of higher plants. Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells keratinocyte stem cells of cornea – skin and hair follicles –tumor stem cells.

UNIT III STEM CELLS DIFFERENTIATION **9**

Factors influencing proliferation, physical, chemical and molecular methods for differentiation of stem cells – hormonal role in differentiation, Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties, Embryonic stem cell: Isolation, Culturing, Differentiation, Properties.

UNIT IV REGENERATION AND EXPERIMENTAL METHODS **9**

Germ cells, hematopoietic organs, and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, - Stem cell Techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging.

UNIT V APPLICATION AND ETHICAL ISSUES **9**

Stem cell Therapy for neurodegenerative diseases, spinal cord injury, heart disease, diabetes, Burns, skin ulcers, muscular dystrophy and orthopedic applications, Neural stem cell for central nervous system repair, Stem cell policy and ethics, stem cell regulations, debate, social and ethical concerns associated with it. Stem cell research: Hype, hope and controversy.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Robert Lanza., ‘Essentials of Stem Cell Biology’ fourth edition. Elsevier 2014.
2. Alexander Birbrair, ‘Recent advances in ipsc technology’ kindle 1st edition, 2021.

REFERENCES:

1. Giridharan R. Jayandharan., Gene and cell therapy: Biology and Applications, 2018.
2. Ariff Bongso, EngHinLee., ‘Stem Cells: From Bench to Bedside World’, Scientific Publishing company, 2014.
3. Ali Gholamrezanezhad ‘Stem cells in clinic and Research’, Intech, 2013.

Course code	**21BT744PT**	**Semester**	**VII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**MEDICAL BIOTECHNOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To impart knowledge on the advances in the medical biotechnology field.
- To familiarize various diagnostic techniques for the effective treatment

PREREQUISITE:

- Chemistry of Biomolecules, Applied Microbiology

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C744.1	***Learn*** the basics and characteristics of various diseases	K2
C744.2	***Illustrate*** the diagnostic methods and techniques used to identify the diseases	K3
C744.3	***Outline*** the medical nature of various viruses and other microorganisms	K2
C744.4	***Discuss*** various preventive measures, including vaccination and antibiotics	K2
C744.5	***Apply*** the concepts of modern medicines to various treatments	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C744.1	-	-	1	-	-	2	-	2	-	-	-	2	1	-	1	-
C744.2	1	1	2	-	2	1	1	-	1	1	-	-	-	-	-	1
C744.3	1	-	1	-	2	1	-	-	1	-	-	-	-	-	-	-
C744.4	2	2	1	1	-	-	-	-	2	2	1	-	1	-	-	2
C744.5	2	2	2	3	2	1	2	2	2	-	1	2	3	-	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I AN INTRODUCTION TO HUMAN DISEASES **6**

Introduction: Human Health and Disease, Characteristics - Classification of Disease: Congenital, Hereditary, Inflammatory, Degenerative, Metabolic, Neoplastic disease, Alzheimer disease, Cardiovascular disease.

UNIT II MEDICAL VIROLOGY **9**

Adenoviruses, Pox viruses, Arboviruses, Retroviruses, Human Papillomavirus, Influenza Virus, Dengue Virus- Medical Mycology: Fungi, Mold, Yeast,Pathogenic fungi - Superficial Mycoses, Subcutaneous Mycoses, Systemic Mycoses.

UNIT III DIAGNOSTIC TECHNIQUES **10**

Prenatal diagnosis: Invasive techniques and Non-invasive techniques - Detection of Epigenetic– Micro-array technology – genomics and cDNA arrays - Detection and Therapy: Tuberculosis, Yellow Fever, Japanese encephalitis, Dengue fever, Acquired Immune Deficiency Syndrome (AIDS), Cholera, Malaria, and Cancer.

UNIT IV PREVENTION AND TREATMENT **10**

Introduction: Vaccination, Types - mode of action: Subunit Vaccine, Peptide vaccine, Dendritic cell vaccine, DNA Vaccine, Attenuated vaccine, vector vaccine - Antibiotics mode of action: antibacterial, anti-fungal, antiviral, antitumor antibiotics - synthetic chemotherapeutic agent - Significance and development of microbial resistance to antibiotics.

UNIT V MODERN MEDICINE **10**

Introduction: Modern medicine - Production of Monoclonal Antibodies, Target drug delivery - Human Gene Therapy - In situ-Cell and tissue engineering- Stem cell therapy- Nanomedicines- Gene products in medicine: Humulin, Erythropoietin, Growth Hormone/Somatostatin, Interferon - application of Modern Medicine

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. B. R. and Pasternak, “Molecular Biotechnology: Principle and applications of recombinant DNA” ASM Press, 2010.
2. Bernard R Glick and Jack J.Pasternak, “Molecular Biotechnology Principle and application of Recombinant DNA” ASM Press, 2022.

REFERENCES:

1. Bernard R. Glick, Terry L. Delovitch, Cheryl L. Patten, “Medical Biotechnology” ASM Press, 2013
2. Verma, P. S. “Chordate Zoology” India, S. Chand Limited, 2010.

Course code	**21BT745PT**	**Semester**	**VII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**BIO-BUSINESS STARTUP POLICY AND HUMAN RIGHTS**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide students with the knowledge and abilities to recognise and evaluate the chances for entrepreneurship and innovation.
- To comprehend the sources of innovative opportunities to raise awareness of diverse human rights acceptances.

PREREQUISITE:

- Constitution of India

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C745.1	***Understand*** the fundamentals of Bio-business	K2
C745.2	***Discuss*** about the vital role of partnership.	K2
C745.3	***Apply*** the MSME policies in entrepreneurship development	K3
C745.4	***Understand*** the consumer Protection act	K2
C745.5	***Relate*** the purpose of Human Rights in various aspects	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C745.1	2	1	-	-	-	-	2	-	-	-	2	2	2	-	-	-
C745.2	2	1	-	-	-	2	2	-	3	-	2	2	2	-	-	-
C745.3	2	1	-	-	-	2	2	-	3	-	2	2	-	-	-	-
C745.4	2	1	-	-	-	-	2	2	-	-	-	2	-	-	-	-
C745.5	2	1	-	-	-	-	2	2	-	-	-	2	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION TO BIO BUSINESS 9

Introduction to Bio Business - Fundamentals of Biotech for bio-Business- Contemporary Vs antique Bio business- Wealth Creation in Bio business- Promotion and Procedure for incorporation of a company - Classification of Companies - Conversion of Private Company into Public and Public Company to Private – Share Capital and Classification of Shares.

UNIT II OUTLINES OF PATERNSHIP ACT 9

Partnership: Definition – Essential Features of Partnership - Partner: Classification - Dissolutionof Partnership and Dissolution of Partnership Firm Rights- Duties and Liabilities of Partners -Limited Liability Partnership – Features-Indian Partnership Act- 1932.

UNIT III MICRO, SMALL AND MEDIUM ENTERPRISES DEVELOPMENT ACT AND VENTURE CAPTIAL 9

History - Classification of Enterprises - Registration of Enterprises - Benefits of Registering MSME – Constitution of National Board of Micro- Small and Medium Enterprises – Powers and Functions of the Board-Micro- Small and Medium Enterprises Development Act, 2006- Registration of Venture Capital Funds - Eligibility Criteria - Conditions and Restrictions on Investment.

UNIT IV OUTLINES OF THE CONSUMER PROTECTION ACT 9

Aims and Objectives of the Act - Consumer - Definition - Consumer Disputes- Product Defects and Liability-Misrepresentation and Fraud-Contractual Disputes-Consumer Education and Awareness- Consumer Disputes Redressal Agencies and Jurisdiction - Rights of Consumers protection Act 2019.

UNIT V OUTLINE OF HUMAN RIGHTS 9

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People- Implementation of Human Rights –National and State Human Rights Commission – Judiciary – Role of NGO's- Media- Educational Institutions- Social Movements

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Dr. S. Sankaran., "Business Regulatory Frame Work" Margham Publications, Chennai,2015.
2. Dr Kapoor S.K., "Human Rights under International law and Indian Laws", Central Law Agency, Allahabad, 2017

REFERENCES:

1. Chandra U., "Human Rights", Allahabad Law Agency, Allahabad, 2014.
2. Bulch and Ani, Dr. K. R, "Business Environment and Law" Himalaya Publishing House, Mumbai, 2013
3. The Micro, small and Medium Enterprises Development Act, 2006.

