P.S.R. ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Sevalpatti (P.O), Sivakasi – 626140

CURRICULUM AND SYLLABI

REGULATION 2019

B.Tech., BIOTECHNOLOGY

(FULL TIME)

DEPARTMENT VISION & MISSION

Vision

- To produce graduates capable of effectively using the imparted scientific and technical knowledge to meet the dynamic demands of biotechnological industry with social values.

Mission

- Offering under graduate programme by providing effective and well balanced curriculum and equip themselves to gear up to the challenges awaiting them.
- Providing the technical, research and intellectual resources that will enable the students to have a successful career in the field of Biotechnology.
- Providing need based training and professional skills to satisfy the needs of society and the industry.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO's)

- Lead a professional career by acquiring the basic knowledge in the field of specialization and allied Engineering.
- Assess the real life problems and deal with them confidently relevance to the society.
- Engage in lifelong learning by pursuing higher studies and participating in professional organizations.
- Exhibit interpersonal skills and able to work as a team for success.

PROGRAMME SPECIFIC OUTCOMES (PSO's)

1. Acquire competency in applications of engineering principles to biological systems.
2. Able to design and analyze varied biotechnological solutions for industrial applications.
3. Apply biochemical and microbial processing techniques for agriculture and medical applications.
4. Exhibit interpersonal knowledge to develop futuristic bioengineering solutions.

PROGRAMME OUTCOMES (PO's)

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design / Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

P.S.R. ENGINEERING COLLEGE, SIVAKASI – 626140.

(An Autonomous Institution, Affiliated to Anna University, Chennai)

DEPARTMENT OF BIOTECHNOLOGY

Consolidated Curriculum Structure

(UG REGULATION 2019 – B.Tech. (BT)

Programme: B.Tech - BIOTECHNOLOGY

Sem-ester	Theory Courses					Theory Cum Practical Courses		Institution Non-Credit Courses	Practical Courses		Special Courses	Value Added / Mandatory Courses	Total Credits
1	191HS11 Communicative English (2)	191HS12 Calculus and Linear Algebra(4)	191HS13 Engineering Physics (2)	191HS14 Engineering Chemistry (2)	191CSF1 Programming for Problem Solving (3)	191MEF7 Mechanical Workshop (3)	-	-	191HS17 Physics and Chemistry Laboratory–I (1)	191CSF7 C Programming Laboratory (1)	-	-	***18***
2	191HS21 Technical English (2)	191HS22 Differential Equations and Numerical Methods (4)	191HS23 Physics of Materials (2)	191HS24 Environmental Science(2)	191ME21 Engineering Graphics (3)	191EE21 Basic Electrical and Electronics Engineering (3)	-	-	191HS27 Physics and Chemistry Laboratory – II (1)	191EEF7 Basic Electrical and Electronics Laboratory (1)	-	-	***18***
3	191HS31 Transforms and Discrete Mathematics (3)	191BT31 Material and Energy Balance (3)	191BT32 Microbiology (3)	191BT33 Cell and Molecular Biology (3)	-	191BT34 Essential Biochemistry (4)	191BT35 Plant Biology and Genetics (4)	191HS37 Communication Skills – I (0)	191BT37 Cell and Microbiology (2	-	-	Value Added Course –I	***22***
4	191HS42 Probability and Statistics (3) (2L+2T)	191BT41 Recombinant DNA Technology (3)	191BT42 Immunology and Immunotechnology (3)	191BT43 Enzyme Technology and Biotransformation (3)	-	191BT44 Bio Analytical techniques (4)	191BT45 Fundamentals of Heat and Mass Transfer (4)	191HS47 Communication Skills – II (0)	191BT47 Immunology and Immunotechnology Laboratory (2)	-	-	191MC0* Mandatory Course – I	***22***

Sem-ester	Theory Courses					Theory Cum Practical Courses		Institution Non-Credit Courses	Practical Courses		Special Courses	Value Added / Mandatory Courses	Total Credits
5	191BT51 Chemical Reaction Engineering (3)	191BT52 Plant and Animal Biotechnology (3)	191BT53 Bioprocess Principles (3)	191BT54 Protein Engineering (3)	**191BT* Elective – I (3) & II (3)**		-	191HS57 Business English (0)	191BT57 Molecular Biology and Genetic Engineering Laboratory (2)	191BT58 Basic Bioprocess Laboratory (2)	-	Value Added Course – II	***22***
6	191BT61 Bioprocess Engineering (3)	191BT62 Biopharmaceutical Technology (3)	191BT63 Metabolic Engineering (3)	**191BT* Elective – III (3)**	***191OE** Open Elective – I (3)***		191BT64- Bioinformatics and computational Biology (4)	191HS67 Career English (0)	191BT67 Bioprocess Engineering Laboratory (2)		19BT69 Mini Project (2)	191MC0* Mandatory Course – II	***23***
7	191BT71 Bio Separation Engineering (3)	191BT72 IPR and Bio Ethics (3)	191ME71 Total Quality Management (3)	**191BT* Elective – IV & V (3) (3)**	***191OE** Open Elective – II (3)***	-	-	-	191BT77 Bio Separation Laboratory (2)	191BT78 Nano-Biotechnology Laboratory (1)	191BT79 Project – I (2)	Value Added Course – III	***23***
8	-	-	**191BT* Elective – VI (3)**	**191BT* Elective – VII (3)**	-	-	-	-	-	-	191BT89 Project – II (6)	-	***12***
												TOTAL CREDITS	***160***

P.S.R. ENGINEERING COLLEGE, SIVAKASI – 626140.
UG REGUALTION – 2019
CHOICE BASED CREDIT SYSTEM
B.Tech - BIOTECHNOLOGY
CURRICULUM [I – VIII SEMESTERS – FULL-TIME]
Total Credits: 160

S. No.	Course Code	Name of the Course	Category	L–T–P	Credit
SEMESTER I					
Theory					
1	191HS11	Communicative English	HSMC	2–0–0	2
2	191HS12	Calculus and Linear Algebra	BSC	3–2–0	4
3	191HS13	Engineering Physics	BSC	2–0–0	2
4	191HS14	Engineering Chemistry	BSC	2–0–0	2
5	191CSF1	Programming for Problem Solving	ESC	3–0–0	3
Practical					
6	191MEF7	Mechanical Workshop	ESC	1–0–4	3
7	191HS17	Physics and Chemistry Laboratory –I	BSC	0–0–2	1
8	191CSF7	C Programming Laboratory	ESC	0–0–2	1
				No. of Credits:	**18**

S. No.	Course Code	Name of the Course	Category	L–T–P	Credit
SEMESTER II					
Theory					
1	191HS21	Technical English	HSMC	2–0–0	2
2	191HS22	Differential Equations and Numerical Methods	BSC	3–2–0	4
3	191HS23	Physics of Materials	BSC	2–0–0	2
4	191HS24	Environmental Science	BSC	2–0–0	2
5	191MEF1	Engineering Graphics	ESC	1–0–4	3
6	191EEF1	Basic Electrical and Electronics Engineering	ESC	3–0–0	3
Practical					
7	191HS27	Physics and Chemistry Laboratory – II	BSC	0–0–2	1
8	191EEF7	Basic Electrical and Electronics Laboratory	ESC	0–0–2	1
				No. of Credits:	**18**

S. No.	Course Code	Name of the Course	Category	L–T–P	Credit
SEMESTER III					
Theory					
1	191HS31	Transforms and Discrete Mathematics	BSC	2–2–0	3
2	191BT31	Material and Energy Balance	PC	3–0–0	3
3	191BT32	Microbiology	BSC	3–0–0	3
4	191BT33	Cell and Molecular Biology	BSC	3–0–0	3
5	191BT34	Essential Biochemistry	BSC	3–0–2	4
6	191BT35	Plant Biology and Genetics	BSC	3–0–2	4
Practical					
7	191HS37	Communication Skills – I	HSMC	0–0–2	0
8	191BT37	Cell and Microbiology Laboratory	PC	0–0–4	2
9		*Value Added Course - I*	NC	2–0–0	0
				No. of Credits:	**22**

S. No.	Course Code	Name of the Course	Category	L–T–P	Credit
SEMESTER IV					
Theory					
1	191HS42	Probability and Statistics	BSC	2–2–0	3
2	191BT41	Recombinant DNA Technology	PC	3–0–0	3
3	191BT42	Immunology and Immunotechnology	PC	3–0–0	3
4	191BT43	Enzyme Technology and Biotransformation	PC	3–0–0	3
5	191BT44	Bio Analytical Techniques	PC	3–0–2	4
6	191BT45	Heat and Mass Transfer	PC	3–0–2	4
Practical					
7	191HS47	Communication Skills – II	HSMC	0–0–2	0
8	191BT47	Immunology and Immunotechnology Laboratory	PC	0–0–4	2
9	191MC*	Mandatory Course - I	NC	2–0–0	0
				No. of Credits:	**22**

S. No.	Course Code	Name of the Course	Category	L–T–P	Credit
SEMESTER V					
Theory					
1	191BT51	Chemical Reaction Engineering	PC	3–0–0	3
2	191BT52	Plant and Animal Biotechnology	PC	3–0–0	3
3	191BT53	Bioprocess Principles	PC	3–0–0	3
4	191BT54	Protein Engineering	PC	3–0–0	3
5	191BTE*	*Program Elective – I*	PE	3–0–0	3
6	191BTE*	*Program Elective - II*	PE	3–0–0	3
7		*Value Added Course - II*	NC	2–0–0	0
Practical					
8	191HS57	Business English	HSMC	0–0–2	0
9	191BT57	Molecular Biology and Genetic Engineering Laboratory	PC	0–0–4	2
10	191BT58	Basic Bioprocess Laboratory	PC	0–0–4	2
				No. of Credits:	**22**

S. No.	Course Code	Name of the Course	Category	L–T–P	Credit
SEMESTER VI					
Theory					
1	191BT61	Bioprocess Engineering	PC	3–0–0	3
2	191BT62	Biopharmaceutical Technology	PC	3–0–0	3
3	191BT63	Metabolic Engineering	PC	3–0–0	3
4	191BT64	Bioinformatics and Computational Biology	PC	3–0–2	4
5	191BTE*	*Program Elective – III*	PE	3–0–0	3
6	191OE*	*Open Elective – I*	OE	3–0–0	3
Practical					
7	191HS67	Career English	HSMC	0–0–2	0
8	191BT67	Bioprocess Engineering Laboratory	PC	0–0–4	2
9	191BT69	Mini Project	PROJ	0–0–4	2
10	191MC*	Mandatory Course - II	NC	2–0–0	0
				No. of Credits:	**23**

S. No.	Course Code	Name of the Course	Category	L–T–P	Credit
SEMESTER VII					
Theory					
1	191ME71	Total Quality Management	PC	3–0–0	3
2	191BT71	Bio Separation Engineering	PC	3–0–0	3
3	191BT72	Intellectual Property Rights and Bioethics	HSSM	3–0–0	3
4	191BTE*	*Program Elective – IV*	PE	3–0–0	3
5	191BTE*	*Program Elective – V*	PE	3–0–0	3
6	191OE*	*Open Elective – II*	OE	3–0–0	3
Practical					
7	191BT77	Bio Separation Laboratory	PC	0–0–4	2
8	191BT78	Nano-Biotechnology Laboratory	PC	0–0–2	1
9	191BT79	Project – I	PROJ	0–0–4	2
10		Value Added Course - III	NC	2–0–0	0
				No. of Credits:	**23**

S. No.	Course Code	Name of the Course	Category	L-T-P	Credit
SEMESTER VIII					
Theory					
1	191BTE*	*Program Elective – VI*	PE	3–0–0	3
2	191BTE*	*Program Elective – VII*	PE	3–0–0	3
Practical					
3	191BT89	Project –II	PROJ	0–0–12	6
				No. of Credits:	**12**
				Total No. of Credits:	**160**

S. No.	Categories	R-2019 Credits	AICTE Weightage
1	HSMC – Humanities and Social Science including Management Courses.	4	12
2	BSC – Basic Sciences and Biological sciences	38	19
3	ESC – Engineering Sciences	14	32
4	PC – Program Core	67	43
5	PE – Program Elective	21	18
6	OE – Open Elective	6	18
7	EEC – Employability Enhancement Courses	0	0
8	MC – Mandatory Course	0	0
9	PROJ – Project	10	18
	TOTAL	**160**	**160**

LIST OF PROGRAM ELECTIVES					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L–T–P**	**Credit**
1.	191BTEA	Thermodynamics for Biotechnologist	PE	3–0–0	3
2.	191BTEB	Green Biotechnology and Pollution Abetment	PE	3–0–0	3
3.	191BTEC	Entrepreneurship and Start-ups	PE	3–0–0	3
4.	191BTED	Bio Waste Management	PE	3–0–0	3
5.	191BTEE	Process Equipment & Plant Design	PE	3–0–0	3
6.	191BTEF	Cancer Therapeutics	PE	3–0–0	3
7.	191BTEG	Principles of Food Processing	PE	3–0–0	3
8.	191BTEH	Tissue Engineering	PE	3–0–0	3
9.	191BTEI	Stem Cell Technology	PE	3–0–0	3
10.	191BTEJ	Bio Conjugate Technology	PE	3–0–0	3
11.	191BTEK	Transport Phenomena	PE	3–0–0	3
12.	191BTEL	Biophysics	PE	3–0–0	3
13.	191BTEM	Rational Drug Discovery	PE	3–0–0	3
14.	191BTEN	Nano Biotechnology	PE	3–0–0	3
15.	191BTEO	Neurobiology	PE	3–0–0	3
16.	191BTEP	Gene Expression & Transgenic	PE	3–0–0	3
17.	191BTEQ	Structural Biology	PE	3–0–0	3
18.	191BTER	Marine Biotechnology	PE	3–0–0	3
19.	191BTES	Genomics & Proteomics	PE	3–0–0	3
20.	191BTET	Fundamentals of Molecular Pathology	PE	3–0–0	3
21.	191BTEU	Molecular Modelling	PE	3–0–0	3
22.	191BTEV	Human Anatomy and Medical Coding	PE	3–0–0	3
23.	191BTEW	Fundamentals of Research Methodology	PE	3–0–0	3