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE
PROFESSIONAL ELECTIVE - IV		
1	21BT751PT	Clinical Nutrition
2	21BT752PT	Marine Bioprospecting and Pharmacology
3	21BT753PT	Tissue Engineering
4	21BT754PT	Bioproduct Planning and Strategy
5	21BT755PT	Forensic Biotechnology

Course code	21BT751PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	CLINICAL NUTRITION		3	0	0	3

COURSE OBJECTIVES:

- To understand about food groups, nutrients, nutrition & health, metabolism & acid base balance of body, energy.
- To equip students with ability to manage a healthy society and country.

PREREQUISITE:

- Chemistry of Biomolecules, Bio Organic Chemistry

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C751.1	***Understand*** the physiological and metabolic role of macronutrients, micronutrients and other food components in human nutrition	K2
C751.2	***Describe*** the physiological and metabolic role of macronutrient, micronutrient and other food components in human nutrition.	K2
C751.3	***Understand*** the basis of nutrient requirements and recommendations.	K2
C751.4	***Explore*** the sources, functions, deficiencies, and toxicity of various nutrients.	K2
C751.5	***Analyze*** macronutrient and micronutrients in food.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C751.1	2	–	–	–	–	2	–	2	–	–	–	1	–	–	–	–
C751.2	2	–	–	–	–	2	–	2	–	–	–	1	–	–	–	–
C751.3	2	–	–	–	–	2	–	2	–	–	–	1	–	–	–	–
C751.4	2	–	–	–	–	2	–	2	–	–	–	1	–	–	–	–
C751.5	2	–	–	–	–	2	–	2	–	–	–	1	–	–	–	–

Note:1:Light,2: Moderate,3:Substantial

SYLLABUS **No. of Credits:3**

UNIT I UNDERSTANDING NUTRITION 9

Basic concept: history, body composition– methods of measuring body composition– Anthropometric measurements- Bioelectrical impedance analysis (BIA)- Dual-energy X-ray absorptiometry (DXA)- Hydrostatic weighing- Air displacement plethysmography (Bod Pod)- Nutrition requirements– National and international nutrition recommendation.

UNIT II ENERGY METABOLISM 9

Principles and definition– components and calculation of energy requirements– Methods of determining energy requirements– measurement of physical activity level (PAL)– basal metabolic rate (BMR) and total energy expenditure (TEE)– Energy cost of activities. Recommendations for physical activity for different age groups– Impact of altered energy metabolism.

UNIT III MACRONUTRIENTS 9

Carbohydrates- - -Classification – Role of dietary fiber -Digestion, absorption and metabolism– functions– Sources, RDA and nutrient requirement- **Proteins-** metabolism of proteins, functions– Sources, RDA and nutrient requirement, protein turn over and synthesis– methods of assessing protein quality and requirements– Protein deficiency and inborn errors – **Lipids-** Classification–Metabolism: Digestion, absorption and metabolism of fatty acids function– Sources, RDA and nutrient requirement– Essential fatty acids and eicosanoids, regulation of lipids– Disorders of lipid metabolism– Dyslipidemias– Lipid storage diseases.

UNIT IV REGULATORY NUTRIENTS 9

Vitamins and minerals: Classification– Metabolism: Digestion, absorption and transport mechanism of action– Functions, sources, bioavailability, RDA and nutrient requirement–Deficiency–Toxicity– Phytonutrients– phytochemicals and plant sterols– functional food and anti-nutritional factors.

UNIT V BODY FLUID AND ELECTROLYTE BALANCE. 9

Water distribution in body- Intracellular and extracellular fluid compartments- Distribution of water in various tissues and organs- Factors influencing water distribution, including osmotic pressure and hydrostatic pressure gradients- maintenance of fluid and electrolyte balance, role of kidney, acid base balance

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Gibney MJ, Elia M, Ljungqvist & Dowsett J. 2005. Clinical Nutrition. The Nutrition Society Textbook Series. Blackwell Publishing Company.
2. Gropper, S. A. S., Smith, J. L., & Groff, J. L. 2009. Advanced nutrition and human metabolism. 5thedition. Australia; Belmont, CA: Wadsworth Cengage Learning.

REFERENCES:

1. Nix S. 2016. Williams' Basic Nutrition & Diet Therapy. 15thED. Mosby-Elsevier.
2. Shils, M.E., Shike, M, Ross, A.C., Caballero B and Cousins RJ. 2005. Modern Nutrition in Health and Disease. 10thEd. Lipincott, William and Wilkins.

Course code	21BT752PT	Semester	VII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	MARINE BIOPROSPECTING AND PHARMACOLOGY		3	0	0	3

COURSE OBJECTIVES:

- To understand the principles and techniques of marine bioprospecting
- To gain insights into the pharmacological properties of marine-derived compounds and potential therapeutic applications.

PREREQUISITE:

- Applied Microbiology, Chemistry of Biomolecules, Cell Biology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C752.1	***Understand*** the physical and chemical properties of seawater and the importance of different biogeochemical cycles.	K2
C752.2	***Identify*** and differentiate the types of marine organisms, their classifications, and their ecological importance.	K2
C752.3	***Identify*** the bioactive compounds from marine resources	K2
C752.4	***Gain*** knowledge in marine pharmacology	K2
C752.5	***Learn*** about important marine sources for valuable products.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C752.1	2	1	–	–	–	1	3	1	–	–	–	–	1	–	–	–
C752.2	2	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
C752.3	2	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
C752.4	3	2	2	–	2	–	–	–	–	–	–	–	1	–	–	–
C752.5	1	–	–	–	–	1	–	1	1	1	–	2	1	–	–	–

Note:1:Light,2: Moderate,3:Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION TO MARINE ENVIRONMENT 9

World oceans and seas – ocean currents – Physical and Chemical properties of sea water –abiotic and Biotic factors of the sea – Ecological divisions of the sea – History of Marine biology – Bio-geochemical cycles – Food Chain and Food web.

UNIT II IMPORTANT MARINE ORGANISMS 9

Phytoplankton – Diatoms and Dinoflagellates - Zooplankton – Nektons – Benthos – Foraminiferans - Radiolarians - Marine Mammals – Marine algae – Seaweeds – Sea grass - Mangroves and Salt marshes – Coral reefs – Deep Sea animals and Adaptation – Intertidal zone – Fauna and Flora.

UNIT III BIOACTIVE COMPOUNDS AND BIOMATERIALS FROM MARINE ENVIRONMENT 9

Diversity of Marine derived compounds – Alkaloid, Terpenoids and Steroids, Nucleoside, amino acids, Peptides, Dipeptides, Polypeptide, Macrolide– Marine Toxins –Marine biominerals– Biomineralized structures– Bio composites– Biopolymers –Polysaccharides, Chitin, Marine Collagens.

UNIT IV MARINE PHARMACOLOGY 9

Principles & Mechanisms of drug action–Pharmacokinetics & pharmacodynamics–Marine derived pharmaceuticals: Marine bio-resources, Secondary metabolites, Marine proteins and lipids & molecular Biology approaches–Marine biotoxins and Potential Pharmacological uses of Phyco-toxins.

UNIT V IMPORTANT MARINE PRODUCTS 9

Agar agar – Algin – Carageenan – Single Cell Protein - Green fluorescent protein (GFP) & Red fluorescent protein (RFP) characteristics and their applications – Green mussel adhesive protein – Chitosan and its applications –Fish Protein Hydrolysate – Omega 3 Fatty acids – Rare Sugars - Ornamental fishes

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Se-kwon Kim, (2015) Handbook of Marine Biotechnology, Springer.
2. Pelczar M.J. Jr., Chan E.C.S. and Kreig N.R., (2001) Microbiology, (5th Edition), Tata McGraw Hill.

REFERENCES:

1. Felix, S., (2010) Handbook of Marine and Aquaculture Biotechnology, Agrobios India.
2. Lakra, W.S. (2008) Fisheries Biotechnology, Narendra Publishing House.

Course code	21BT753PT	Semester	VII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	TISSUE ENGINEERING		3	0	0	3

COURSE OBJECTIVES:

- To learn the fundamentals of tissue engineering and tissue repairing.
- To acquire knowledge on clinical applications of tissue engineering.
- To understand the basic concept behind tissue engineering focusing on the stem cells, Biomaterials and its applications.

PREREQUISITE:

- Cell Biology, Principles of Immunology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C753.1	***Understand*** the components of the tissue architecture	K2
C753.2	***Acquire*** knowledge on stem cell characteristics and its applications.	K2
C753.3	***Discuss*** the properties and broad applications of biomaterials	K2
C753.4	***Learn*** the basic biology of stem cells	K2
C753.5	***Analyze*** the role of tissue engineering and stem cell therapy	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C753.1	1	-	-	2	1	-	-	-	2	-	-	1	2	-	2	2
C753.2	2	1	-	2	-	-	-	3	-	-	-	-	2	-	3	3
C753.3	1	2	-	2	-	2	-	3	-	-	-	2	3	-	2	3
C753.4	2	1	1	3	1	2	-	2	-	-	-	1	2	-	3	3
C753.5	1	-	1	2	1	2	-	2	1	-	-	1	2	-	3	3

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION 9

Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular component, ECM component, mechanical measurements and physical properties.

UNIT II TISSUE ARCHITECTURE 9

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, morphogenesis and organ development in human, Basic properties, Cell-Matrix& Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

UNIT III BIOMATERIALS 9

Biomaterials: Properties of biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, fabrication technology of scaffolds, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology

UNIT IV BASIC BIOLOGY OF STEM CELLS 9

Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchyme stem cells, Stem Cell markers,FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, hematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pluripotent stem cells.

UNIT V CLINICAL APPLICATIONS 9

Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, Stem cells and Gene therapy Physiological models, tissue engineered therapies, product characterization, components, safety, efficacy. Preservation –freezing and drying. Patent protection and regulation of tissue-engineered products; Microtomy, histochemical staining ethical issues.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Palsson, B., ”Tissue Engineering” Pearson Publishers, 2016.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H. P. Fundamentals of Tissue Engineering and Regenerative Medicine, 2016.

REFERENCES:

1. Bernard Kennedy (editor). Stem cell transplantation, Tissue engineering, and cancerapplications, Nova Science Publishers, 2018.
2. Raphael Gorodetsky, Richard Schäfer. Stem cell-based tissue repair. RSC Publishing, 2011
3. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, 2019

Course code	21BT754PT	Semester	VII			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**BIOPRODUCT PLANNING AND STRATEGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To impart the knowledge of various aspects of bioproducts and their development and innovation
- To familiarize the students with market analysis and opportunity identification

PREREQUISITE:

- Basic Industrial Biotechnology, Bioethics and Intellectual Property Rights

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C754.1	***Understand*** the basics of bioproducts	K2
C754.2	***Discuss*** the steps involved in the project selection and evaluation	K2
C754.3	***Learn*** the basics in new product development	K2
C754.4	***Interpret*** the techniques used in new product development	K3
C754.5	***Develop*** business models for the new product development	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C754.1	2	-	-	-	-	-	1	1	-	-	-	-	1	-	-	2
C754.2	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2
C754.3	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-	2
C754.4	3	2	2	-	2	-	-	-	-	-	-	-	1	-	-	2
C754.5	3	-	-	-	-	1	-	1	1	1	-	2	1	-	-	2

Note: 1:Slight, 2: Moderate,3:Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION TO BIOPRODUCTS 9

Bioproducts: Classification; Organic acids, amino acids and alcohols; Antibiotics, Vitamins and Steroids; Industrial Enzymes, Biopesticides, Biofertilizers, Bio preservatives, Biopolymers, Biofuels (Biobutanol, Bioethanol)

UNIT II PROJECT SELECTION AND EVALUATION 9

Introduction to project selection, Importance and Steps: Collection of ideas and purpose of the project, Identification, Prioritization, Initiation– Constrained Optimization Methods for Project Selection; Benefit Measurement; Methods for Project Selection Review, Selection criteria, screening ideas for new products (evaluation techniques)**;** Pre-project evaluation, ongoing evaluation; post project evaluation.

UNIT III NEW PRODUCT PLANNING 9

Idea generation (Idea Formulation); Screening of ideas (Evaluation); Concept Testing, Business analysis; Test marketing, Commercialization (Market Introduction); Product development; Design of prototype, testing, quality standards, marketing research, introducing new products

UNIT IV NEW PRODUCT DEVELOPMENT 9

Research and new product development; Product design and development; Project management in new product development; Patents - Patent search, Patent laws, International code for patents, Intellectual property rights (IPR); The use of patents in innovation management; Patenting of Life- Exclusions from patents – Alternatives to patenting.

UNIT V MODEL PREPARATION & EVALUATION 9

Creative design; Model Preparation; Scale up and Scale down Models; Modelling and simulation techniques; Casestudies; Testing - Cost evaluation – Patent application- types of patent- Patent procedure

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. C. Merle Crawford and C. Anthony Di Benedetto. "New Products Management" 12th Edition, Pearson, 2017.
2. Gary Armstrong and Philip Kotler. "Marketing: An Introduction" 14th Edition, Pearson, 2020.

REFERENCES:

1. Karl T. Ulrich and Steven D. Eppinger. "Product Design and Development" 7th Edition, McGraw-Hill Education, 2011.
2. Robert G. Cooper. "Successful New Products: The Key Elements" 3rd Edition, Productivity Press, 2019.

Course code	**21BT755PT**	**Semester**	**VII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**FORENSIC BIOTECHNOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To Provide a comprehensive understanding of the fundamental principles and techniques employed in forensic biotechnology.
- To enable the students with skills in interpreting and analyzing DNA profiles
- To sensitize how forensic biotechnology is integrated into criminal investigations.

PREREQUISITE:

- Chemistry of Biomolecules, Principles of Genetic Engineering.

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C755.1	***Understand*** the basic of forensic Science.	K2
C755.2	***Outline*** the role of serology and biochemistry.	K2
C755.3	***Analyze*** the importance of microbial forensic and toxicology	K3
C755.4	***Explore*** different methods in forensic analysis.	K2
C755.5	***Overview*** the emerging technology in forensic biotechnology	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
C755.1	2	1	-	-	-	3	-	2	-	-	-	-	3	-	-	-
C755.2	2	1	-	-	-	3	-	2	-	-	-	-	3	-	-	-
C755.3	2	1	-	2	-	3	-	2	-	-	-	-	3	-	-	-
C755.4	2	1	-	2	2	3	-	2	-	-	-	-	3	-	-	-
C755.5	2	1	-	-	-	3	-	2	-	-	-	-	3	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	**No. of credits: 3**

UNIT I INTRODUCTION TO FORENSIC SCIENCE 9

Overview of Forensic Science- Historical perspective- Role and significance in criminal investigations- Basic of Biotechnology in Forensics- Milestones in the application of biotechnology in forensics- Evolution of DNA profiling techniques

UNIT II FORENSIC SEROLOGY AND BIOCHEMISTRY 9

Forensic Serology- Types of forensic evidences- Blood and Bloodstain Analysis- Methods for identifying the presence of blood at a crime scene- Blood Typing- Saliva Analysis- Identification of other body fluids- Protein analysis- Gel electrophoresis- Mass spectrometry- Enzyme Analysis - Enzyme assays- Applications in forensic investigations.

UNIT III MICROBIAL FORENSIC AND FORENSIC TOXICOLOGY 9

Basics of Microbial Forensics- Bacterial and viral identification- Applications in bioterrorism and criminal investigations- Microbial DNA Fingerprinting- Techniques for strain identification- Introduction to Forensic Toxicology- Poison detection and analysis- Methods for Toxicological Analysis- Chromatography techniques - Immunoassays

UNIT IV DNA ANALYSIS IN FORENSICS 9

DNA Extraction and Quantification-Methods and techniques -Quantification Tools-Polymerase Chain Reaction (PCR) in Forensic DNA Analysis- DNA amplification- STR analysis- Real-time PCR applications- DNA Sequencing Techniques-Sanger sequencing-
Next-generation sequencing (NGS)

UNIT V RECENT TRENDS IN FORENSIC BIOTECHNOLOGY 9

New era of forensic science- DNA Phenotyping- Biosensors for forensic analysis- Isotope Detection- Forensic Palynology - CRISPR Technology in Forensics- Automatic Finger Print Identification system

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. James,S.H. and Nordby, J.J. Forensic Science: An Introduction to Scientific And Investigative Techniques 4th ed. CRC Press: USA; (2015).
2. Medical immunology by Danniel P. Stites, Abba I. Jerr, Tristram G. Parstow, Ninth edition; Prentice Hall International Inc.2001

REFERENCES:

1. Saferstein, R. Criminalistics-An Introduction to Forensic Science 6th ed. PrenticeHall: New Jersey;(2015)

Course code	21BT76P	Semester	VII			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PRINCIPLES OF BIOSEPARATION PROCESSES LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To provide hands-on training in bio separation techniques through simple experimentations in the laboratory.
- To apply the downstream processing principles for product isolation and purification.