OPEN ELECTIVES OFFERED BY DEPARTMENT OF CSE					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L–T–P**	**Credit**
3	191OE1A	Green Computing	OE	3–0–0	3
4	191OE1B	Java Scripts	OE	3–0–0	3
2	191OE1C	Python Foundations	OE	3–0–0	3
1	191OE1D	Web Development using PHP	OE	3–0–0	3

OPEN ELECTIVES OFFERED BY DEPARTMENT OF ECE					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L–T–P**	**Credit**
1	191OE2A	Agriculture Electronics	OE	3–0–0	3
2	191OE2B	Consumer Electronics	OE	3–0–0	3
3	191OE2C	Medical Electronics	OE	3–0–0	3
4	191OE2D	Multimedia Compression and Communication	OE	3–0–0	3

OPEN ELECTIVES OFFERED BY DEPARTMENT OF EEE					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L–T–P**	**Credit**
1	191OE4A	Domestic and Industrial Electrical Installation	OE	3–0–0	3
2	191OE4B	Electrical Materials	OE	3–0–0	3
3	191OE4C	Energy Auditing and Conservation	OE	3–0–0	3
4	191OE4D	Energy Storage Systems	OE	3–0–0	3
5	191OE4E	Renewable and Sustainable Energy	OE	3-0-0	3
6	191OE4F	Vehicular Electric Power System	OE	3-0-0	3

OPEN ELECTIVES OFFERED BY DEPARTMENT OF BIO-TECHNOLOGY					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L–T–P**	**Credit**
1	191OE5A	Biomaterials	OE	3–0–0	3
2	191OE5B	Biosensors	OE	3–0–0	3
3	191OE5C	Bioweapons and Security	OE	3–0–0	3
4	191OE5D	Food and Nutrition Technology	OE	3–0–0	3

OPEN ELECTIVES OFFERED BY DEPARTMENT OF MECHANICAL ENGINEERING					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L–T–P**	**Credit**
1.	191OE6A	Maintenance Engineering	OE	3–0–0	3
2.	191OE6B	Non-Destructive Testing and Materials	OE	3–0–0	3
3.	191OE6C	Operations Research and Management	OE	3–0–0	3
4.	191OE6D	Renewable Sources of Energy	OE	3–0–0	3
5.	191OE6E	Robotics	OE	3–0–0	3

OPEN ELECTIVES OFFERED BY DEPARTMENT OF CIVIL ENGINEERING					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L–T–P**	**Credit**
1	191OE7A	Air and Noise Pollution Control	OE	3–0–0	3
2	191OE7B	Energy Science and Engineering	OE	3–0–0	3

3	191OE7C	Environment and Ecology	OE	3–0–0	3
4	191OE7D	Fundamentals of Fire Safety	OE	3–0–0	3

OPEN ELECTIVES OFFERED BY DEPARTMENT OF BIOMEDICAL ENGINEERING					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L–T–P**	**Credit**
1	191OE8A	Brain Computer Interface and its Applications	OE	3–0–0	3
2	191OE8B	Internet of Things in Medicine	OE	3–0–0	3
3	191OE8C	Speech Processing	OE	3–0–0	3
4	191OE8D	Telehealth Technology	OE	3–0–0	3

MANAGEMENT ELECTIVES OFFERED BY DEPARTMENT OF MBA					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L-T-P**	**C**
1	191BAEA	Engineering Economics and Accounting	HS	3–0–0	3
2	191BAEB	Entrepreneurship	HS	3–0–0	3
3	191BAEC	Essentials of Management	HS	3–0–0	3
4	191BAED	Intellectual Property Rights	HS	3–0–0	3
5	191BAEE	Professional Ethics in Engineering	HS	3–0–0	3
6	191BAEF	Women Studies and Women Empowerment	HS	3–0–0	3

MANDATORY COURSES					
S. No.	**Course Code**	**Name of the Course**	**Category**	**L–T–P**	**Credit**
1	191MC01	Design Thinking	MC	2–0–0	0
2	191MC02	Essence of Indian Traditional Knowledge	MC	2–0–0	0
3	191MC03	Indian Constitution	MC	2–0–0	0
4	191MC04	Universal Human Values	MC	2–0–0	0
5	191MC05	Yoga	MC	1-0-1	0

VALUE ADDED COURSES

The value-added courses on recent trends are offered in Semester III, V and VII for the knowledge enrichment of the students.

191HS11	COMMUNICATIVE ENGLISH	L	T	P	C
		2	0	0	2

Programme: B.Tech - Biotechnology **Sem: 1 Category: HSMC**

Aim: To acquire basic Language Skills in order to communicate with English Language Speakers.

Course Outcomes: The Students will be able to

CO1: Develop the basic reading and writing skills.

CO2: Listen actively and grasp the contents of the speech.

CO3: Develop their speaking skills and speak fluently in real contexts.

CO4: Develop vocabulary of a general kind by developing their reading skills.

CO5: Use the grammar effectively to exhibit their speaking and writing skill.

CO6: Speak in English with clarity.

SHARING INFORMATION RELATED TO ONESELF, FAMILY AND FRIENDS. 6

Reading – Short comprehension passages, Practice in skimming and scanning. **Writing –** Sentence structures, Developing Hints. **Listening–** Short texts, Short formal and informal conversations. **Speaking** – Introducing oneself, Exchanging personal information. **Language Development** – WH questions, Asking and answering YES or NO questions, Parts of Speech. **Vocabulary Development –** Prefixes & Suffixes, Subject verb Agreement.

GENERAL READING AND FREE WRITING 6

Reading – **Comprehension** – Pre-reading & Post-reading. Comprehension questions (Multiple choice questions, Short questions, Open-ended questions), Short narratives and Descriptions from Newspapers including Dialogues. **Writing –** Paragraph writing, Use of Phrases and Clauses in sentences, Listening Telephonic conversations. **Speaking** – Sharing information of a personal kind, Greetings.

Language Development – Noun Pronoun agreement. **Vocabulary Development** – The Concept of Word Formation. (Norman Lewis' *Word Power Made Easy*)

GRAMMAR AND LANGUAGE DEVELOPMENT 6

Reading – Short texts & Longer passages (Cloze reading). **Writing** – Importance of proper punctuation, Jumbled sentences. **Listening –** Listening to longer texts and filling up the table, Product description, Narratives from different sources. **Speaking –** Asking about routine actions and Expressing opinions.

Language Development – Degrees of Comparison, Pronouns. **Vocabulary Development –** Misplaced modifiers, Relative clauses.

READING AND LANGUAGE DEVELOPMENT. 6

Reading- Comprehension. **Reading** longer texts- reading different types of texts. **Writing**- letter Writing, informal or personal letters-Achieving Coherence. **Listening**- listening to dialogues or conversations and completing exercises based on them. **Speaking**- Speaking about oneself- Speaking about one's friend. **Language Development**- Articles. **Vocabulary Development** – Root words from foreign languages and their use in English.

EXTENDED WRITING 6

Reading- Longer texts- close reading. **Writing**- Organizing principles of paragraphs in documents. **Listening** – Listening to talks, conversations. **Speaking** – Participating in conversations, short group

conversations. **Language Development** - Cliches, Tenses. **Vocabulary Development** - Prepositions.

Total Periods: 30

Text Books:

1. Board of Editors. "Fluency in English: A course book for Engineering and Technology". Orient Blackswan, Hyderabad: 2016.
2. Kumar, Sanjay and PushpLata, "Communication Skills: A Workbook", New Delhi: OUP, 2018

References:

1. www.oxfordonlineenglish.com
2. www.ielts.up.com
3. www.ted.com
4. www.testpreppractice.com
5. www.beccambridgeenglish.org

Extensive Reading

1. Shiv Khera, *You Can Win*, Macmillan Books, New Delhi, 2003.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1												2				
CO2								1								2
CO3										3				1		
CO4								1								
CO5									2						3	
CO6										2						

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS12	CALCULUS AND LINEAR ALGEBRA	L	T	P	C
		3	2	0	4

Programme: B.Tech. Biotechnology **Sem: 1 Category: BSC**

Aim: The course is aimed at developing the basic mathematical skills of engineering students.

Course Outcomes: The Students will be able to.

CO1: Find the inverse and the positive powers of a square matrix.

CO2: Apply the concept of orthogonal reduction to diagonalise the given matrix

CO3: Determine the evolute of curves, Beta and Gamma Functions.

CO4: Apply Lagrangian multiplier method to find maxima and minima of an unconstrained problem.

CO5: Apply the concepts of Differentiation and Integration in Vectors

CO6: Predict an analytic function, when its real or imaginary part is known.

MATRICES **12**

Characteristic equation - Eigen Values and Eigen vectors of a real matrix - Properties of Eigen values - Cayley-Hamilton Theorem (without proof) and its application - Orthogonal Transformation of a Symmetric matrix to diagonal form - Quadratic form - Orthogonal reduction to canonical form.

CALCULUS **12**

Radius of Curvature - Cartesian and Parametric Coordinates - Circle of Curvature - Involutes and evolutes –Beta and Gamma functions and their properties.

MULTIVARIABLE CALCULUS **12**

Partial Derivatives - Total Derivative - differentiation of Implicit function – Jacobian - Taylor's Expansion - Maxima/Minima for function of two variables - Method of Lagrange's multipliers.

VECTOR CALCULUS **12**

Gradient, Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepiped.

COMPLEX VARIABLE – DIFFERENTIATION **12**

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy– Riemann equation and Sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function(without proof) – Harmonic conjugate – Construction of analytic functions – Conformal mapping : $w = z + c$, cz, $1/z$, and bilinear transformation.

Total Periods: 60

Text Books:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rdEdition, 2014.
2. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th edition, Pearson, Reprint, 2002

References:

1. Veerarajan.T., "Engineering Mathematics for first year", 4thEdition, Tata Mc-Graw – Hill, Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, 2006.
2. G.B. Thomas and R.L. Finney, "Calculus and Analytic Geometry", Pearson, 9th Edition, 2002.
3. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.
4. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36th Edition, 2010.
5. J. W. Brown, R. V. Churchill, Complex Variables and Applications, Mc-Graw-Hill, 7th Edition, 2004.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3		1								3		2	1	
CO2	2	3		3								2				1
CO3	3	3										2	2			
CO4	1	1													2	
CO5	3	2		2										2		
CO6	2	2		1								3	2			2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS13	ENGINEERING PHYSICS	L	T	P	C
		2	0	0	2

Programme: B.Tech. Biotechnology **Sem:** 1 **Category:** BSC

Aim: To endow the students with the fundamentals of Physics and apply new ideas in the field of Engineering and Technology.

Course Outcomes: The Students will be able to

CO1: Understand the theory and various crystal structures.

CO2: Know about the basic configuration of a Laser, types of lasers and the industrial applications of Laser.

CO3: Understand principle behind fiber optic communication and the electronic devices involved in the transmission and reception of data.

CO4: Know about basics of properties of matter and its applications.

CO5: Gain knowledge about basic equations of Quantum mechanics and its applications.

CO6: Understand the basic concepts of acoustics and ultrsonics.

SOLID STATE PHYSICS **6**

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Crystal Defects-point, Line and surface defects - burger vector.

WAVE OPTICS **6**

LASERS: Introduction – Principle of Spontaneous emission and stimulated emission. Population inversion, pumping. Einsteins A and B coefficients – Derivation- Types of lasers – CO_2, Nd-YAG - Industrial Applications - Lasers in welding, cutting and Soldering

FIBER OPTICS: Optical Fiber-Classification- Principle and propagation of light in optical fibres-Numerical aperture and Acceptance angle-Fibre optical communication system- Sensors (Active and passive) –Displacement and Temperature Sensors.

PROP ERTIES OF MATTER **6**

Elasticity–Stress - strain diagram and its uses -factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple- torsion pendulum: theory and experiment -bending of beams -bending moment –cantilever: theory and experiment–uniform and non-uniform bending: theory and experiment – I shaped girders - stress due to bending in beams.

QUANTUM PHYSICS **6**

Black body radiation – Planck's theory -Photoelectric effect - Matter waves – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box.

ACOUSTICS AND ULTRASONICS **6**

ACOUSTICS: Classification of sound - loudness and intensity - Weber-Fechner Law - standard intensity and intensity level - decibel - reverberation - reverberation time - Sabine's formula - absorption coefficient and its determination – factors affecting acoustics of buildings: focusing, interference, echo, Echelon effect, resonance - noise and their remedies

Ultrasonics: Ultrasonics - production – magneto striction and piezoelectric methods - acoustic grating - industrial applications - NDT.

Total Periods: 30

Text Books:

1. Gaur R. K., Gupta S. C., "Engineering Physics" Dhanpat Rai Publications, New Delhi (2016).
2. Avadhanulu M. N., Kshirsagar, P. G., "A Text book of Engineering Physics", S.Chand and company, Ltd., New Delhi, 2017.,

References:

1. Serway and Jewett., "Physics for Scientists and Engineers with Modern Physics",6th Edition, Thomson Brooks/Cole, Indian reprint (2016)
2. AritherBeiser, "Concepts of Modern Physics", Tata McGraw Hill, NewDelhi (2015).

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2						3				2	1		3
CO2	2	3	1		2	1			1			2	1		1	1
CO3	2	1	2		1	1	2			1			2	1		3
CO4	2	3	1	1	3								1		2	1
CO5	1	1		2										2		1
CO6	1	2	3	1	1	2	3						2		1	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS14	ENGINEERING CHEMISTRY	L	T	P	C
		2	0	0	2

Programme: B.Tech. Biotechnology **Sem:** 1 **Category:** BSC

Aim: To impart a sound knowledge on the principles of chemistry involving the different application oriented topics required for all engineering branches.

Course Outcomes: The Students will be able to.

CO1: Demonstrate the essential concept of water and their properties and applications

CO2: The treatment of water for potable and industrial purposes.

CO3: Understand the operating principles and the reaction involved in electrochemistry.

CO4: Know the principles and application of spectroscopy.

CO5: Learn the basic ingredients required for paint formulation.

CO6: Know the preparation techniques of consumer products.

WATER TECHNOLOGY **6**

Hardness -Types and Estimation by EDTA method- alkalinity –types of alkalinity and Determination- Domestic water treatment –disinfection methods – Boiler feed water– internal conditioning– external conditioning – desalination and reverse osmosis.