PREREQUISITE:

- Bioprocess Engineering, Mass Transfer Operations

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C706.1	***Demonstrate*** the basic bio separation process	K3
C706.2	***Utilize*** the advanced techniques for separating bioproducts	K3
C706.3	***Perform*** various separation technique such as cell disruption, filtration for bio product development	K3
C706.4	***Apply*** the chromatography methods for purification of bio products	K3
C706.5	***Relate*** the strategies used in different bio separation process thereby understanding the principles of each techniques.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAMSPECIFIC OUTCOMES

CO. No.	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C706.1	2	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-
C706.2	1	2	1	1	2	-	2	-	-	-	-	-	2	2	-	-
C706.3	-	2	2	2	2	-	2	-	2	-	-	2	2	1	1	1
C706.4	-	3	3	1	3	3	-	-	2	2	2	1	2	2	1	-
C706.5	-	-	1	2	1	2	-	-	-	-	-	3	1	1	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

List of Experiment	No. of Credits: 2

1. Solid liquid separation – centrifugation.
2. Solid liquid separation – microfiltration
3. Precipitation-Ammonium sulphite precipitation
4. Batch Sedimentation
5. Flocculation
6. Ultrafiltration
7. Cell Disruption by Sonication and High-Pressure Homogenizer
8. Cell Disruption by Enzymatic Method
9. Protein Concentration by Salting Out
10. Aqueous two-phase Extraction
11. Affinity chromatography
12. Western blotting- identify the presence and purity of specific protein

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Sivashankar,B. Bioseparations: Principles and techniques. India: PHI Learning, 2006.
2. Mosier, Nathan S.., Ladisch, Michael R. Modern Biotechnology: Connecting Innovationsin Microbiology and Biochemistry to Engineering Fundamentals. Germany: Wiley, 2011

REFERENCES:

1. Raja Ghosh “Principles of Bioseparations Engineering”. World Scientific, 2006.
2. Forciniti, D., “Industrial Bioseparation: Principles & Practice”, Blackwell, 2008

VEL TECH HIGH TECH

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Course code	21EE05P	Semester	VII			
Category	EMPLOYABILITY ENHANCEMENT COURSE (EEC)		L	T	P	C
Course Title	PROJECT PHASE - I		0	0	4	2

COURSE OBJECTIVES:

- To emphasize project-based learning

PREREQUISITE:

- All Core Courses

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms Level
On successful completion of this Course, students will be able to		
C707.1	***Use*** current information and literature in science and prepare and present scientific data.	K2
C707.2	***Understand*** complex problems through gained engineering knowledge.	K2
C707.3	***Solve*** problems critically using modern tools	K3
C707.4	***Analyze*** and apply the process engineering concepts an incredibly wide diversity of applications in the field of biotechnology.	K4
C707.5	***Evaluate*** the scientific problem as a team and learn to manage the project	K5
C707.6	***Create*** and demonstrate suitable solution that has social impact	K6

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C707.1	3	-	2	-	-	-	1	1	-	1	-	1	1	1	1	1
C707.2	-	3	2	-	-	-	1	1	-	1	-	1	1	1	1	1
C707.3	-	-	3	-	3	-	1	1	-	1	-	1	1	1	1	1
C707.4	3	3	3	3	1	-	1	1	-	1	-	1	1	1	1	1
C707.5	-	-	-	-	1	-	1	1	2	1	2	1	1	1	1	1

Note: 1: Slight, 2: Moderate, 3:Substantial

DOMAINS

Students are advised to carry out the projects in the following domains, but not limited with

1. Biochemistry
2. Bio-organic Chemistry
3. Cell Biology
4. Microbiology
5. Marine Biology
6. Industrial Biotechnology
7. Plant Science
8. Computational Biology
9. Natural Products
10. Bioproducts Development
11. Bioprocess Engineering

Total: 60 Hours

ONLINE RESOURCES

1. https://swayam.gov.in/nc_details/NPTEL
2. https://www.sciencedirect.com/
3. https://www.ncbi.nlm.nih.gov/
4. https://www.ncbi.nlm.nih.gov/pmc/
5. https://mtccindia.res.in/
6. https://www.atcc.org/

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Course code	**21EE03P**	**Semester**	**VII**			
Category	**EMPLOYABILITY ENHANCEMENT COURSES (EEC)**		**L**	**T**	**P**	**C**
Course Title	**TECHNICAL SEMINAR**		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

- To assess the student's overall proficiency and scholastic attainment in various degree course subjects through a comprehensive proficiency assessment.

PREREQUISITE:

- Technical English

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms Level**
On successful completion of this course, students will be able to		
C708.1	***Apply*** Technical Presentation Skills	K2
C708.2	***Express*** research and critical analysis skills.	K2
C708.3	***Demonstrate*** the application of engineering concepts.	K3
C708.4	***Create*** professional documentation and reports.	K4
C708.5	***Employ*** visual aids and technology effectively.	K5
C708.6	***Participate*** in peer review and offer constructive feedback.	K6

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
C708.1	-	-	-	-	-	-	-	-	2	3	-	1	-	-	-	-
C708.2	-	-	-	-	-	-	-	-	2	3	-	1	-	-	-	-
C708.3	-	-	-	-	-	-	-	-	2	3	-	1	-	-	-	-
C708.4	-	-	-	-	-	-	-	-	2	3	-	1	-	-	-	-
C708.5	-	-	-	-	-	-	-	-	2	3	-	1	-	-	-	-
C708.6	-	-	-	-	-	-	-	-	2	3	-	1	-	-	-	-

Note:1: Slight, 2: Moderate, 3:Substantial

DOMAINS

Students are advised to carry out the technical seminar in the following domains, but not limited with

S. No	List of domains	No. of Credit: 1
1.	Bioprocess Engineering	
2.	Genetic Engineering and Molecular Biology	
3.	Bioinformatics	
4.	Bioethics and Biotechnology Regulations	
5.	Pharmaceutical Biotechnology	
6.	Medical Biotechnology	
7.	Environmental Biotechnology	
8.	Industrial Biotechnology	
9.	Plant Biotechnology	
10.	Stem Cell Biology and Regenerative Medicine	
11.	Biomedical Engineering	
12.	Computational Biology	
13.	Bioproducts Development	

Total: 30 Periods

ONLINE RESOURCES

1. https://bioprocessintl.com/
2. https://www.ebi.ac.uk/
3. https://www.pharmtech.com/
4. https://www.nih.gov/
5. https://www.epa.gov/
6. https://www.atcc.org/
7. https://www.isscr.org/
8. https://www.embs.org/
9. https://sbolstandard.org/
10. https://www.nano.gov/
11. https://www.ishs.org/
12. https://iums.org/

VIII SEMESTER

SEMESTER VIII											
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**				
							L	**T**	**P**	**C**	
THEORY											
1	-	Professional Elective - V	PEC	40	60	100	3	0	0	3	
2	-	Professional Elective - VI	PEC	40	60	100	3	0	0	3	
PRACTICAL											
3	21EE06P	Project Phase - II	PROJ	60	40	100	0	0	12	6	
TOTAL										**12**	

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE
PROFESSIONAL ELECTIVE - V		
1	21BT811PT	Lifestyle Diseases and Clinical Trials
2	21BT812PT	Bioconjugate Technology and Applications
3	21BT813PT	Bioprocess Equipment and Plant Design
4	21BT814PT	Clinical Data Management
5	21BT815PT	Agricultural Biotechnology

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Course code	21BT811PT	Semester	VIII			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**LIFESTYLE DISEASES AND CLINICAL TRIALS**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To impart knowledge on lifestyle-related diseases.
- To familiarize the associated risk factors and its preventive strategies.
- To understand the importance and concepts in the design of clinical trials.

PREREQUISITE:

- Chemistry of Biomolecules

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this course, students will be able to		
C811.1	***Outline*** various lifestyle diseases and healthy habits	K2
C811.2	***Learn*** the prevention, treatment & and management of diseases	K2
C811.3	***Describe*** about Diabetes mellitus & Nephritis	K2
C811.4	***Understand*** the epidemiology & and characteristics of Lifestyle diseases	K2
C811.5	***Apply*** the knowledge of clinical trials for Drug development	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C811.1	1	-	-	1	-	1	-	-	-	-	1	2	-	-	-	-
C811.2	1	-	2	2	2	2	1	2	1	2	-	2	-	-	-	-
C811.3	-	1	2	1	2	1	-	2	-	-	-	2	-	-	-	-
C811.4	-	-	-	2	2	2	1	2	-	1	-	2	-	-	-	-
C811.5	1	1	2	2	2	2	2	2	1	-	2	1	3	-	-	-

Note:1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits:3**

UNIT I INTRODUCTION TO HEALTHY LIFESTYLE 6

Introduction: Lifestyle, food habits, healthy habits, exercise, and unhealthy – Biomolecules: carbohydrates, lipids, proteins, nucleic acids, vitamins, minerals – Brief outline: Mental Health, Stress, Role of diet & nutrition, Preventive measure.

UNIT II LIFESTYLE DISEASES 9

Lifestyle diseases: Introduction & Risk factors: Eating, smoking, drinking, stress, physical activity, illicit drug use- Lifestyle Disorders, Epidemiology: CVD, Stroke, COPD,Atherosclerosis, Hypertension , Stroke & Blood glucose regulation – Diabetes mellitus and Obesity Weight control andBMI – Cancer.

UNIT III DIABETES MELLITUS AND NEPHRITIS 12

Introduction of Diabetes mellitus: type 1, type 2 & gestational – Obesity: classification, BMI symptoms, causes, diagnosis, treatment and management, Case study – The function of kidney:Outline, GFR – nephritis : causes, symptoms, diagnosis – liver disease : viral hepatitis, alcoholic liver disease, and cirrhosis, symptoms, causes – diagnosis :liver function test, serum bilirubin, serum albumin, serum alkaline phosphatase, ALT, AST and LDH, -Advanced treatment of Nephritis.

UNIT IV INTRODUCTION TO CLINICAL TRIALS 6

Introduction to clinical trials – stages of Clinical trials in practice – pre-study requirements for clinical trials; – Regulatory approvals,trial responsibilities, and protocols – Roles and responsibilities of investigators, sponsors, and others – Requirements of clinical trials protocols.

UNIT V ROLE OF CLINICAL TRIALS IN NEW DRUG DEVELOPMENT 12

Drug development and trial planning – Trail Design: Randomized and uncontrolled – Protocol development – Patient selection – Sample size and power – Basic statistics for clinical trial : Statistical Analysis: normal distribution, and significance tests – Key concepts of Clinical Investigation, Legislative requirements for investigations medicinal products – Case study on recent Drug Discovery: Trofinetide, Heparin

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. DM Vasudevan, Sreekumari S, Kannan Vaidyanathan “Textbook of Biochemistry for Medical Students” Jaypee Brothers Medical Publishers Pvt. Limited,2019.
2. Rippe J, “Lifestyle medicine”, 2nd Edition, CRC press, Newyork, 2013.

REFERENCES:

1. Tom Brody, “Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines”, Academic Press, 2016.
2. Stuart J. Pocock, “Clinical Trials: A Practical Approach”, John Wiley & Sons, 2013.

Course code	21BT812PT		Semester	VIII		
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	BIOCONJUGATE TECHNOLOGY ANDAPPLICATIONS		3	0	0	3

COURSE OBJECTIVES:

- To provide students with a comprehensive understanding the functional targets and chemistry of active groups
- To gain knowledge about the linkers and cleavable reagent systems.

PREREQUISITE:

- Chemistry of Biomolecules, Principles of Immunology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C812. 1	***Understand*** the concepts of Amino Acids, Peptides and Proteins	K2
C812. 2	***Explain*** Amine reactive chemical reactions and its types	K2
C812.3	***Infer*** cross linkers and its types and cleavable reagent systems	K2
C812. 4	***Learn*** Enzyme and Nucleic Acid Modification and Conjugation	K2
C812. 5	***Illustrate*** bioconjugates and its types, applications, synthetic polymers.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C812. 1	2	1	1	-	-	-	-	-	-	-	-	-	3	3	-	-
C812. 2	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C812.3	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C812. 4	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C812. 5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-

Note:1: Slight, 2: Moderate, 3: Substantial

SYLLABUS		No. of Credits: 3
UNIT I	**FUNCTIONAL TARGETS**	**9**

Introduction to Bioconjugation - Modification of Amino Acids, Peptides and Proteins, Protein Structure and Reactivity– Modification of sugars, polysaccharides and glycoconjugates – Carbohydrate structure and Functionality-Modification of nucleic acids and oligonucleotides, Polynucleotide structure and Functionality.

UNIT II CHEMISTRY OF ACTIVE GROUPS 9

Amine reactive chemical reactions – Thiol reactive chemical reactions – carboxylate reactive chemical reactions – Hydroxyl reactive chemical reactions – Aldehyde and ketone reactive chemical reactions –Photochemical reactions, and Cycloaddition reactions.

UNIT III BIOCONJUGATE REAGENTS 9

Zero length cross linkers – Homo bifunctional cross linkers – Heterobifunctional cross linkers – Trifunctional cross linkers – Cross bridges - Cleavable reagent systems – Tags and Probes – General reaction conditions – spacer arm length, Spacer arm cleavability, Spacer arm composition, Spacer arm structure and solubility.

UNIT IV ENZYME AND NUCLEIC ACID MODIFICATION AND CONJUGATION 9

Properties of common enzymes – Activated enzymes for conjugation – Biotinylated enzymes – chemical modification of nucleic acids – Biotin labelling of DNA- Enzyme conjugation to DNA – Fluorescent of DNA - Vaccines and Immunogen Conjugates.

UNIT V BIOCONJUGATE APPLICATIONS 9

Preparation of Hapten- Carrier Immunogen conjugates - Antibody modification and conjugation immunotoxin– Liposome conjugated and derivatives - Colloidal – gold- labeled proteins - Bioconjugates in Diagnostics.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Greg T. Hermanson, “Bioconjugate Techniques”, Academic Press, 3rd edition,2013.
2. Sonny S. Mark, “Bioconjugation Protocols: Strategies and Methods”, Humana Press Inc, 2nd edition,2011.

REFERENCES:

1. David L. Nelson, Michael M. Cox, “Lehninger Principles of Biochemistry”, 8th Edition, W H Freeman & Co, 2021.
2. Ravin Narain, “Chemistry of Bioconjugates: synthesis, characterization and biomedical applications” 1st edition, Wiley, 2013.
3. Kenneth J Oliver, Sara A Hurvitz, “Antibody drug conjugates: fundamentals of drug development and clinical outcomes to target cancer” 1st edition, 2016.

Course code	21BT813PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	BIOPROCESS EQUIPMENT AND PLANT DESIGN		3	0	0	3

COURSE OBJECTIVES:

- To learn the principles of designing a bioprocess plant layout for efficient workflow and safety.
- To gain knowledge on techniques to design bioprocess equipment in a process plant.
- To familiarize students with these key concepts to make design and operating decisions.

PREREQUISITE:

Bioprocess Engineering

COURSE OUTCOMES

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C813.1	***Understand*** the design, configuration and working principle of bioreactors	K2
C813.2	***Acquire*** basic knowledge on media design for fermentation process	K2
C813.3	***Learn*** the construction and design process of bioreactor accessories	K2
C813.4	***Implement*** the scale up and scale down process in bioreactors	K3
C813.5	***Develop*** the process for microbial, plant and animal cell bioreactors	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C813.1	3	2	-	-	-	1	-	-	-	-	-	-	3	3	-	-
C813.2	3	2	-	1	-	-	-	-	-	-	-	-	2	2	-	-
C813.3	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C813.4	3	3	2	-	-	1	1	-	-	-	-	-	2	2	-	-
C813.5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I BIOREACTOR DESIGN & CONFIGURATION 9

Bioreactor Operation – Batch operation, semi-continuous and fed-batch operation, Continuous Operation – Microbiological Reactors – Characteristics of an Ideal reactor – Design of reactor system – Reactor design procedure – Enzyme reactors, CSTR, Per fluent.

UNIT II MEDIA DESIGN FOR FERMENTATION PROCESS 9

Medium requirements for fermentation process – carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements – medium formulation of optimal growth and product formation – design of various commercial media for industrial fermentations – medium optimization methods.

UNIT III BIOREACTOR ACCESSORIES DESIGN DEVELOPMENT 9

Fermenter Vessel – Reactor Design- Heating and cooling coils design – Aeration system – Sealing assembly - Baffles –Impeller – Sparger –Feed ports – Foam control – Valves – Controlling Devices for Environmentalfactors – Use of Designing software (Super pro & Oasis)in Fermenter.