ELECTROCHEMISTRY **6**

Electrochemical cells – reversible and irreversible cells – EMF –measurement of emf – Single electrode potential – Nernst equation– reference electrodes –Standard Hydrogen electrode –Calomel electrode – Ion selective electrode – glass electrode and measurement of pH – electrochemical series

SPECTROSCOPIC TECHNIQUES AND APPLICATIONS **6**

Introduction of UV-Visible and IR spectroscopy and selection rules- principles and instrumentation of UV-Visible (electronic) spectroscopy – IR (vibrational) spectroscopy - its applications. Fluorescence spectroscopy and its applications in medicine-colorimetry– estimation of iron by colorimetry .

INORGANIC & ORGANIC COATINGS **6**

Paint–Definition–Components of Paints and their functions–Varnish–Definition–Preparation of Oil Varnish–Differences between Paint and Varnish–Special Paints–Luminescent Paints, Fire Retardant Paints- Aluminium Paints - Distemper.corrosion control– electroplating (Au) and electroless (Ni) plating.

PREPARATION OF CONSUMER PRODUCTS **6**

Washing Powder- Cleaning powder - phenoyls (white, Black &coloured)- Shampoo- liquid blue- inks - blue –red - green inks – Soap - bathing & detergent – oils - Face powder and bleaching powder.

Total Periods: 30

Text Books:

1. P. Kannan, A. Ravikrishnan, “Engineering Chemistry”, Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009.
2. P.C.Jain and Monica Jain, “Engineering Chemistry” Dhanpat Rai Pub, Co., 2002.

References:

1. S.S. Dara, S.S. Umare, “Engineering Chemistry”, S. Chand & Co. Ltd., New Delhi 2010.
2. B.K.Sharma, “Engineering chemistry” Krishna Prakasan Media (P) Ltd., Meerut (2001).
3. B.Sivasankar, “Engineering chemistry” Tata McGraw Hill Pub., 2006.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2		1	1	1	1				2	2	2	1		1
CO2	2	2	1	2	1	2	1				1	1		1		2
CO3	2	1	1	2	2							2		1		
CO4	2	2	1		1						2	1			2	
CO5	2	2	1		1	1						2				2
CO6	2	2	1	1	2	1			1	1	1	1			2	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191CS11 **PROGRAMMING FOR PROBLEM SOLVING**

L	T	P	C
3	0	0	3

Programme: B.E./B.Tech. (EEE, CIVIL, MECH, BIO-TECH) **Sem:** 1 **Category:** ESC

Aim: To provide an awareness to Computing and Programming.

Course Outcomes: The Students will be able to

CO1: Understand the basic terminologies of Computer and various Problem solving techniques.

CO2: Write, compile and debug programs in C language.

CO3: Use different data types in a computer program.

CO4: Design programs involving decision structures, loops and functions.

CO5: Understand the dynamics of memory by the use of pointers.

CO6: Use different data structures and create/update basic data files.

INTRODUCTION **9**

Generation and Classification of Computers- Basic Organization of a Computer - Number System - Binary - Decimal - Conversion - Problems. Software - Types, Development Steps. Algorithm - Pseudo code - Flow Chart. Problem formulation - Problem Solving.

C PROGRAMMING BASICS **9**

Introduction to Unix Operating System - Introduction to ' C' programming - fundamentals - structure of a 'C' program - compilation and linking processes - Constants, Variables - Data Types - Expressions using operators in 'C' - Managing Input and Output operations - Decision Making and Branching - Looping statements - solving simple scientific and statistical problems.

ARRAYS AND STRINGS **9**

Arrays - Initialization - Declaration - One dimensional and Two dimensional arrays. String- String operations - String Arrays. Simple programs –Bubble Sort – Linear Search -Matrix Operations.

FUNCTIONS AND POINTERS **9**

Function - Definition of function - Declaration of function - Pass by value - Pass by reference - Recursion - Pointers - Definition - Initialization - Pointers arithmetic - Pointers and arrays- Example Problems.

STRUCTURES AND FILES **9**

Introduction - need for structure data type - structure definition - Structure declaration - Structure within a structure - Union - Programs using structures and Unions - File Manipulation - Storage classes - Pre-processor directives.

Total Periods: 45

Text Books:

1. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2017.
2. Balagurusamy E, "Programming in ANSI C", Tata Mcgraw-Hill Education, 2016
3. ReemaThareja, "Computer Fundamentals and Programming in C", 2e, Oxford University Press, 2016.

References:

1. Byron S Gottfried, "Programming with C", Schaum's Outlines, 3rdEdition, McGraw-Hill, 2017.
2. Dromey R.G., "How to Solve it by Computer", Pearson Education, 4th Reprint, 2007.
3. Kernighan.B.W and Ritchie,D.M, "The C Programming language", 2nd Edition, Pearson Education, 2006.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2						3	2		3	3	3		
CO2	3	3	3						2	1		3	3	3	3	2
CO3		3	2						2			2	3	2		
CO4		3	3						3			3	3		3	
CO5	2	3	2									2		2		
CO6		2	3						2			3	2			2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MEF7	MECHANICAL WORKSHOP	L	T	P	C
		1	0	4	3

Programme: **B.E./B.Tech. (EEE, CIVIL, MECH, BioTech)** **Sem:** **1** **Category:** **ESC**

Prerequisite: Nil

Aim: To Provide exposure to the students with hands on experience on various basic Engineering Practices.

Course Outcomes: The Students will be able to

CO1: Make the square fitting, vee & step fitting.

CO2: Produce simple wooden joints using wood working tools.

CO3: Fabricate tray and funnel in sheet metal

CO4: Create simple lap, butt and tee joints using arc welding equipment's.

CO5: Identify the various pipe joints

CO6: Make the pipe connections

FITTING OPERATIONS & POWER TOOLS **12**

Preparation of square fitting, vee & step – fitting models.

CARPENTRY **12**

Study of the joints in roofs, doors, windows and furniture; Hands-on-exercise: Dismantling & Assembling of various wooden furniture; Preparation of T Joint, dove tail joint

SHEET METAL FORMING **12**

Preparation of tray and funnel.

WELDING **12**

Preparation of arc welding of butt joints and lap joints

PLUMBING **12**

Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings; Hands-on-exercise - basic pipe connections – Mixed pipe material connection – Connections with different joining components.

Total Periods: 60

LIST OF EQUIPMENTS (For a batch of 30 Students)

1. Fitting vice (fitted to work bench) - 15Nos
2. Fitting Tools – 15 set
3. Carpentry vice (fitted to work bench) - 15 Nos.
4. Models of industrial trusses, door joints, furniture joints - 5 Nos.
5. Standard woodworking tools - 15 Sets
6. Hand Shear – 01
7. Standard tools and calipers for sheet metal work – 05
8. Arc welding transformer with cables and holders - 5Nos.
9. Welding booth - 5 Nos
10. Welding accessories like welding shield, chipping hammer, Wire brush, etc., - 5Sets
11. Assorted components for plumbing consisting of metallic pipes, Plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings - 15 Sets.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	3				3							2
CO2	2	2	3	3	3				3							2
CO3	2	2	3	3	3				3							1
CO4	2	2	3	3												1
CO5	2	2	3	3												1
CO6	2	2	3	3	3				3							1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS17	PHYSICS AND CHEMISTRY LABORATORY-I	L	T	P	C
		0	0	2	1

Programme: **B.E./B.Tech. (Common to all Branches)** **Sem:** **1** **Category:** **ESC**

Prerequisite: Engineering Physics & Engineering Chemistry

Aim: To introduce the basic Physics concepts through experiments and to impart the basic analysis in chemistry.

Course Outcomes: The Students will be able to

CO1: Understand the laser light propagation in optical fiber and the rigidity modulus of the materials.

CO2: Understand the velocity of sound in liquid and propagation light in the medium.

CO3: Know about the stress analysis and thermal conductivity of the material.

CO4: Gain knowledge of water quality parameter of potable water.

CO5: Determine the unknown concentrations of chemicals.

CO6: Apply the instrumental technique for calculating the amount of unknown substance.

LIST OF EXPERIMENTS – PHYS ICS PART (A minimum of five experiments shall be offered) 15

1. a. Determination of Particle Size using Diode LASER.
   b. Determination of wavelength of the LASER source.
   c. Determination of Acceptance angle and Numerical aperture of an optical fiber.
2. Torsional pendulum – Determination of rigidity modulus.
3. Determination of Velocity of sound and compressibility of liquid - Ultrasonic Interferometer.
4. Determination of Dispersive power of a prism using Spectrometer.
5. Determination of Young's modulus of the material - Non uniform bending.
6. Determination of thermal conductivity of a bad conductor - Lee's Disc method.

LIST OF EXPERIMENTS–CHEMISTRY PART (A minimum of five experiments shall be offered) 15

1. Estimation of Total Hardness of their home town Water by EDTA method.
2. Estimation of Alkalinity of Water sample.
3. Estimation of Chloride ion in water sample by Argentometric method.
4. Estimation of Ferrous Ion by Potentiometric Titrations.
5. Conductometric Titration of strong acid Vs strong base.

Total Periods: 30

References:

1. A.I. Vogel, "Text book of Quantitative Inorganic Analysis", ELBS, London (2006).
2. A. Ravikrishnan, "Practical Engineering Chemistry", Sri Krishna Publications, Chennai (2002).
3. Engineering Physics Laboratory Manual. & Engineering Chemistry Laboratory Manual.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1		2		1					1				
CO2	1	2	2				1					1				
CO3	2	2	2				1					1				
CO4	2	2	1		1		2					1				
CO5	3	2	1	2	2		1					2				
CO6	2	1	3		2		2					2				

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191CS17 **C PROGRAMMING LABORATORY** **L T P C**
0 0 2 1

Programme: B.E./B.Tech. Common to all Branches **Sem: 2 Category: ESC**

Aim To provide practical knowledge in developing C Programming.

Course Outcomes: The Students will be

CO1: Able to have fundamental concept on basics commands in Linux.

CO2: Able to write, compile and debug programs in C language.

CO3: Able to formulate problems and implement algorithms in C.

CO4: Able to effectively choose programming components that efficiently solve computing problems in real-world.

CO5: Able to design application oriented programs in C.

CO6: Structures and unions through which derived data types can be formed.

LIST OF EXPERIMENTS:

1. Draw a flowchart for various algorithms using Raptor
2. C Programming using Simple statements and expressions.
3. Scientific problem solving using decision making and looping.
4. Simple programming for one dimensional and two-dimensional arrays.
5. Solving problems using String functions.
6. Programs with user defined functions - Includes Parameter Passing.
7. Program using Recursive Function and conversion from given program to flow chart.
8. Programs using pointers
9. Program using structures and unions.
10. Program using files.

Total Periods 60

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Standalone desktops with C compiler 30 Nos.

(or)

Server with C compiler supporting 30 terminals or more.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2						2				3	1	1	
CO2	3	2	2						2				3	2	2	
CO3	3	2	3						2				3	3	2	
CO4	2	3	2						2				3	2	2	2
CO5	3		2						2				3	2	1	
CO6	2		2										2	2	1	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS21 **TECHNICAL ENGLISH**

L	T	P	C
3	0	0	3

Programme: **Sem: 2** **Category: HSMC**

Prerequisites: Acquire proficiency in Technical English

Aim: To develop the students' Intellectual, Personal & Professional abilities.

Course Outcomes: The Students will be able to

CO1: Remember words and its meanings for the specific purpose.

CO2: Understand the basic nuances of language.

CO3: Apply written communication methodologies at workplace.

CO4: Develop Listening skill to respond and to gather information.

CO5: Interpret the text using comprehending skill.

CO6: Involve in professional correspondences confidently.

INTRODUCTION TO TECHNICAL ENGLISH **6**

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises. **Speaking** – Asking for and giving directions. **Reading** – reading short technical texts, Newspapers. **Writing** - Purpose statements, Extended definitions, Writing Instructions & Recommendations, Checklists. **Vocabulary Development** - Technical Vocabulary. **Language Development** – Subject Verb Agreement.

READING AND STUDY SKILLS **6**

Listening - Listening to longer technical talks and completing exercises based on them. **Speaking** – Describing a process. **Reading** – Reading longer technical texts, Newspapers identifying various transitions in a text- paragraphing. **Writing -** Techniques for writing Precisely. **Vocabulary Development -**vocabulary used in formal letters/emails and reports. **Language Development -** Personal & Impersonal Passive voice, Numerical adjectives.

TECHNICAL WRITING AND GRAMMAR **6**

Listening - Listening to classroom lectures on Engineering / Technology. **Speaking** – Introduction to Technical presentations. **Reading** – Reading longer texts both general and Technical, practice in rapid reading. **Writing**- Describing a process, Use of sequence words, Causes and Effects **Vocabulary Development** - Sequence words, Nominal compounds, Misspelled words. **Language Development** - Embedded sentences.

REPORT WRITING **6**

Listening- Listening to documentaries and Making notes. **Speaking** – Mechanics of presentations. **Reading** – Reading for detailed comprehension. **Writing -** Job application, cover letter, Resume preparation. **Vocabulary Development -** Finding suitable synonyms, Paraphrasing. **Language Development** – Clauses, If conditionals.

GROUP DISCUSSION AND JOB APPLICATIONS **6**

Listening - TED/Ink talks. **Speaking** – Participating in a Group discussion. **Reading** – Reading and Understanding Technical articles. **Writing** – Writing reports, Minutes of Meeting, Introduction and Conclusion. **Vocabulary Development -** Verbal analogies**. Language Development -** Reported speech.

Total Periods: 30

Text Books:

1. SudharshanaN.P. and C.Savitha. English for Technical Communication. New Delhi: Oxford University Press, 2017.

References:

1. www.bbc.co.uk/learning english
2. www.bec Cambridge english.org

3. www.englishenglish101.com
4. www.islcollective.com

Extensive Reading

1. Kalam, Abdul. *The Wings of Fire*. Hyderabad: UP, 1999. Print.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2															2	
CO3								1		2			3			
CO4																
CO5				2												
CO6											2			1		

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS22	DIFFERENTIAL EQUATIONS & NUMERICAL METHODS	L	T	P	C
		3	2	0	4

Programme: **B.E. / B.Tech. (Common to all branches)** **Sem:** **2** **Category:** **BSC**

Prerequisites: Engineering Mathematics – I

Aim: To analyze the engineering problems using the techniques and the mathematical skills acquired by studying ODE and PDE uses numerical methods.