UNIT IV PROCESS DESIGN DEVELOPMENT 9

Materials of construction for bioprocess plants – Design considerations for maintaining sterility of process streams processing equipment's, selection, specification – Design of heat and mass transfer equipment used in bioprocess industries – Design and operation of bioreactor for microbial, plant cell and animal cell.

UNIT V BIOREACTOR SCALE UP AND SCALE DOWN 9

Scale-up Techniques: – Scale up by geometric similitude. constant power consumption per volume, constant mixing time, constant impeller tip speed – constant volumetric mass transfer coefficient; Scale–down Related Aspects; Case Studies in Bioreactor Scaleup and Scale-down Aspects, modern plant design.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Michael L. Shuler, Fikret Kargi, Matthew De Lisa,. Bioprocess Engineering, 3rd Edition, Prentice Hal, 2017
2. Pauline Doran, Bioprocess Engineering Calculation, 2 nd Edition, Blackwell Scientific Publications, 2012
3. James M. Lee, Biochemical Engineering, Prentice Hall, 1992

TEXT BOOKS:

1. Ullmann's, Chemical Engineering and Plant design, Vol 2, Wiley - VCH Verlag GmbH & Co , 2005
2. Bioprocess engineering Basic Concepts 2nd ed. Michael L.Shuler, Fikert Kargi Prentice Hall or India, 2015
3. Biochemical Engineering Fundamentals 2nd ed. James E.Bailey, David F.Ollis, 2017
4. Process Design Case Studies, Scott, R. and N. Macleod. 1992. VCH Publishers, New York

Course code	21BT814PT	Semester	VIII			
Category	PROFESSIONAL ELECIVE COURSE (PEC)		L	T	P	C
Course Title	CLINICAL DATA MANAGEMENT		3	0	0	3

COURSE OBJECTIVES:

- To understand the principles involved in ethical, legal and regulatory issues in clinical trials.
- To familiarize students with relevant regulatory guidelines and requirements governing clinical data management.
- To understand the role of data management in generating accurate and reliable clinical trial reports.

PREREQUISITE:

Research methodology, Bioethics and IPR

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C814.1	***Understand*** the fundamental concepts, principles and phases of clinical research	K2
C814.2	***Outline*** the principles of clinical research ethics, regulations and responsibilities	K2
C814.3	***Implement*** clinical trial protocols and maintain a database for clinical trial data	K3
C814.4	***Apply*** the methods for data analysis and management in the context of clinical trials	K3
C814.5	***Summarize*** the roles of regulatory agencies and their interactions	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C814.1	3	-	-	1	-	1	-	1	-	-	-	-	3	3	-	-
C814.2	3	-	-	-	-	2	1	1	-	-	-	-	2	2	-	-
C814.3	2	1	-	2	-	-	-	-	-	-	-	-	2	2	-	-
C814.4	3	3	-	2	-	1	-	1	-	-	-	-	2	2	-	-
C814.5	2	-	-	-	-	-	-	1	-	-	-	-	2	2	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION TO CLINICAL RESEARCH 9

Clinical research – Types of Clinical Research – Clinical Pharmacology: Pharmacokinetics – Pharmacodynamics – Bioavailability – bioequivalence – Good Clinical Practice – Drug Development Process: Phase I, II, III & IV – Clinical trial materials

UNIT II GUIDELINES, REGULATION & ETHICS IN CLINICAL RESEARCH 9

History of clinical research: Sulphanilamide tragedy, Thalidomide Disaster – Guidelines for good clinical Practice – ICMR guidelines for Biomedical Research on Human subjects – Regulations in clinical Research: Drug and Cosmetic Act – FDA – Y-Ethics Committee – responsibilities – Submission and Approval process: IND, NDA and ANDA – DCGI submission procedure.

UNIT III CLINICAL TRIAL MANAGEMENT 9

Basics of clinical Trails – Phases of clinical trials – Randomization , Single or double – Blind studies – types of Clinical trials – Randomized controlled trials – Clinical trials metrics collection – Clinical research operation, monitoring and clinical evaluation – GMP – GLP – QA and QC.

UNIT IV CLINICAL DATA MANAGEMENT 9

Clinical Data management: Data processing – Database – Data management and its benefits – Types of data – Collection methods – Data entry – Data assurance – QC and Assurance of data – Medical coding – Dictionary management – Maintenance of quality documents – Standard operating procedure – Guidelines for data management.

UNIT V PHARMA REGULATORY AFFAIRS 9

Pharmacovigilance – Safety specification and risk management plan – Drug hypersensitivity – Guidelines in pharmacovigilance – Drug regulatory authorities – Drug policy in India – Regulation on alternative system of medicine – Safety of herbal medicines – Medical and scientific writing.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Fundamentals of clinical trials, by Friedman, LM; Furberg, CD; Demets, DL; 2015. ISBN 978-1- 4419-1585-6, Publisher Springer
2. Clinical Trials Handbook: Design and Conduct, Cutis L. Meinert, ISBN 978-1-1182-1846-4, Publisher Wiley, 2012

REFERENCES:

1. Bellary S, Krishnankutty B, Latha MS. Basics of case report form designing in clinical research. Perspect Clin Res. 2014;5(4):159-166. doi:10.4103/2229-3485.140555

Course code	**21BT815PT**	**Semester**	**VIII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**AGRICULTURAL BIOTECHNOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To familiarize students with basics of agriculture and its impact
- To discuss the various agricultural and horticultural crops production.
- To describe the farm machinery design and to develop the entrepreneurship opportunities in agriculture

PREREQUISITE:

- Chemistry of Biomolecules, Cell Biology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C815.1	***Understand*** the basics of crop physiology	K2
C815.2	***Infer*** the various agricultural and horticultural crops and its production	K2
C815.3	***Describe*** the water irrigation and drainage system	K2
C815.4	***Apply*** the engineering concepts and modern techniques in farm machinery design	K3
C815.5	***Prepare*** the business modules for entrepreneurship opportunities in agriculture	K3

COURSE OUTCOME SMAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C815.1	2	1	-	-	-	1	3	1	-	-	-	-	1	-	-	2
C815.2	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2
C815.3	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2
C815.4	3	2	2	-	2	-	-	-	-	-	-	-	1	-	-	2
C815.5	1	-	-	-	-	1	-	1	1	1	-	2	1	-	-	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I CROP PHYSIOLOGY 9

Introduction to agriculture biotechnology; Importance of Crop Physiology in Agriculture; Plant mineral nutrition - classification of nutrients, Photosynthesis - Light reaction- Photosynthetic pathways; Factors affecting photosynthesis, Stress Physiology - Classification of stresses

UNIT II CROP PRODUCTION TECHNOLOGY 9

Crop Production: Concepts of agronomy; Classification of crops; Techniques of raising field crops, horticultural crops, medicinal and aromatic plants; water management for higher productivity, management of insects and pests, diseases and weeds; Farm planning and management; Crop growth assessment; Organic farming and sustainable agriculture; Greenhouse crop production; Crop Simulation

UNIT III IRRIGATION AND DRAINAGE ENGINEERING 9

Water for Irrigation: Sources of water, utilization in various sectors, irrigation potential, and scope for further development. Farm Water Delivery System and Control water regulating and diversion structures. Measurement of Irrigation Water; Irrigation Requirement

UNIT IV FARM MACHINERY DESIGN AND TESTING 9

Evolution of farming with biotechnological aids; Design consideration of Agril. Machines their draft requirement, Engineering materials and their properties. Planting Machinery; Design of seed metering mechanism, Design considerations of seed and fertilizer box and frame. Testing Procedure of Agril Machinery; Performance requirements design of safety devices.

UNIT V ENTREPRENEURSHIP DEVELOPMENT IN AGRO-INDUSTRIES 9

Agro-industry trends, patterns and developmental impacts, characteristics of agro-entrepreneurs, SWOT analysis - business models for small scale and urban farming, Rural tourism, Rural entrepreneurship, Overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. G. D. Bansal. “Agricultural Biotechnology: Challenges and Prospects” CRC Press, 2017.
2. Sonia Soloneski and Marcelo L. Larramendy. “Biotechnology for Crop Protection”, Academic Press, 2018.