Course Outcomes: The Students will be able to

CO1: Use suitable method to solve higher order Differential Equations.

CO2: Use suitable method to solve higher order PDE.

CO3: Interpolate discrete data by means of continuous function.

CO4: Discover Numerical integration using Trapezoidal and Simpson's $1/3^{rd}$ rules.

CO5: Find the solution for the IVPs in ODE using single step and Multistep methods.

CO6: Find the solution of BVPs in PDE using finite difference methods.

ORDINARY DIFFERENTIAL EQUATIONS **12**

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

PARTIAL DIFFERENTIAL EQUATIONS **12**

Formation of partial differential equations–Lagrange's linear equation–Solutions of standard types of first order partial differential equations (without reducing the standard type) –Linear homogenous partial differential equations of second and higher order with constant coefficients.

SOLUTION OF EQUATION & INTERPOLATION, NUMERICAL DIFFERENTIATION **12**

Solutions of Polynomial and transcendental equations – Newton Raphson method - Interpolation using Newton's forward and backward difference formulae - Interpolation with unequal intervals- Newton's divided difference and Lagrange's formulae - Numerical differentiation using Newton's forward and backward difference formula - Numerical Integration – Trapezoidal rule and Simpson's $1/3^{rd}$ rule.

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS **12**

Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method – Milne's predictor – corrector methods for solving first order equations – Finite difference methods for solving second order equation.

BOUNDARY VALUE PROBLEMS OF PARTIAL DIFFERENTIAL EQUATIONS **12**

Finite differences solution of one-dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two-dimensional Laplace and Poisson equations.

Total Periods: 60

Text Books:

1. B.S. Grewal, 'Higher Engineering Mathematics', Khanna Publishers, 36^{th} Edition, Delhi, 2005.
2. Grewal B.S. and Grewal J. S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2004).

References:

1. Greenberg. *M.D*. "Advanced Engineering Mathematics, 2^{nd} Edition, Pearson Education Inc. (First Indian reprint), 2002.
2. Venkataraman. M.K., "Engineering Mathematics", Volume I and II Revised enlarged Fourth Edition,The National Publishing Company, Chennai, 2004.
3. Kreyszig, E., Advanced Engineering Mathematics, 8th edition, John Wiley Sons, 2001.
4. Chapra S.C., Canale R.P., "Numerical Methods for Engineers", Tata Mc-Graw Hill, New Delhi, (2007).

5. Gerald C.F., and Wheatley P.O., “Applied Numerical Analysis”, Pearson Education Asia, New Delhi, (2006).

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1		1								3		2	1	
CO2	2	2		2												1
CO3	2	1		2								1	2			
CO4	1	2		3								2			2	
CO5	2	3												2		
CO6	3	3			3				1			2	2			2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS23	PHYSICS OF MATERIALS	L	T	P	C
		2	0	0	2

Programme: **Common to all Branches** **Sem:** **2** **Category:** **BSC**

Prerequisites: Engineering Physics

Aim: To endow the students with the fundamentals of physics, materials and apply new ideas in the field of Engineering and Technology.

Course Outcomes: The Students will be able to

CO1: Understand the theory and processing of conducting, superconducting materials.
CO2: Acquire knowledge of classification of semi conducting materials.
CO3: Gain knowledge about the types of magnetic materials and their applications.
CO4: Enhance the knowledge about dielectric materials and their applications.
CO5: Understanding on the functioning of optical materials for optoelectronics.
CO6: Know about the basics of quantum structures and their applications in spintronic.

ELECTRICAL PROPERTIES OF MATERIALS **6**

Conductors: classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – Draw backs of classical theory –Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals.

Super Conductors: properties - Types of super conductors - Applications of superconductors – SQUID, cryotron, magnetic levitation.

SEMICONDUCTOR PHYSICS **6**

Intrinsic semiconductor – carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – Extrinsic semiconductors – carrier concentration derivation in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration– Hall effect – Determination of Hall coefficient – Applications.

MAGNETIC AND DIELECTRIC MATERIALS **6**

Magnetic Materials: Origin of magnetic moment – Bohr magneton – Dia and para magnetism – Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – anti – ferromagnetic materials – Ferrites – applications. **Dielectric Materials:** Polarization - electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation –dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer) – ferroelectricity and applications.

OPTICAL PROPERTIES OF MATERIALS **6**

Classification of optical materials–carrier generation and recombination processes-Absorption -emission and scattering of light in metals, insulators and Semiconductors (concepts only)- photocurrent in a P-N diode –solar cell–photo detectors-LED-optical storage techniques.

NEW MATERIALS **6**

Metallic glasses: Preparation, properties and applications. **Shape memory alloys (SMA):** Characteristics - Properties of NiTi alloy – Applications -Advantages and disadvantages of SMA. **Nanomaterials:** synthesis – chemical vapour deposition– ball milling - properties of nanoparticles and applications. **Bio Materials :** Classification – Properties – Applications

Total Periods: 30

Text Books:

1. William D. Callister, Jr., "Material Science and Engineering", John Wiley & Sons Inc., Seventh Edition, New Delhi (2017).
2. Kasap, S.O. "Principles of Electronic Materials and Devices", McGraw -Hill Education, 2016.

References:

1. Koch C., "Nanostructured materials: processing, properties and applications", William Andrew pub. 2011.

2. Charles P. Poole and Frank J.Ownen., “Introduction to Nanotechnology”, Wiley India 2016.
3. Charles Kittel., “Introduction to solid state Physics”, John Wiley & Sons, 7th Edition, Singapore 2012.
4. Ragavan, V., “Material science and Engineering”, Prentice Hall of India (2004).
5. Umesh K Mishra, Jasprit Singh, “Semiconductor Device Physics and Design”, Springer,2014.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1			3			1			1	3	1		
CO2	3	2	2	1		1						1	2	1	1	
CO3	1		2	1		2	1		1				1	2		
CO4	2	2	1	1		2		1					2	2		
CO5	3	1	3	2	2								2	1	1	
CO6	3	3	3	2	3	2	1			1			3		1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS24	ENVIRONMENTAL SCIENCE	L	T	P	C
		2	0	0	2

Programme: **B.E. / B.Tech. (Common to all branches)** **Sem:** **2** **Category:** **BSC**

Prerequisites: Basic Science

Aim: To impart the social groups and individuals to acquire knowledge of pollution and environmental degradation.

Course Outcomes: The Students will be able to

CO1: Understand the basic concepts of environment and energy resources.

CO2: Get knowledge about the ecosystem.

CO3: Identify and analyze causes, effects and control measures of various types of pollution.

CO4: Get the knowledge about types of disaster and mitigation measures.

CO5: Understand the impact of social issues and climate change

CO6: Understand to create the green environment.

ENVIRONMENT AND ENERGY RESOURCES **6**

Environment- definition, scope and importance – Need for public awareness – Forest resources-deforestation–Energy resources: Growing energy needs, renewable (solar energy and wind energy) and non-renewable energy sources-Nuclear energy – fission and fusion reactions and light water nuclear reactor for power generation (block diagram only), Petroleum processing and fractions.

ECOSYSTEM **6**

Ecosystem: Concept of an ecosystem – Structure and function of an ecosystem: Producers, consumers and decomposers, Energy flow in the ecosystem-Nitrogen cycle, Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the Forest ecosystem and Aquatic ecosystems (lake and rivers).

ENVIRONMENTAL POLLUTION **6**

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Marine pollution (d) Noise pollution. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution –Disaster management: floods-landslides.

SOCIAL ISSUES AND EARTH'S CLIMATE SYSTEM **6**

Population-variation among nation-Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting– climate change, global warming, acid rain, Ozone layer depletion.

GREEN CHEMISTRY **6**

Introduction to green chemistry- 12 principles of green chemistry-toxicology and green chemistry- energy and green chemistry-education in green chemistry. Reuse and recycling technologies-material selection for green design-recycled water technology.

Total Periods: 30

Text Books:

1. Ravikrishnan, "Environmental Science and Engineering, Sri Krishna Hitech Publishing Company Private Limited, 2010.
2. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.

References:

1. Anubha Kaushik, C.P. Kaushik, "Environmental Science and Engineering", New Age International Publishers, 2016.

2. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill Publishing Company Ltd, New Delhi, ISBN: 0070601690, 2006.
3. Raman Sivakumar, Introduction to Environmental Science and Engineering, Tata McGraw Hill Education Private Limited, New Del2010.
4. P.Meenakshi, Elements of Environmental Science and Engineering, PHI learning (P) Ltd., India.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2		1	1	1	1				2	3	2	1		1
CO2	2	2	1		1	2	1				1	2		1		2
CO3	2	1	1	2	2			1				2		1		
CO4	2	2	1		1						2	2			2	
CO5	2	2	1		1	1						2				2
CO6	2	2	1		2	1			1	1	1	2			2	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MEF1	ENGINEERING GRAPHICS	L	T	P	C
		1	0	4	3

Programme: B.E./B.Tech. (EEE,CIVIL,MECH,BIO-TECH) Sem: 2 Category: ESC

Aim: To develop graphic skills in students.

Course Outcomes: The Students will be able to

CO1: Follow the conventions used in engineering graphics.

CO2: Practice plane curves and free hand sketching.

CO3: Draw the projections of points, lines and plane.

CO4: Draw the projections of simple solids and their sectional views.

CO5: Describe the applications of development of surfaces.

CO6: Practice isometric and perspective projections.

Concepts and conventions (Not for Examination)

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions (1) and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

PLANE CURVES **12**

Conics – Construction of ellipse, Parabola and hyperbola by eccentricity method – Construction of cycloid – Construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

PROJECTION OF POINTS, LINES AND PLANE SURFACES **12**

Projection of Points in all four quadrants - Projection of straight lines located in the first quadrant – inclined to both planes – Determination of true lengths and true inclinations – Projection of regular polygonal and circular lamina inclined to both reference planes.

PROJECTION OF SOLIDS **12**

Projection of simple solids like Prisms, Pyramids, Cylinder and Cone when the axis is inclined to one reference plane.

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES **12**

Sectioning of above solids in simple vertical position by cutting planes inclined to HP and perpendicular to VP – Obtaining true shape of section; Development of lateral surfaces of truncated solids – Prisms, Pyramids, Cylinder and Cone

ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS **12**

Principles of isometric projection – isometric scale – isometric projections of truncated Prisms, Pyramids, Cylinder and Cone; Conversion of Isometric Views to Orthographic Views and Vice-versa.

Total Periods: 60

Text Books:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, (2016)

References:

1. Venugopal K. and Prabhu Raja V., **"**Engineering Graphics**",** New Age International (P) Ltd., 2016.
2. Shah M.B. and Rana B.C., **"**Engineering Drawing**",** Pearson Education (2009).
3. John K.C., "Engineering Graphics for degree", PHI Learning Pvt. Ltd., New Delhi, (2015).
4. Kumar M.S., "Engineering Graphics"**,** D.D. Publications, (2015)

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		3		2					3			1			1
CO2	3		2		2					3			1			1
CO3	3		2		2					3			1			1
CO4	3		3		2					3		1	1			1
CO5	3		3		2					3			1			1
CO6	2		2		2					3		1	1			1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EEF1	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

Programme: B.E./B.Tech. (CIVIL, MECH, BIO-TECH) **Sem:** 2 **Category:** ESC

Prerequisites: Algebra, Calculus and Electrostatics

Aim: To provide comprehensive idea about AC and D C circuit analysis, working principles and applications of basic machines in electrical engineering and protection schemes in power system.

Course Outcomes: The Students will be able to

CO1: Analyze DC and AC circuits using basic laws.

CO2: Understand the operation of measuring instruments.

CO3: Apply the basic laws governing the operation of the instruments.

CO4: Demonstrate about DC machines, AC machines and its applications.

CO5: Analyze and compare the construction, theory and characteristics of the semiconductor devices.

CO6: Design basic combinational and sequential logic circuits.

ELECTRICAL CIRCUITS & MEASUREMENTS **12**

Ohm's Law – Kirchhoff's Laws –Reduction of series and parallel circuits - Mesh and Nodal Analysis of DC circuits – Introduction to AC Circuits - RMS Value, Average value, Form factor and peak factor phasor representation – Single Phase AC series circuits with R, RL, RC & RLC- Power and Power factor. Introduction to three phase circuits- Star and delta connected balanced load. Electrical measurements - Introduction, Operating torques, Operating Principles of Moving Coil and Moving Iron Instruments, Dynamometer type Watt meters and Energy meter.

DC MACHINES & TRANSFORMER (Qualitative treatment only) **8**

DC Generators - construction, principle of operation, Types, EMF equations and applications. DC Motors - operation, Types, Speed and torque equation – speed control of DC shunt motors. Single Phase Transformer - Constructional details and operation, Types, EMF equation, transformation ratio.

AC MACHINES (Qualitative treatment only) **8**

Synchronous generators - construction and operation, EMF equation - Synchronous motors – principle of operation. Three phase induction motor – Types, Construction and operation, Torque equation, slip torque characteristics, Single phase induction motor - construction, operation and applications.

SEMICONDUCTOR DEVICES AND APPLICATIONS (Qualitative treatment only) **9**

Introduction to semiconductors-PN Junction Diode – characteristics, breakdown effect and applications - Half wave and Full wave rectifiers, Zener Diode - characteristics and voltage regulator. Bipolar Junction Transistor – operation of NPN and PNP, characteristics of CB, CE, CC configurations. Transducer - Thermistor, Thermocouple, Hall effect, peltier effect.

DIGITAL ELECTRONICS (Qualitative treatment only) **8**

Number System – Binary, octal, hexadecimal, Logic Gates (AND, OR,NOT,NAND,NOR,XOR,XNOR), Half and Full Adders – Flip-Flops –RS, JK, T and D - Counters – synchronous up counter, synchronous down counter, asynchronous up counter, asynchronous down counter, shift registers – shift right and shift left register

Total Periods: 45

Text Books:

1. Muthusubramanian R, Salivahanan S, "Basic Electrical, Electronics and Computer Engineering", McGraw Hill, New Delhi, 2009.
2. B L Theraja, AK Theraja,'A Text book of Electrical Technology: Volume 2 AC and DC Machines', S.Chand; Twenty Third edition, 2006.

3. R.S. Sedha, “A Textbook of Applied Electronics” S. Chand & Co., 2008.

References:

1. V N Mittle, Arvind Mittle “Basic Electrical Engineering”, McGraw Hill, New Delhi, 2005.
2. Nagsarkar T K and Sukhija M S, “Basics of Electrical Engineering”, Oxford University press (2012).
3. V K Mehta, Rohitmehta “Principles of Electronics”, S.Chand& Company Ltd, (2015).
4. Mahmood Nahvi and Joseph A. Edminister, “Electric Circuits”, Schaum’ Outline Series, McGraw Hill, (2014).
5. NPTEL Video Lecture Notes on “Basic Electronics “ by Prof. M.B Patil, IIT Bombay

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1							3		3	3	2	3
CO2	3	2									2		3	2	1	3
CO3	3	3		1							2		3	2		3
CO4	3	2									2		3	3	2	3
CO5	3	2		1							3		3	3		3
CO6	3	3	3	2							3		3	2		3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EEF7	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY	L	T	P	C
		3	0	0	3

Programme: B.E./B.Tech. (CIVIL, MECH, BIO-TECH) **Sem:** 2 **Category:** ESC

Aim:

Course Outcomes: The Students will be able to

CO1: Facilitate the operation of fluorescent lamp, staircase wiring and simple wiring.

CO2: Apply the circuit theory concepts and analyze the outcome.

CO3: Illustrate the VI characteristics of PN diode.

CO4: Examine the V-I characteristics of a Zener diode.

CO5: Obtain various characteristics of DC Machines.

CO6: Model and analyze the performance characteristics of induction motors.

LIST OF EXPERIMENTS

1. Simple wiring connection
2. Staircase wiring
3. Fluorescent lamp wiring
4. Study of electronic components and equipments
5. Verifications of ohm's law and kirchoff's voltage law
6. Characteristics of semiconductor diode
7. Characteristics of zener diode
8. Speed control of dc shunt motor
9. Load test on dc shunt motor
10. Load test on single phase induction motor

Total Periods 30

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1				3		3		3	2	2	2
CO2	3	2		2	1				3		2		3	2		2
CO3	3	2		2	1				3		2		3	2		3
CO4	3	3	2	2	1				3		2		3	2		3
CO5	3	2		2	1				3		3		3	2	1	2
CO6	3	2		2	1				3		3		3	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS27 **PHYSICS AND CHEMISTRY LABORATORY-II**

L	T	P	C
0	0	2	1

Programme: **B.E./B.Tech. (Common to all Branches)** **Sem:** **1** **Category:** **ESC**

Prerequisite: Engineering Physics & Engineering Chemistry

Aim: To introduce the basic Physics concepts through experiments and to impart knowledge on the application of chemistry in engineering branches.

Course Outcomes: The Students will be able to

CO1: Learn the interference of light and young's modulus of the materials.

CO2: Understand the properties of flow of the liquid.

CO3: Know the band gap of material and resistance of the given coil.

CO4: Determine the quantity of unknown solution by instrumental technique.

CO5: Determine the concentration of an identified analyze by volumetric analysis

CO6: Analyze the characteristics of water.

LIST OF EXPERIMENTS – PHYSICS PART (A minimum of five experiments shall be offered) 15

1. Determination of thickness of thin wire – Air wedge method
2. Determination of Young's modulus of the material – Uniform bending
3. Determination of viscosity of liquid – Poiseuille's method.
4. Determination of wavelength of mercury spectrum- Spectrometer Grating.
5. Determination of Band Gap of a semiconductor material.
6. Determination of specific resistance of a given coil of wire – Carey Foster Bridge.

LIST OF EXPERIMENTS–CHEMISTRY PART (A minimum of five experiments shall be offered) 15

1. Esimation of HCl by pH metry
2. Estimation of Copper in brass by EDTA method.
3. Estimation of iodine in iodized salt with thiosulfate
4. Determination of percentage of calcium in limestone by EDTA method
5. Determination of DO in water (Winkler's method)

Total Periods: 30

References:

1. Text book of Quantitative Inorganic Analysis, A.I.Vogel, ELBS,London, (2006).
2. "Practical A. Ravi Krishnan Engineering Chemistry", Sri Krishna Publications, Chennai (2002).
3. Engineering Physics Laboratory Manual
4. Engineering Chemistry Laboratory Manual

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	1		1					1				
CO2	2		1	1	1		1					1				
CO3	2	2		1	1		1					1				
CO4	2	2	1		2		1									
CO5	3	2	2		2							2				
CO6	3	2	2	2			2					2				

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS31	TRANSFORMS AND DISCRETE MATHEMATICS	L	T	P	C
		2	2	0	3

Programme: B.E. Computer Science and Engineering **Sem: 3 Category: BSC**

Aim: To introduce basic mathematical ideas such as reasoning techniques, basic counting techniques and their applications.

Course Outcomes: The Students will be able to.

CO1: Apply Laplace transform to solve first and second order differential equations with elementary function.
CO2: Explain the Fourier transform and with their properties.
CO3: Determine Z-inverse transform using convolution theorem and partial fraction method.
CO4: Apply mathematical induction and prove a relation.
CO5: Invent Eulerian and Hamiltonian paths to find shortest paths.
CO6: Make use of graph theoretic models to solve basic problems in networks.

LAPLACE TRANSFORMS **9**

Laplace transform — Properties of Laplace Transforms – Laplace Transform of periodic functions –Inverse Laplace transforms by partial fraction method and Convolution theorem (excluding proof) – Solving ODE using Laplace transformation techniques.

FOURIER TRANSFORMS **9**

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms– Properties–Transforms of simple functions–Convolution theorem –Parseval's identity.

Z-TRANSFORMS **9**

Z-transforms–Elementaryproperties–InverseZ-transform–Convolutiontheorem– Formation of difference equations – Solution of difference equations using Z-transform.

INTRODUCTION TO COUNTING **9**

Decision problems on Propositional logic – Basic counting techniques – inclusion & exclusion-Pigeonhole principle – Permutations and combinations – Recurrence relations – Solving Linear recurrence relations and generating functions.

INTRODUCTION TO GRAPHS **9**

Graphs and their basic properties– Graph terminology and special types of graphs - Representing graphs and graph isomorphism – Euler and Hamilton paths.

Total Periods: 45

Text Books:

1. B.S. Grewal, 'Higher Engineering Mathematics', 36thEdition, Khanna Publishers, Delhi, 2005.
2. Grewal B.S. and Grewal J. S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2004).

References:

1. Greenberg. *M.D*. "Advanced Engineering Mathematics, 2nd Edition, Pearson Education Inc. (First Indian reprint), 2002.
2. Venkataraman. M.K., "Engineering Mathematics", Volume I and II Revised enlarged 4th Edition, The National Publishing Company, Chennai, 2004.
3. Trembly J. P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw–Hill Pub., New Delhi, 30th Re-print (2007).
4. Dr.P.Kandasamy, Dr.K.Thilagavathy, Dr.K.Gunavathy, "Transforms and Partial Differential Equation", S.Chand & Company Ltd. Ram Nagar, New Delhi.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1		1								3		2	1	
CO2	3	2		3												1
CO3	3	1		2								2	3			
CO4	2	3		2								3			2	
CO5	2	2												2		
CO6	1	2			2				2			3	3			2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT31	MATERIAL AND ENERGY BALANCE	L	T	P	C
		3	0	0	3

Programme: B.Tech - Biotechnology **Sem: 3 Category: PC**

Aim: To give intensive quantitative training in the practical applications of the principles of physical chemistry to the solution of complicated industrial problems and in methods of predicting missing physicochemical data from generalized principles.

Course Outcomes: The Students will be able to

CO1: Understand and apply the basics of calculations related to material and energy flow in the processes.

CO2: Predict the behaviour of gas and liquid mixtures.

CO3: Perform simultaneous material and energy balances with and without chemical reactions.

CO4: Correlate the chemical reaction with biological reaction.

CO5: Recognize the basic mechanisms of chemical reaction.

CO6: Solve practical problems related to humidification/dehumidification and saturation.

INTRODUCTION **9**

Units and dimensions, Stoichiometry of chemical equations, Mole and weight fractions, Unit operations and unit processes with reference to material and energy balance calculations.

BEHAVIORS OF GAS AND LIQUID MIXTURES **9**

Gas laws, Raoult's law, Henry's law, Duhring's plot, Saturation, Partial saturation, Relative saturation, Real gases, Bubble point and dew point temperatures.

MATERIAL BALANCE CALCULATIONS **9**

Law of conservation of mass, General material balance equation, Material balance calculations without chemical reactions, Material balance calculations with chemical reactions, Recycling, Bypass, Purge, Analysis of degrees of freedom.

ENERGY BALANCE CALCULATIONS **9**

General energy balance equation, Internal energy, Enthalpy, Heat capacity of gases, liquids, and solids, Latent heats, Heats of formation, combustion, reaction and dissolution, Enthalpy-concentration chart, Energy balance calculations in unit operations and systems with and without chemical reactions, Energy balance calculations in humidification and adiabatic cooling.

CHEMICAL REACTION EQUILIBRIA **9**

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; equilibrium conversion of single and multiple reactions.

Total Periods: 45

Text Books:

1. Narayanan K.V., Lakshmikutty B. " Stoichiometry and process calculation", 1st edition, Prentice Hall India(2006)
2. Bhatt, B.I. and Vora, S.M., Stoichiometry, Tata McGraw Hill (2004).

References:

1. Hougen, O.A., Watson, K.M. and Ragatz, R.A., Chemical Process Principles, Volume-I, C.B.S. Publications (2004).
2. Felder, R.M, and Rousseau, R.W., Elementary Principles of ChemicalProcesses, C.B.S. Publications (2000)

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		3			2		2				3		2	3
CO2			3			2						2		2		
CO3	2	3		3	2		3		2				3	1	2	2
CO4	2	2		3	1		3		2				2	1	2	2
CO5	3	3	2	2			2			2			2	1	2	
CO6		2				1					1					1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT32 **MICROBIOLOGY** **L T P C**
3 0 0 3

Programme: B.Tech. Biotechnology **Sem: 3 Category: BSC**

Aim: To impart basic knowledge of all classes of microorganisms namely, bacteria, viruses, and fungi.

Course Outcomes: The Students will be able to

CO1: Learn the fundamental concepts of Microscopy and different organisms.
CO2: Be able to obtain knowledge in morphology and staining techniques.
CO3: Obtain a significant knowledge in advanced aspects of molecular analysis.
CO4: Gain knowledge about microbes interaction and therapeutic modalities.
CO5: Learn about various diseases and microbial application.
CO6: Apply the basic principles of microorganism to construct the biological systems.

FUNDAMENTAL CONCEPTS OF THE MICROBES **9**

Introduction, History and scope of microbiology, classification and nomenclature of microorganisms. Basics of Microscopy, Staining: simple, differential (Gram staining, Acid fast staining), special staining (flagella, capsule, endospore).

MICROBIAL STRUCTURE AND REPRODUCTION **9**

Structural organization and multiplication of bacteria, viruses (Virus - TMV, HIV & T4 bacteriophage - lytic, lysogenic cycle), Fungi - Fungal morphology - Mycelial and yeast forms - sexual and asexual Reproduction.

MICROBIAL GROWTH AND MOLECULAR SYSTEMIC **9**

Microbial Nutrition and growth- Types of growth media, growth phases, various culture types, Types of fungal growth media, Microbial Metabolism - Aerobic & anaerobic respiration, Entner Duodruffs pathway, nitrogen fixation. Molecular systemic- Polyphasic approach 16s rRNA gene sequencing.

CONTROL OF MICROORGANISMS **9**

Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.

MICROBIAL DISEASE AND APPLICATIONS OF MICROBIOLOGY **9**

Infection- Causes and Transmission of Infectious Diseases, Identification of Microorganisms from Specimens, Epidemiology of Infectious Disease. Bioterrorism agents.

Total Periods: 45

Text Book:

1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
2. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.
3. Bernard R. Glick & Jack J. Pasternak. 2002. Molecular Biotechnology. Indian edition. Panima Publishing Corporation.

References:

1. Tortora, G.J., Funke, B.R. and Case, C.L. 2012. Microbiology, An Introduction. 11th Edition. Pearson Education.
2. Stainer, Ingharam, Wheelis and Painter. 1987. General Microbiology. 5th Edition. Macmillan Education, London.
3. R.W. Old and S.B. Primrose. 1985. Principles of gene manipulation. Blackwell Scientific Publications.
4. R.A. Atlas. 1998. Microbiology, Fundamental and Applications. 2nd Edition. McMillan Publishers.
5. Powar and Daginawala. 2010. General Microbiology. Volume – I. Himalaya Publishing House

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1		3	1			1					2	1	3	2
CO2	3	1	3	2	3	1	1					1	1	2	1	3
CO3			2	1	3	1				1				1		2
CO4			1		3		1	2					2	2		1
CO5	1	1				2	3	1			1	1	1		2	
CO6	1	2			2			1				2	2	2	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT33	CELL AND MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem: 3 Category: BSC**

Aim: The course aims to develop skills of the Students in the area of Cell Biology and molecular biology.

Course Outcomes: The Students will be able to

CO1: Differentiate and identify microbial, plant and animal cells.
CO2: Explicate the transport phenomena across the plasma membrane.
CO3: Identify the cell machinery of signal amplification.
CO4: Understand the mechanism of gene replication and transcription.
CO5: Gain knowledge on gene repairing and regulation process.
CO6: Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.

CELL STRUCTURE AND CELL DIVISION **9**

Structure and function of Prokaryotic and Eukaryotic cells. Structure and functions of cell organelles - Mitochondria, ER, Ribosome, Golgibodies, Nucleus. Organization of Plasma membrane, Membrane models. Cell division-Mitosis and Meiosis, Cell cycle and its regulation.

TRANSPORT ACROSS CELL MEMBRANE **9**

Passive and active transports, Permeases, Sodium -potassium pumps, Ca^{2+} ATPase pump, ATP dependent proton pumps, cotransport, symport, antiport, Endocytosis and Exocytosis.