REFERENCES:

1. Harry L. Field. “Introduction to Agricultural Engineering Technology: A Problem Solving Approach”, Springer, 2019.

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE
		PROFESSIONAL ELECTIVE - VI
1	21BT821PT	Biopharmaceutical Technology
2	21BT822PT	Neurobiology and Cognitive Sciences
3	21BT823PT	Bioentrepreneurship
4	21BT824PT	Biosafety and Hazard Management
5	21BT825PT	Plant Biotechnology

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Course code	21BT821PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	BIOPHARMACEUTICAL TECHNOLOGY		3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge in physicochemical properties, pharmacology and the formulation of commonly used pharmaceuticals.
- To familiarize the principles and manufacture of drugs and pharmaceutical products like vaccines, tissue and tissue products

PREREQUISITE:

- Chemistry of Biomolecules, Bio organic Chemistry

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C821. 1	***Understand*** the concepts of drugs development and regulations	K2
C821. 2	***Discuss*** the principles of drug metabolism, radioactivity and pharmacokinetics	K3
C821. 3	***Learn*** the concepts of drugs manufacturing process and applications	K2
C821. 4	***Explain*** the principles of drug packaging and Good Manufacturing Practice	K2
C821. 5	***Apply*** the knowledge of various biopharmaceuticals like vaccines, tissue and tissue products, cellular & gene Therapy	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C821. 1	2	1	1	-	-	-	-	-	-	-	-	-	3	2	-	2
C821. 2	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C821. 3	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C821. 4	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C821. 5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS		No. of Credits: 3

UNIT I INTRODUCTION **9**

Pharmaceutical industry & development of drugs - types of therapeutic agents and their uses - economics and regulatory aspects Preclinical trials, Clinical Trials; Conventional and Biological product approval process; Generics and Biosimilars;Drug regulations

UNIT II DRUG ACTION, METABOLISM AND PHARMACOKINETICS **10**

Mechanism of drug action - physico-chemical principles of drug metabolism radioactivity – pharmacokinetics: Absorption, Distribution, Metabolism and Elimination, Pharmacoeconomics, Pharmacodynamics, PK/PD Model.

UNIT III MANUFACTURE OF DRUGS, PROCESS AND APPLICATIONS **10**

Types of reaction process and special requirements for bulk drug manufacture, new dosage forms, Progress in the Design of Biodegradable Polymer-Based Microspheres for Parenteral Controlled Delivery of Therapeutic Peptide/Protein

UNIT IV SOLID AND LIQUID DRUG MANUFACTURING **10**

Compressed tablets - dry and wet granulation - slugging or direct compression - tablet presses; coating of tablets; capsule preparation; oval liquids – vegetable drugs – topical applications - preservation of drugs; analytical methods and other tests used in drug manufacture; packing techniques - quality management - GMP.

UNIT V BIOPHARMACEUTICALS **6**

Blood products, therapeutic enzymes, Vaccines, Tissue and tissue products, Cellular & Gene Therapy Products, Antibody, Adjuvants, Cytokines, plasminogen activators, recombinant blood cell or plasma factors, fusion proteins, enzymes, receptors, hormones, mAbs, recombinant DNA vaccines, and antisense oligonucleotide.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Finkel, Richard, et al., “Lippincott’s Illustrated Reviews Pharmacology” V Edition. Wolters Kluwer / Lippincott Williams & Wilkins, 2011.
2. Gary Walsh, “Biopharmaceuticals: Biochemistry and Biotechnology”, II Edition. Wiley-Blackwell, 2003.
3. Shayne Cox Gad, “Pharmaceutical Manufacturing Handbook: Production and Processes” 1st EditionWiley-Interscience, 2008.

REFERENCES:

1. Gareth Thomas, “Medicinal Chemistry. An introduction” II Edition. John Wiley, 2008.
2. Katzung B.G. “Basic and Clinical Pharmacology”I5th Edition. McGraw Hill / Medical. 2021.

Course code	21BT822PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	NEUROBIOLOGY AND COGNITIVE SCIENCES		3	0	0	3

COURSE OBJECTIVES:

- To know the general organization of brain and physiological and cognitive processes.
- To apply the molecular, cellular, and cognitive bases of learning and memory.

PREREQUISITE:

- Cell Biology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C822.1	***Know*** the general organization of brain, neurons and glial cells.	**K2**
C822.2	***Learn*** physiological aspects and coding of neurons.	**K2**
C822.3	***Explore*** behavioural aspects such as sleep feeding and motivation.	**K2**
C822.4	***Interpret*** the mechanism of five senses.	**K3**
C822.5	***Apply*** the mechanism of action of neurotransmitters and hormones.	**K3**

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C822.1	1	-	-	-	-	-	1	2	-	-	-	3	3	2	-	1
C822.2	2	2	-	-	-	-	2	2	-	-	-	2	3	2	-	-
C822.3	1	-	1	-	-	-	1	2	-	-	-	2	3	2	-	1
C822.4	1	-	-	-	-	-	1	2	-	-	-	3	3	2	-	-
C822.5	1	1	-	-	-	-	1	2	-	-	-	3	3	2	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I NEUROANATOMY **9**

Central and peripheral nervous systems; Structure and function of neurons; types of neurons; Synapses; Glial cells; myelination; Blood Brain barrier; Neuronal differentiation;Characterization of neuronal cells; Meninges and Cerebrospinal fluid; Spinal Cord.

UNIT II NEUROPHYSIOLOGY **9**

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission; information representation and coding by neurons

UNIT III NEUROPHARMACOLOGY **9**

Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; Characteristics of neurites; hormones and their effect on neuronal function.

UNIT IV APPLIEDNEUROBIOLOGY **9**

Basic mechanisms of sensations like touch, pain, smell and taste; neurological mechanisms of vision and audition; skeletal muscle contraction, Electrical properties of neurons.

UNIT V BEHAVIOUR SCIENCE **9**

Basic mechanisms associated with motivation; control of feeding, sleep, hearing and memory; Neuron terminology, Disorders associated with the nervous system, History and cytology ofneurons.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Liqun luo., Principles of Neurobiology, 2020.
2. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University, 2016.

REFERENCES:

1. Mason P., Medical Neurobiology, Oxford University Press, 2017.

Course code	**21BT823PT**	**Semester**	**VIII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**BIOENTREPRENEURSHIP**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To impart the recent market trends in business administration with respect to biotechnology.
- To develop skills in business planning specific to biotech startups, including the creation of business models, market analyses, and financial projections.

PREREQUISITE:

- Bioethics and Intellectual Property Rights, Total Quality Management

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C823.1	***Learn*** the recent market trends and economy.	K2
C823.2	***Understand*** about the business developmental plan.	K2
C823.3	***Infer*** about entrepreneurship and business administration.	K2
C823.4	***Develop*** exposure to the financial management and documentation in business.	K3
C823.5	***Analyze*** the legal and ethical complications in marketplace.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C823.1	-	1	2	1	-	2	-	2	3	3	3	1	1	1	-	2
C823.2	1	2	1	1	-	2	-	-	2	2	1	-	-	1	-	-
C823.3	1	-	-	-	-	1	-	-	3	1	1	1	1	1	-	2
C823.4	1	1	-	-	-	1	-	1	-	1	3	-	-	-	-	2
C823.5	1	2	1	2	-	2	2	3	2	1	2	1	-	-	-	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits:3**

UNIT I INTRODUCTION TO BIO-ENTREPRENEURSHIP 9

Definition of Bio entrepreneurship, traits of an entrepreneur; Copyright, Patents, trademark, plant breeders and farmers rights, biodiversity related issues: Bio piracy, International and Indian business policies with the focus on Bio and Pharmaceutical products.

UNIT II ENTREPRENEUR AND ENTREPRENEURSHIP 9

Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development, Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

UNIT III PLANNING A SMALL SCALE ENTERPRISES 9

Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site. Financing new/small enterprises; Techno Economic Feasibility Assessment, Preparation of Business Plan, Forms of business organization/ownership. Case study of any top three Biotechnology Companies

UNIT IV THE MARKET AND OPERATIONAL ASPECTS 9

Target customer and their problems, demographics, personality traits and behavior. Market opportunity, market size, growth rate, growth potential, market trends, opportunities, value proposition canvas. Product/service, manufacturing, resources, mode of sales, sales process, go-to-market strategy.

UNIT V FINANCING OPTIONS AND PREPARING THE PITCH 9

Sources of funding for startups, IPR process, Legal aspects relating to the startup, team formation, scalability of the model, social and ethical aspects of the business, Winning negotiations, elevator pitch, exit strategy.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Shishsir Mishra, “From starting small to winning big: the guide for startup entrepreneurs”, Business expert press, 2020.
2. Cynthia Greene, “Entrepreneurship Ideas in Action”—South-Western, 2018.