CELL RECEPTORS AND CELL SIGNALING **9**

Membrane bound, cytosolic and nuclear receptors, autocrine, paracrine and endocrine signaling, signal amplification, CAMP, role of IP_3, CAMP and G-protein role in signal transduction, Ca^{2+} influx and its role in cell signaling.

REPLICATION AND TRANSCRIPTION **9**

Genetic material - Conservative, Semi-Conservative - DNA replication: Messelson & Stahl experiment. Fidelity of DNA replication, Inhibitors of DNA replication. Transcription in prokaryotes and Eukaryotes - Transcription factors - promoters and enhancers.

EXPRESSION OF GENE AND REGULATION **9**

Genetic code - Translation and post translational modifications, Operon Concept - Lac, gal, trp operon – Mutation – Repair – Regulation of gene expression in prokaryotes and Eukaryotes.

Total Periods: 45

Text Book:

1. Ajoy Paul, A text Book of Cell and Molecular Biology, Books and Allied Publishers 2007.
2. David Freifelder, Molecular Biology-2nd Edition, Narosa publishing house, 1998.

References:

1. Darnell J Lodish,H. Baltimore, Molecular cell biology, Free Man,1990.
2. De Roberties and De Roberties.JR, Cell and Molecular Biology- BI publications ,1987.
3. Stryer, L., Biochemsitry, 4th Edition, W.H. Freeman & Co., 2000.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	2	1		1	2	2	2		2	3			
CO2	1	2	2	3	2	1	1	2	2	3	1	2		2		
CO3	1	2	3	2	2	2	2	3	2	2					3	
CO4		1	3	2	1		2			1				2		1
CO5	1	3	2			2										2
CO6			2	1							2	3	2	3		1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT34	ESSENTIAL BIOCHEMISTRY	L	T	P	C
		3	0	2	4

Programme: B.Tech. Biotechnology **Sem: 3 Category: BSC**

Aim: To enable the students, learn the basic fundamental of biochemical processes.

Course Outcomes: The Students will be able to

CO1: Describe the basic design of life, structure, function physicochemical properties of water in the biological system.
CO2: Explain the structure and functional role of carbohydrates in biological reactions.
CO3: Differentiate the simple and complex structure of lipids along with the metabolism.
CO4: Gain knowledge in the hierarchical organization of proteins and their metabolic pathways.
CO5: Apply the basic principles of chemistry to construct the biological systems.
CO6: Describe the synthesis of biomolecules and role in metabolic pathway.

WATER **9**

Structure of water; non covalent (weak) interactions - hydrogen bonding, ionic, hydrophobic, van der Waals, osmolarity and osmolality; introduction to buffering system and biological buffers; Cellular reactions of water- ionization, concept of pH, pK, acids and bases, Henderson-Hassel balch equation.

CARBOHYDRATES **9**

Nomenclature; structure, classification and functions of carbohydrates: monosaccharides – disaccharides –polysaccharides – Metabolism of Carbohydrates - Glycolysis – Citric acid cycle – gluconeogenesis – glycogenesis – glycogenolysis – Pentose phosphate pathway – glyoxalate cycle; Regulations.

LIPIDS **9**

Classification – structure and functions of lipids; Fatty acids – TAG structure and properties Phospholipids – functions; Derived lipids – cholesterol – Metabolism of Lipids - Fatty acid biosynthesis and degradation; Cholesterol biosynthesis and ketone bodies formation.

AMINOACIDS AND PROTEINS **9**

Classification, Structure and function of aminoacids – Properties; Proteins – Classification – hierarchy of proteins – primary, secondary, tertiary and quaternary structure – Determination of primary structure; biologically important peptides. Metabolism – synthesis and degradation of aminoacids.

NUCLEIC ACIDS AND VITAMINS **9**

Structure and function of bases: purines and pyrimidines; Nucleotides – Nucleosides; Structure of DNA and RNA. Metabolism – Denova – Salvage pathway and degradation of nucleotides. Vitamins – classification; biological importance, deficiency disorders and biochemical functions; Anti-oxidants and their role in biological systems.

Total Periods: 45

COMPONENT LAB – LIST OF EXPERIMENTS

1. Titration of weak acid-weak base.
2. Quantitative Test for carbohydrates.
3. Distinguish reducing and non-reducing sugars.
4. Using Ninhydrin for distinguishing Imino and amino acids.
5. Estimation of Protein content.
6. Estimation of fatty acids from oil
7. Estimation of nucleic acid by spectrophotometer.

Text Book:

1. David L. Nelson and Michael M Cox, Lehninger's Principles of Biochemistry, Macmillan Worth Publisher, 6th Edition, 2012.

References:

1. Voet D., Prat W.C., Voet J., "Principles of Biochemistry", John Wiley and Sons, 4th Edition 2012.

2. Berg J. M., Tymoczko J. L., Stryer, L., "Biochemistry" 7th Edition, Macmillon, 2012.
3. Rodwell V., Bender D., Botham K., Kennelly P., Anthony Weil P., "Harpers Illustrated Biochemistry" McGraw Hill, 30th Edition 2015.
4. Jeyaraman J., "Laboratory Manual in Biochemistry", New Age International Publi., 2nd Edition, 2011.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1		2			2					2	2			1
CO2	2			2		2								2		
CO3	1		2			2				1	2					2
CO4		3	2	1	2						1	2			3	1
CO5	2	2	3	2		2		1			2			3		
CO6		1			2				1				2		1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT35	PLANT BIOLOGY AND GENETICS	L	T	P	C
		3	0	2	4

Programme: B.Tech. Biotechnology **Sem: 3 Category: BSC**

Aim:

Course Outcomes: The Students will be able to

CO1: Able to understand the mechanism of assimilation geochemical and transformation.
CO2: Understand the process of plant growth and maturation.
CO3: Knowing the innate protective mechanism of plant and respond to environment.
CO4: Gain the knowledge on gene responsibility and expression.
CO5: Develop the fundamental techniques for genetic engineering.
CO6: Understand the process of gene exchange and role of transposons

PLANT PHYSIOLOGY **9**

Plant Metabolism and regulation pathways, Carbon assimilation: photosynthesis, photorespiration and sucrose transport; Non-photosynthetic generation of energy and precursors. Storage of carbon. Metabolism in plastids. Nitrogen, phosphorus, sulfur and iron assimilation; Movement of water and minerals.

PLANT GROWTH **9**

Plant Development; Embryo and seed development. Root and shoot development. Transition from vegetative to reproductive phase and from sporophyte to gametophyte. Plant response to environmental signals: Seed germination. Signaling during seedling development and flowering

PLANT MANAGEMENT **9**

Plant response to environmental biotic and abiotic stress. Interactions of plants with other organisms: Microbial pathogens, pests, parasites, viruses and viroid. Defense mechanism in plants. Useful interactions between plants and organisms. Plant domestication and agriculture: The history of plant domestication with specific examples. Scientific plant breeding and role of markers in plant breeding.

GENETIC MATERIAL **9**

Mendelian genetics, Discovery of DNA as genetic material, Experiments of Griffith; Avery, McCleod and; McCarthy, and Harshey and Chase. RNA as genetic material- Experiment of Fraenkel and Singer, Transformation; Transduction and Conjugation: F factor-mediated transformation.

TRANSPOSABLE ELEMENTS **9**

Transposable elements Maize and Drosophila; Introduction and Types of Gene mutations- Base substitution and Frame shift mutations; Mutagens - Physical and chemical; Reverse mutation in bacteria; DNA repair mechanism (Mismatch repair photo reactivation, excision and SOS repair); Beneficial and harmful effects of mutations.

Total Periods: 45

COMPONENT LAB – LIST OF EXPERIMENTS

1. Plant cell structure and arrangement in monocot and dicot stem, root and leaf
2. Response of plants to light and gravity.
3. Vegetative propagation and crafting.
4. Rhizosphere microbial population analysis.
5. Mono and dihybrid analysis using color beads
6. Extraction of RNA from animal and plant tissues.
7. Preparation of Drosophila polytene chromosome squashes.

Text Book:

1. Plant Biology. Allison Smith et al. Garland Science, 2010.
2. Biochemistry & Molecular Biology of Plants. Bob Buchanan, Wilhelm Gruissem, Russell Jones. John Wiley & Sons, 2002

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1				2				2		2		1	
CO2	3	2		3	1		2				2	1		3	2	
CO3		2	3			2					2	2	3		2	
CO4	3	2	2	2				2						2	3	
CO5	2	1			2	1		2		3		2		2		3
CO6	3	2	2	1	2		1	2	1	2					2	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS37	COMMUNICATION SKILLS – I	L	T	P	C
		0	0	2	MC

Programme: B.E./ B.Tech. (Common to all Branches) **Sem: 3 Category: HSMC**

Aim: To create an Environment to improve learner's communication skill using Professional English module.

Course Outcomes: The Students will be able to

CO1: Impart basics of Language relating to Business Communication
CO2: Impart basics of Grammar relating to Business Communication
CO3: Imbibe the spirit of accurate and appropriate Basic Communication
CO4: Familiarize with the Professional Communication Module
CO5: Improve learners ability to understand Technical Communication

Language & Grammar **2**

1 Use of Verb, Article, Adjectives, Adverbs, Preposition, Conjunction, Comparative Superlative,
2 Noun –Antecedent & Precedent
3 Spelling &Punctuation
4 Concord
5 Use of Active & Passive voice
6 Use of Conditional Sentence & Reported speech

Reading **4**

1. Reading technical reports for Gist
2. Reading Technical Article, Graphs, Charts, Adverts, Notices & Proposals for Structure and detail

Writing **3**

1. Writing E-mails for giving Instruction/ Summarizing/Persuading/Giving assurance/asking a comment
2. Writing an Introduction to Report/Proposal/Technical Description
3. Writing Instructions & Recommendations for User manuals/Equipment's/devices/New Inventions

Listening **3**

1. Listening to Technical News for Gist
2. Listening to Technical Interviews for gathering information
3. Listening to a Presentation for inferring meaning

Speaking **6**

1 Self-Introduction
2 Have your say- Recent gadgets/Technical Innovations/ Scientific Inventions.

TOTAL **18 PERIODS**

TEXT BOOKS

1. Technical Writing: Process and Product, Gerson, Pearson Education India, 2007, ISBN: 8131709280, 9788131709283
2. Business Benchmark Pre-Intermediate to Intermediate: Student's Book BEC Preliminary Edition, Norman Whitby, PB + 2 Audio CDs,ISBN: 9780521759397

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1						2				3		2				3
CO2										3						3
CO3								2	1	3		1				3
CO4	1								1	3				2	2	3
CO5	1					3			1	1	2	2				
CO6						3	1		1	1		2				

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT37 CELL AND MOLECULAR BIOLOGY LABORATORY

L	T	P	C
0	0	4	2

Programme: B.Tech. Biotechnology **Sem: 3 Category: PC**

Aim: The course provides the practical knowledge about Microscope, cell structure, staining, genetic materials and functions.

Course Outcomes: The Students will be able to

CO1: Describe sterilization techniques and good laboratory practices in microbiology.

CO2: Identify the different types of microscope in cells identification.

CO3: Understand cell separation and identification

CO4: Demonstrate the effect of osmosis and tonicity.

CO5: Identify various stages of mitosis using staining techniques.

CO6: Gain lab knowledge and make benefit into the microbiology based industry.

LIST OF EXPERIMENTS

1. Microscope – Bright field, phase contrast and fluorescent microscopy.
2. Introduction to principles of sterile techniques and cell propagation
3. Staining Techniques.
4. Osmosis and Tonicity.
5. Staining for different stages of mitosis in *Allium Cepa* (Onion).
6. Plating techniques.
7. Microbial medium and culture preparation.
8. Isolation and characterization of soil bacteria.
9. Microbiological examination of food products.
10. Antimicrobial activity

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				2		2					3	1	2	
CO2	2	3		3	2								3	2	3	
CO3		3				2	2	3		3			3		3	
CO4	2	3		2	3								3			
CO5	2	2		2	2							2	2	3	2	
CO6	2	1	2		2	1	1			1		2	2	2	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS42	PROBABILITY AND STATISTICS	L	T	P	C
		2	2	0	3

Programme: **B.E./B.Tech. (CIVIL CSE, EEE, MECH, BIOTECH & BIOMEDICAL)** **Sem: 4** **Category: BSC**

Aim: To analyze the engineering problems using the techniques and the mathematical skills acquired by studying ODE and PDE uses numerical methods.

Course Outcomes: The Students will be able to

CO1: Classify the discrete and continuous random variables.

CO2: Analyze the binomial, Poisson, geometric, uniform, exponential and normal distribution.

CO3: Understand the Two-dimensional Random Variables.

CO4: Analyze the differences between means& standard deviations.

CO5: Test the independence of attributes for small samples.

CO6: Classify the tests for single variance and equality of variances.

PROBABILITY AND RANDOM VARIABLES **9**

Probability spaces – Conditional probability – Bayes rule - Discrete and continuous random variables – Moments - Moment generating functions and their properties.

DISCRETE AND CONTINOUS PROBABILITY DISTRIBUTION **9**

Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and normal distributions – Function of Random Variable.

TWO DIMENSIONAL RANDOM VARIBLES **9**

Joint distributions - Marginal and conditional distributions – Covariance - Correlation and Regression - Transformation of random variables - Central limit theorem (for 2-D random variables).

STATISTICS **9**

Curve fitting by the method of least squares – fitting of Straight lines , Second degree parabolas and more general curves – Test of significance – Large sample test for single proportion , difference of proportions, single mean, difference of means and difference of standard deviations.

TESTING OF HYPOTHESIS **9**

Sampling distributions – Testing of hypothesis for mean, variance, proportions and differences using Normal, t, Chi-square and F distributions - Tests for independence of attributes and Goodness of fit.

Total Periods: 45

Text Book:

1. B.S. Grewal, 'Higher Engineering Mathematics', Thirty Sixth Edition, Khanna Publishers, Delhi, 2005.
2. Grewal B.S. and Grewal J. S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2004).

1. Greenberg. *M.D.* "Advanced Engineering Mathematics, Second Edition, Pearson Education Inc. (First Indian reprint), 2002.
2. Venkataraman. M.K., "Engineering Mathematics", Volume I and II Revised enlarged 4th Edition The National Publishing Company, Chennai, 2004.
3. Kreyszig, E., Advanced Engineering Mathematics, 8th edition, John Wiley Sons, 2001.
4. Chapra S.C. and Canale R.P., "Numerical Methods for Engineers", Tata Mc-Graw Hill, New Delhi (2007).
5. Gerald C.F., and Wheatley P.O., "Applied Numerical Analysis", Pearson Education Asia, New Delhi, (2006).

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	3			2							3	2		2
CO2	2	2	2			3							2			2
CO3	3		2			2							1	2		3
CO4	2	2												3		1
CO5		3	1			2								3		2
CO6	1					3							3			

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT41 **RECOMBINANT DNA TECHNOLOGY**

L	T	P	C
3	0	0	3

Programme: B.Tech. Biotechnology **Sem: 4 Category: PC**

Aim: To study the various underlying principles of genetic engineering that forms the basis of rDNA technology.

Course Outcomes: The Students will be able to

CO1: Acknowledge the basic principles of genetic Engineering to create rDNA.

CO2: Resourceful in current applications of biotechnology and advances in different research areas.

CO3: Explain the gene transfer methodologies, and in brief the applications and related issues of rDNA technology.

CO4: Evaluate various cell culture screening techniques for selection and diagnosis of genetic diseases.

CO5: Build the C-DNA & genomic library using molecular techniques.

CO6: Apply the concept of Genetic Engineering in Biological fields with its ethics.

BASICS RECOMBINANT DNA TECHNOLOGY **9**

Enzymes in molecular biology Restriction endonuclease, Ligases, Reverse transcriptase, Nucleases, Polymerase, Alkaline phosphatase, Terminal transferase, T4 polynucleotide kinase; Linker, Adaptors, Homopolymers. DNA - protein interactions, electro-mobility shift assay.

EXPRESSION CASSETTE & VIRAL VECTOR **9**

Expression cassette – promoters (Constitutive, Inducible, Tissue specific), reporters and markers (Antibiotic resistant, Herbicide resistant, Ant-metabolite). Recombinant selection and Biochemical screening; Polymerase chain reaction (PCR), sequencing strategies, Blotting techniques: Southern and Northern blotting. Yeast plasmid vector, Viral vectors.

GENE TRANSFER METHODS **9**

Transformation –Microinjection, Liposome mediated transfer; DEAE Dextran mediated, CaPO4 mediated gene transfer. Expression systems of Prokaryotes (Bacteria) and Eukaryotes (Yeast and Mammalian).

SCREENING & SELECTION METHODS **9**

Gene cloning techniques for mammalian cells, Transgenic animals, *In-vitro* fertilization and embryo transfer, Molecular biological technique for rapid diagnosis of genetic disease and gene therapy.

APPLICATIONS OF R-DNATECHNOLOGY IN BIOLOGICAL FIELDS **9**

Molecular Techniques – RFLP, RAPD, AFLP, DNA Finger printing, DNA Foot printing, Microarray (DNA & Non-DNA). Libraries - Genomic library; C-DNA library & its types; Bioethics & Biosafety in genetic engineering.

Text Books:

1. Glick R. and J. J. Pasternak. 2002. Molecular Biotechnology (Ed: 3). ASM Press, Washington.Old
2. RW and SB Primrose. 1989. Principles of gene manipulation (Ed: 4). Blackwell scientific publications, London.
3. Alberts B, Johnson A., Lewis, J., M., Roberts, K., and P. Walter. Molecular Biology of the Cell, Fourth Edition. Garland & Co. 2002.

References:

1. Brown T. A. 1988. Gene cloning – An introduction. VNR (UK) co. Ltd, England.
2. Ernst L Winnacker. 2002. From genes to clones - Introduction to gene technology. VCR Pub., Weinheim.
3. James D Watson et al., 1992. Recombinant DNA (Ed: 2) WH freeman and co., New York.
4. Lodish H et al., Molecular Cell Biology, Sixth edition, W.H Freeman & Co. 2007.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		1			1		1		3	2	2	1	2	1	
CO2				3	2		1	1					2	3		1
CO3					1	3				1		2	3	1		2
CO4			1		2		1				2		2		2	1
CO5	1			2		3		1				2	1	2		
CO6						2		3	1	1	2		3		1	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT42	IMMUNOLOGY AND IMMUNOTECHNOLOGY	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** 4 **Category:** PC

Aim: To understand the basic concepts of immune system, elucidate the immune response of humans to foreign substances and to study the modern techniques of immunology that help determine human protection.

Course Outcomes: The Students will be able to

CO1: Learn the fundamental concepts of immunity, contributions of the organs and cells in immune responses.

CO2: Realize how the MHC molecules function and host encounters an immune insult.

CO3: Obtain a significant knowledge in advanced aspects of tumor immunotechnology.

CO4: Gain knowledge about immunologic processes and therapeutic modalities.

CO5: Acquire therapeutic skills- plan & execute experimental techniques independently as well as to analyse and interpret data.

CO6: Apply this knowledge to develop vaccine, clinical diagnosis and therapies for autoimmune diseases.

FUNDAMENTAL CONCEPTS OF THE IMMUNE SYSTEM **9**

Cells of immune system; innate and acquired immunity; primary and secondary lymphoid organs; antigens: chemical and molecular nature; Haptens; adjuvants; types of immune responses; antigen processing and presentation. Theory of clonal selection. Principles and applications - Monoclonal and Polyclonal antibody production.

HUMORAL AND CELLULAR IMMUNITY **9**

B cell development, maturation, activation and differentiation. Immunoglobulins, basic structure, classes & subclasses of immunoglobulins, antigenic determinants, Generation of antibody diversity. T cell development, maturation, activation and differentiation. Major Histocompatibility Complex (MHC), TCR; antibodies: structure and functions; antibodies: genes and generation of diversity

IMMUNOTECHNOLOGY **9**

Principles, methods of immunization. Hybridoma technology -monoclonal & polyclonal antibody production, antigen nature, animals of choice and purification of antibodies. Quantification of immunoglobulin by RID, EID and nephlometry. Immunization techniques, antibody titer assessment. Immunohistochemistry. Purification of antibody - ammonium sulphate precipitation, PEG Precipitation, affinity purification and column chromatography

CELLULAR IMMUNOLOGY **9**

Purification of mononuclear cells from peripheral blood, isolation and characterization of T cell subsets, B cells and macrophages. High content screening & cell imaging by fluorescent activated cell sorter (FACS). Assessment of delayed type hypersensitivity reactions. Macrophage cultures, assay for macrophage activation and isolation of dendritic cells.

THERAPEUTIC AGENTS **9**

Rationale for vaccine design based on clinical requirements. Recombinant DNA and protein based vaccines, plant - based vaccines and reverse vaccinology. Peptide vaccines, conjugate vaccines, cell therapy and cell based vaccines. Growth factors, interferon, tumor necrosis factor, cytokines, lymphokines & chemokines.

Text Books:

1. Kuby Immunology by Thomas J. Kindt, Barbara A. Osborne, Richard Goldsby
2. Roitt, I. and Male, B., "Immunology", Mosby Publ, 2002.
3. P.J.Delves I S.J.artin I D.R.Burton I I.M.Roitt. 2006. Essential Immunotechnology. 12th Edition

References:

1. Goldsby R.A. Kindt T.I and Osborne B.A Kuby. 2000. Immunology 4th Edition. WH Freeman & Co, NY.
2. Abbas,Lichtman,Shiv Pillai Cellular and Molecular Immunology 6th edition Elsevier 2017.
3. Introduction to Medical Immunology by Gabriel Virella.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3				1		1					2		2	1
CO2	1	3	1	3	1			1				2	1		1	
CO3		1		2	1	2		1			1		2	1	1	1
CO4		1			3		2	1			1	1		2	2	3
CO5		1	2	3		2			1	2	1	1	2	2	1	2
CO6	1	2		3	2	2		2	1	2			2	1	1	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT43	ENZYME TECHNOLOGY AND BIOTRANSFORMATION	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** 4 **Category:** PC

Aim: To learn enzyme reactions and its characteristics along with the production and purification process.

Course Outcomes: The Students will be able to

CO1: Acknowledge enzyme and enzyme reactions to proceed various concepts in Biotechnology

CO2: The theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.

CO3: Implement the process of immobilization in food, pharmaceutical and chemical industries.

CO4: Develop the production and purification of enzymes from natural sources.

CO5: Combine the Enzyme Biotransformation characterization and applications.

CO6: Summarize the enzyme reactions, Kinetics in Industrial purposes.

INTRODUCTION TO ENZYMES **9**

Classification of enzymes – Mechanisms of enzyme action – Concept of active site and energetics of enzyme substrate complex formation – Specificity of enzyme action – Principles of catalysis – Collision theory and transition state theory.

KINETICS OF ENZYME ACTION **9**

Kinetics of single substrate reactions; estimation of Michelis-Menten parameters – Multisubstrate reactions – Mechanisms and kinetics – Turnover number – Types of inhibition and models for substrate and product – Allosteric regulation of enzyme – Monod Changeux Wyman model – pH and temperature effect on enzymes & deactivation kinetics.

ENZYME IMMOBILIZATION AND BIOSENSORS **9**

Physical and chemical techniques for enzyme immobilization – Adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding and suitable examples – Advantages and disadvantages – Design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES **9**

Production and purification of crude enzyme extracts from plant, animal and microbial sources – Methods of characterization of enzymes – Development of enzymatic assays.

BIOTRANSFORMATION APPLICATIONS OF ENZYMES **9**

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.

Text Books:

1. Pandey A., Webb C., Soccol C. R. and Larroche C., Eds " Enzyme Technology", Springer, 2006.
2. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986

References:

1. Wiseman, Alan. Hand book of Enzyme Biotechnology, 3rd ed., Ellis Harwood 1995.
2. Buchholz, K., Kasche, V. and Bornscheuer, U., "Biocatalysts and Enzyme Technology", WILEY–VCH, 2005.
3. Drauz K., Gröger, H. and May O., "Enzyme Catalysis in Organic Synthesis: A Comprehensive Handbook", Volume 1, Wiley-VCH Verlag & Co, 2012.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	1			1	1	2	1	2	2			
CO2	1		2	2	3	1	1	1	2			1		3		
CO3	2	1	1	3	2	2		2	1	1	1	1			2	
CO4	1	3	2	2	1	1	1	2		2	2	2				1
CO5	2	2		1	1				1		1		1	2		
CO6		2	1	1	1			1		2	1			3		1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT44	BIO ANALYTICAL TECHNIQUES	L	T	P	C
		3	0	2	4

Programme: B.Tech. Biotechnology **Sem: 4** **Category: PC**

Aim: To develop the skills of the students in the area of Instrumentation in Biotechnology. This will be prerequisite for understanding specialized courses &project work that will be offered in the subsequent semesters.

Course Outcomes: The Students will be able to

CO1: Recall the theoretical aspects of key analytical techniques and instruments used in biological system.

CO2: Identify and characterize the biomolecules by molecular spectroscopy.

CO3: Demonstrate the different separation and purification methods for separation of biological products.

CO4: Examine radioactive isotopes in the field of medicine.

CO5: Check the role of electro analysis and surface chemistry.

CO6: Conclude the various analytical technique for the application to study cell functions and Disease diagnosis.

BASIC INSTRUMENTSTION **9**

Basics of Microscope and its types - Bright field Microscope, Dark field Microscope, Phase contrast Microscope, Fluorescent Microscope, Electron Microscope (TEM, SEM, Tunnelling EM) & Confocal Microscope, Microtechnique, pH meter.

SPECTROSCOPY **9**

Principles and Working of colorimetry, Spectroscopy: Basic principles, nature of electromagnetic radiation, Beer - Lambert laws - UV-Visible Spectrophotometry, Fluorescence Spectrophotometry, Atomic Absorption Spectrophotometry, FTIR, Raman Spectroscopy, Mass Spectrometry, Nuclear Magnetic Resonance (NMR) - Electron Spin Resonance (ESR).

SEPARATION AND PURIFICATION TECHNIQUES **9**

Electrophoresis of nucleic acids – Agarose gel electrophoresis. Electrophoresis of proteins - SDS-PAGE, IEF and 2D PAGE. Protein purification methods, Chromatography - Principles, methodology and applications of chromatography: paper, Thin layer, column (gel filtration, ion exchange, affinity), GC and HPLC. Basics of flow cytometry.

RADIO ISOTOPE TECHNIQUES **9**

Radioactive isotopes - storage, safety, handling and radioactive waste management. Liquid Scintillation counter - α-counter and β-counter. X-ray Diffraction, Crystallography, Autoradiography. Magnetic Resonance Imaging (MRI) and CT scan.

ELECTRO ANALYSIS AND SURFACE MICROSCOPY **9**

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 SFM.

Total Periods: 45

COMPONENT LAB – LIST OF EXPERIMENTS

1. Precision and validity in an experiment using absorption spectroscopy and Validating Lambert-Beer's law using KMnO4
2. Cell disruption technique by homogenization
3. Isolate and analyse the given sample using paper chromatography.
4. Separation of amino acids using Thin layer chromatography.
5. UV spectra of nucleic acids.
6. Separation of pigments using Thin layer chromatography.
7. UV–spectra of proteins.

Text Books:

1. David T. Plummer, An introduction to Practical Biochemistry, Tata McGraw Hill Edition, 1988.
2. Skoog, "Principles of Instrumental Analysis" Brooks Cole, 6th Edition, 2007.

References:

1. Biophysical chemistry: Principles and Techniques - Upadhaya and Nath - Himalaya publishing house, 2nd Review Edition, 2009.
2. Keith Wilson and John Walker, Practical Biochemistry - Principles and techniques, Cambridge University Press, U.K; 5th Edition, 2003.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1		3	1			1			1			3	
CO2	2	3	2	2	2						2	2	2			
CO3	3	1	2	2	3	3	1	1								2
CO4	1	2	1	2	1							2		3		
CO5	2	2	1			2	2								2	3
CO6	1	1	1	2	1			1			2		3	1	2	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT45	HEAT AND MASS TRANSFER	L-T-P	C
		3-0-0	3

Programme:	Sem:4	Category:	PC

AIM	The course aims to expose the students in the area of Heat and mass transfer. This will serve as a prerequisite for courses like bioprocess, enzyme engineering, Downstream processing and design of process equipment etc.

Course Outcomes: The Students will be able to

CO1: Understand the properties and flow of fluid.