REFERNCES:

1. Chandhimath poornima., ‘Entrepreneurship development and small business enterprises’, Pearson education,2018.
2. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2015.

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Course code	21BT824PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	BIOSAFETY AND HAZARD MANAGEMENT		3	0	0	3

COURSE OBJECTIVES:

- To learn about implementation of safety procedures, risk analysis and assessment, hazard identification.
- To familiarize about the safety audit process occurred in industries.

PREREQUISITE:

- Environmental Sciences, Total Quality Management

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C824.1	***Understand*** potential hazards and the need for safety in industries	K2
C824.2	***Implement*** periodic inspection and prevent accident in industries	K3
C824.3	***Acquire*** knowledge on risk and arrive specific management models	K2
C824.4	***Conduct*** and document safety audits in industries	K2
C824.5	***Apply*** safety standards for hazardous operations	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C824.1	2	1	1	-	-	-	-	-	-	-	-	-	3	3	1	-
C824.2	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C824.3	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C824.4	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
C824.5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION **9**

Safety – Industrial safety- Need for safety in industries, elements of safety - Safety programmes; components and realization; Potential hazards; extreme operating conditions; reduction of workers stress; toxic chemicals; safe handling.

UNIT II QUALITY CHECKS **9**

Implementation of safety procedures – periodic inspection and replacement - Accidents– identification and prevention - promotion of industrial safety- safety awareness and its implementation.

UNIT III RISK ANALYSIS **9**

Overall risk analysis - emergency planning-on site & off-site emergency planning - risk management ISO 14000 - EMS models case studies - Quantitative risk assessment – rapid and comprehensive risk analysis - Risk due to radiation - explosion due to over pressure - jet fire-fire ball – pool fire.

UNIT IV SAFETY AUDITS **9**

Safety audit and its types - Hazard identification safety audits – checklist - what if analysis - vulnerability models event tree analysis fault tree analysis - Hazan past accident analysis Foxborough-Mexico- Vizag Bopal analysis.

UNIT V HAZARDOUS OPERATIONS **9**

Hazop- Risk ranking - guide words – parameters - derivation-causes-consequences-recommendation-coarse – The Hazop report, Hazop methodology- Hazop study-case studies-pumping system-reactor-mass transfer system.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. CCPS (Center for Chemical Process Safety), "Conduct of Operations and Operational Discipline: For Improving Process Safety in Industry" 1st Edition. Wiley-AIChE, 2011.
2. Mihir Kumar Purkai, Piyal Mondal et al, "Hazards and Safety in Process Industries - Case Studies", 1st edition, CRC Press, 2021.
3. Hyatt, N., "Guidelines for process hazards analysis, hazards identification & risk analysis", 1st edition, CRC Press, 2018.

REFERENCES:

1. David Stewart Beyer, "Industrial Accident Prevention", 1st Edition. Forgotten Books, 2018.
2. Daniel Crowl, Joseph Louvar. "Chemical Process Safety: Fundamentals with Applications", 4th Edition. Pearson. 2021.

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Course code	21BT825PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	PLANT BIOTECHNOLOGY		3	0	0	3

COURSE OBJECTIVES:

- To provide knowledge on plant tissue culture methods
- To learn techniques used in plant research and genetically modified crops.

PREREQUISITE:

- Cell Biology, Principles and Techniques of Molecular Biology, Principles of Genetic Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C825. 1	***Understand*** the fundamentals of plant cells, structure and functions	K2
C825. 2	***Infer*** about the concept of plant tissue culture	K2
C825. 3	***Describe*** about the gene transformation techniques	K2
C825. 4	***Apply*** gained knowledge for the development of therapeutic products	K3
C825. 5	***Enumerate*** the risk in plant biotechnology	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C825. 1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C825. 2	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
C825. 3	2	-	1	1	-	1	1	-	-	-	1	2	2	-	-	-
C825. 4	2	1	3	2	-	1	1	1	-	-	2	2	2	1	-	-
C825. 5	2	2	3	3	-	2	3	2	-	1	2	2	2	2	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits:3

UNIT I INTRODUCTION TO PLANT GENOMICS 9

Introduction for DNA - Different forms of DNA – Supercoiling; Cruciform - Eukaryotic DNA organization into nucleosomes - Control sequences - chromatin and chromosome structure - Gene structure and gene expression- Regulation of gene expression

UNIT II PLANT TISSUE CULTURE 9

Introduction - Laboratory organization - Nutrient medium - Sterilization techniques - Types of culture, micropropagation - Cell suspension and secondary metabolites - Invitro propagation of Haploids - Protoplast isolation and fusion

UNIT III PLANT TRANSFORMATION 9

Direct (particle bombardment, PEG, mediated transformation, electroporation, silicon carbide fibre) and indirect gene transformation (Agrobacterium and viral mediated transformation) - vectors - promoters - Markers and reporters used for plant transformation - Chloroplast transformation.

UNIT IV APPLICATION & IMPLICATIONS OF PLANT BIOTECHNOLOGY 9

Transgenic plants – herbicide and pest resistant plants – molecular farming – therapeutic products – Transgenics in crop improvement – Impact of rDNA technology – Implications of plant transformation – Biosafety concerns and Regulatory framework

UNIT V RISK BENEFITS ASSOCIATED WITH PLANT BIOTECHNOLOGY 9

Risk and Benefits associated with Genetically Modified (GM) plants _ Risk Involved in the use of herbal products _ Risk associated with overcollection of Medicinal Plants in Natural Habitats _ The potential of Biofumigants as alternative to Methyl Bromide for the control of pest infestation in Grain and Dry Food products

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Gamburg OL, Philips GC, Plant Tissue & Organ Culture fundamental Methods, Narosa Publications. 1995.
2. Adrian Slater, Nigel W. Scott and Mark R. Fowler, Plant Biotechnology, Oxford UniversityPress, 2008.
3. Ara Kirakosyan, Peter B. Kaufman 'Recent Advances in Plant Biotechnology' Springer, 2009.

REFERENCES:

1. Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.
2. Ignacimuthu. S, Applied Plant Biotechnology, Tata McGraw Hill. 1996.

Course code	**21EE06P**	**Semester**	**VIII**			
Category	**EMPLOYABILITY ENHANCEMENT COURSE (EEC)**		**L**	**T**	**P**	**C**
Course Title	**PROJECT PHASE - II**		**0**	**0**	**12**	**6**

COURSE OBJECTIVES:

- To emphasize project based learning

PREREQUISITE:

- All Core Courses

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms Level**
On successful completion of this Course, students will be able to		
C803.1	***Use*** current information and literature in science and prepare and present scientific data.	K2
C803.2	***Understand*** complex problems through gained engineering knowledge.	K2
C803.3	***Solve*** problems critically using modern tools	K3
C803.4	***Analyze*** and apply the process engineering concepts an incredibly wide diversity of applications in the field of biotechnology.	K4
C803.5	***Evaluate*** the scientific problem as a team and learn to manage the project	K5
C803.6	***Create*** and demonstrate suitable solution that has social impact	K6

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C803.1	3	-	2	-	-	-	1	1	-	1	-	1	1	1	1	1
C803.2	-	3	2	-	-	-	1	1	-	1	-	1	1	1	1	1
C803.3	-	-	3	-	3	-	1	1	-	1	-	1	1	1	1	1
C803.4	3	3	3	3	1	-	1	1	-	1	-	1	1	1	1	1
C803.5	-	-	-	-	1	-	1	1	2	1	2	1	1	1	1	1

Note:1: Slight, 2: Moderate, 3:Substantial

DOMAINS

Students are advised to carry out the projects in the following domains, but not limited with

1. Biochemistry
2. Bio-organic Chemistry
3. Cell Biology
4. Microbiology
5. Marine Biology
6. Industrial Biotechnology
7. Plant Science
8. Computational Biology
9. Natural Products
10. Bioproducts Development
11. Bioprocess Engineering

Total: 180 Hours

ONLINE RESOURCES

1. https://swayam.gov.in/nc_details/NPTEL
2. https://www.sciencedirect.com/
3. https://www.ncbi.nlm.nih.gov/
4. https://www.ncbi.nlm.nih.gov/pmc/
5. https://mtccindia.res.in/
6. https://www.atcc.org/