CO2: Analyse the model and prototype.

CO3: Discuss the fundamental concepts of mass and heat transfer apply those concepts to solve real engineering problems.

CO4: Classify and use the accurate engineering correlations of diffusion and mass transfer coefficients to model a separation process.

CO5: Design and construction with operating principles of process economics of separating equipment.

CO6: Investigate a multi-stage equilibrium separation processes, simultaneous phase equilibrium and mass balances in continuous separation processes and sizing continuous separation units.

FLUID FLOW IN HEAT TRANSFER	**9**
Introduction to concepts of fluids - Pressure measurement by manometers, U-tube, differential and inclined manometers - Orifice meter, Venturimeter, Rota meter, Pumps - Types, selection and specifications, positive displacement pumps - Reciprocating pump – Centrifugal pumps - Characteristics curves of pumps - Fans, blowers and compressors.	
CONDUCTION & CONVECTION	**9**
Introduction – Conduction – Basic concepts of conduction in solids, liquids and gases – One and two dimensional heat conduction – Critical and optimum insulation thickness. Introduction to unsteady state heat transfer. Principles of convection – Equations of forced and free convection.	
RADIATION & HEAT EXCHANGERS	**9**
Basic laws of heat transfer by radiation – black body and gray body concepts – combined heat transfer coefficients by convection and radiation. Heat Transfer equipment – Double pipe, Shell & tube and Plate type heat exchanger.	
DIFFUSION	**9**
Molecular diffusion – Diffusion coefficient – Fick's Law Diffusion - Diffusion in multicomponent gas mixtures – Diffusion in solids – Molecular, Knudsen &surface diffusion – Inter-phase mass transfer – Mass transfer coefficients – Mass transfer in fluidized bed reactor – flow past solids and boundary layers.	
GAS-LIQUID - VAPOUR LIQUID OPERATIONS	**9**
Gas-Liquid equilibrium – Henry's Law – Selection of solvents – Absorption in tray column – Graphical and analytical methods – Absorption in packed column – Design equation for packed column – HTU, NTU concepts. Vapor-Liquid equilibrium – Flash distillation and differential distillation for two component mixture – McCabe-Thiele method.	
Total Periods:	**45**

TEXT BOOKS

1. Geankoplis. C.J "Transport Process & separation Process Principles" IVth Edition Prentice Hall of India 2005.
2. Incropera F.P. Fundamentals of Heat and Mass Transfer. JohnWiley.1998
3. Heat & Mass Transfer by P. K. Nag, Tata McGraw Hill – IIIrd Edition 2003
4. Treybal R.E, Mass Transfer Operations. 3rd Edition, MC Graw- Hill, 1981

REFERENCES

1. Coulson and Richardson's Chemical Engineering. Vol.I & II, Asian Books Pvt. Ltd, 1998.
2. McCabe W.L. Smith J.C. "Unit Operations in Chemical Engineering" 7thEdition McGraw Hill. 2014.

3.Principles of Heat Transfer Frank Kreith, Raj M. Manglik VIIth edition Cenage Learning Inc Mark S. Bohn

COMPONENT LAB – LIST OF EXPERIMENTS

1. Heat exchanger.
2. Simple and steam distillation.
3. Liquid-liquid equilibria in extraction.
4. Adsorption equilibrium.
5. Flow measurement through annular pipe & straight pipe.
6. Flow measurement of orifice and venturi meter.
7. Fluidization.

Text Books:

1. Geankoplis. C.J "Transport Process & separation Process Principles" IVth Edition Prentice Hall of India 2005.
2. Incropera F.P. Fundamentals of Heat and Mass Transfer. JohnWiley.1998
3. Heat & Mass Transfer by P. K. Nag, Tata McGraw Hill – IIIrd Edition 2003
4. Treybal R.E, Mass Transfer Operations. 3rd Edition, MC Graw- Hill, 1981

References:

1. Coulson and Richardson's Chemical Engineering. Vol.I & II, Asian Books Pvt. Ltd, 1998.
2. McCabe W.L. Smith J.C. "Unit Operations in Chemical Engineering" 7thEdition McGraw Hill. 2014.
3. Principles of Heat Transfer Frank Kreith, Raj M. Manglik VIIth edition Cenage Learning Inc Mark S. Bohn

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2			1			1		1		1		3	2	1
CO2	1			2	1	3			1			1		1	3	2
CO3	1		3		2		1					1	1	3	1	
CO4			3	1	1	1			2		1	1	3		2	1
CO5	2			1			3		2		2	1	1	3		1
CO6	1	2	3					1		2		1		3		1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS47	COMMUNICATION SKILLS – II	L	T	P	C
		0	0	2	MC

Programme: B.E./ B.Tech. (Common to all Branches) **Sem: 4 Category: HSMC**

Aim: To create an Environment to experiment Professional English communication module with Intermediate resources.

Course Outcomes: The Students will be able to

CO1: Be competent in Presentation skill

CO2: Develop their accuracy in Written Communication

CO3: Improve their ability to understand Technical Presentations.

CO4: Improve their ability to understand Conversations

CO5: Give the exposure with Internal workplace Communication

CO6: Give the exposure with External workplace Communication

A. Reading **4**

1. Reading Technical Articles, Reports, Proposals for gathering information
2. Reading Technical Journals, User manuals, annual reports for matching information

B. Writing **6**

1. Writing E-mail to inform/respond/Insist/Convince/comment
2. Writing Technical Report (Format, Types, Abstract)
3. Writing Project Introduction/Website/Product
4. Writing User Manuals/Guidelines
5. Writing Product Reviews
6. Writing Useful Expressions for Persuading, Summarizing, gathering information

C. Listening **2**

1. Listening to Telephonic conversation for filling the gaps
2. Listening to Group discussion to gather information
3. Listening to Interviews for writing short answers
4. Listening to Technical Presentation for evaluation

D. Speaking **6**

1. Mini-Presentation on Technical Themes (Samples):
   a) Cloud computing b) 4g c) Mission to Mars
   d) Water Resource e) Sixth Sense Technology
2. Group Discussion on Social and Technical issues

A. Speaking **6**

3 Self-Introduction

4 Have your say- Recent gadgets/Technical Innovations/ Scientific Inventions

TOTAL **18 PERIODS**

TEXT BOOKS

1. Technical Communication: Principles and Practice, 2/e,Meenakshi Raman; SangeetaSharma ISBN: 0198065299, 9780198065296
2. Business Benchmark Pre-Intermediate to Intermediate: Student's Book BEC Preliminary Edition, Norman Whitby, PB + 2 Audio CDs, ISBN: 9780521759397

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1										3	1					
CO2	1									3		3		1		
CO3									2	3	1				3	
CO4	1								2	3		3		1	3	
CO5								1	2	3						2
CO6								1	2	3						2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT47	IMMUNOLOGY AND IMMUNOTECHNOLOGY LABORATORY	L	T	P	C
		0	0	2	1

Programme: B.Tech. Biotechnology **Sem: 4 Category: PC**

Aim: Provides an opportunity to experimentally verify the theoretical concepts already studied. It also helps in understanding the theoretical principles in a more explicit and concentrated manner.

Course Outcomes: The Students will be able to

CO1: Underline a comprehensive and practical understanding of basic immunological principles involved in research and clinical science.

CO2: Interpret the knowledge for identification of immunological cells, their structure, function and Characteristics.

CO3: Apply principles of safety, quality assurance and quality control in Immunology.

CO4: Correlate the immunological disorders and the factors involved in it by various immunological assays.

CO5: Assess the Immunoassay to understand complement fixation system and other diseased conditions.

CO6: determine the toxicity of the natural and commercially available drugs.

LIST OF EXPERIMENTS

1. Selection of animals, preparation of antigens, immunization and methods of bleeding.
2. Separation of serum and plasma storage.
3. Determination of human blood groups by ABO blood group system.
4. Enumeration of leucocytes and Giemsa staining of blood smear for differential counting.
5. Isolation of monocytes from blood (RBC and WBC counts).
6. Separation and enumeration of PBMC's from peripheral blood.
7. Single Radial Immunodiffusion.
8. Testing for typhoid antigens by Widal test.
9. Immunoelectrophoresis.
10. Immunofluorescence.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		2	2	3	2	1			1	1			2			
CO2	1	1	3	2	2			1		1		2	2	1		
CO3	2	2	3	2	1	1				1	2	1			3	
CO4		2	1	3		1				1	1		2			
CO5	1			2		1		1		1						
CO6	2	2	3	2	1	1				1	2	1			3	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT51 **CHEMICAL REACTION ENGINEERING** **L T P C**
3 0 0 3

Programme: B.Tech. Biotechnology **Sem: 5** **Category: PC**

Aim: To develop the skills of the students in the area of chemical reaction engineering. This is a pre-requisite for courses offer in Bioprocess Technology and for designing a bio reactor.

Course Outcomes: The Students will be able to

CO1: Outline of Industrial chemical reactors and chemical kinetics.
CO2: Design and Construct the Ideal reactors of batch and semi-batch reactors.
CO3: Analyze the performance of non-ideal reactors using compartment model, tanks-in series model and dispersion model.
CO4: Evaluate the rate equations of Gas-Solid, Gas-Liquid Reactions.
CO5: List the different phase fluidized beds and reactors.
CO6: Apply the chemical kinetics in different types of industrial reactors.

SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING **9**

Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors.

IDEAL REACTORS **9**

Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; Multiple reactor systems; multiple reactions.

IDEAL FLOW AND NON IDEAL FLOW **9**

RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow.

GAS-SOLID, GAS-LIQUID REACTIONS **9**

Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

FIXED BED AND FLUID BED REACTORS **9**

G/l reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; Reactors for fluid- fluid reactions; tank reactors.

Total Periods: 45

Text Books:

1. Levenspiel O. “Chemical Reaction Engineering”, 3r dEdition. JohnWiley.1999
2. Fogler H.S. “Elements of Chemical Reaction Engineering”, Prentice Hall India.2002

References:

1. Missen R.W., Mims C.A., Saville B.A. “Introduction To Chemical Reaction Engineering And Kinetics”, JohnWiley.1999.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3			1			2		1	3	2	1	
CO2	3	2	1	3			1			2		1	3	2	1	
CO3	3	3	2	3			1			2		1	2	3	1	
CO4	3	3	2	3		2	2			2		1	3	3	3	
CO5		1	2				2			1			1	2		1
CO6	1	2		2						1				3		1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT52	PLANT AND ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** 5 **Category:** PC

Aim: To summarize about different types of cell culture methods. To develop an understanding on patenting genetically engineered animals and ethical issues.

Course Outcomes: The Students will be able to

CO1: Outline the concepts of plant tissue culture.

CO2: Demonstrate the techniques for development of Hybrids, screening and selection procedure.

CO3: Apply plant genetic engineering in plant tissue culture to manipulate the genetic elements using Molecular markers.

CO4: Categorize the different animal tissue culture and Molecular biological technique for rapid diagnosis of genetic disease.

CO5: Inspect the animal gene transfer techniques and their ethical issues.

CO6: Gain the knowledge about the Plant and animal tissue culture

BASICS PLANT TISSUE CULTURE **9**

Plant tissue culture: historical perspective; totipotency; organogenesis; Somatic embryogenesis; establishment of cultures – callus culture, cell suspension culture, media preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production.

SOMATIC HYBRIDIZATION AND TRANSFORMATION TECHNIQUES **9**

Somatic hybridization - protoplast isolation; culture and fusion, hybrids and cybrids, somatic cell genetics; plant cell cultures for secondary metabolite production, plant vectors, basic features of vectors, direct gene transfer methods, Agrobacterium mediated gene transfer and applications.

PLANT GENETIC MANIPULATION AND MOLECULAR MARKERS **9**

Genetic engineering: Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; Genetic transformation; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics.

TRANSGENIC ANIMALS AND DISEASE DIAGNOSIS **9**

Basic techniques of animal cell culture and their application, Gene cloning techniques for mammalian cells, Transgenic animals, *In-vitro* fertilization and embryo transfer, Molecular biological technique for rapid diagnosis of genetic disease and gene therapy.

TRANSFECTION METHODS, PATENT AND ETHICAL ISSUES **9**

Gene transfer methods in animals, Xenotransplantation, Manipulation of Growth hormone, thyroid hormone, patenting genetically engineered animals- Ethical issues. Applications of Transgenic animal technology; animal cloning

Total Periods: 45

Text Books:

1. Gupta, P.K., 1996. Elements of Biotechnology. *Rastogi*and Co., Meerut.
2. Ranga, M.M., 2002. Animal Biotechnology. *Agrobios India Limited.*
3. Ignacimuthu, S., 1996. Applied Plant Biotechnology. *Tata McGraw Hill*.
4. Gamburg, O.L. and Philips, G.C., 1995. Plant Tissue and Organ Culture Fundamental Methods. *Narosa Publications.*

References:

1. Hamond, J., McGarvey, P. and Yusibov, V., 2000. Plant Biotechnology. *Springer Verlag.*
2. Mantal, S.H., Mathews, J.A. and Mickee, R.A., 1985. Principles of Plant Biotechnology. An Introduction of Genetic Engineering in Plants. *Blackwell Scientific Publication.*

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		2		1			1			2	1	3		1	1
CO2		2	3		2	1				1	2		1	3	2	
CO3	1	3		2	1	3			1		1	3	1	2		1
CO4	1		3		2		1		2			1	1		3	
CO5		1		2		3	2	3		1				1		2
CO6	3	3	1	2		1					1			1		

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT53	BIOPROCESS PRINCIPLES	L-T-P	C
		3-0-0	3

Programme: B. Tech Bio-Technology **Sem:** 05 **Category:** PC

Prerequisites:

Aim: To impart knowledge in the area of Bioprocess technology with emphasis on Bioprocess principles to the students.

Course Outcomes:

After completion of this course students

CO1. To understand the basic requirements and parameters monitored in the fermentor.

CO2. Optimize the medium suitable for the production of the biological products based on the microbial growth kinetics.

CO3. Design the sterilization equipment based on the thermal death kinetics.

CO4. Interpret the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes.

CO5. Modify the biological materials to improve its usefulness by finding the optimal formulation materials to facilitate product production.

CO6. Convert the promises of molecular biology and genetic engineering into new processes to make bio products in economically feasible way

OVERVIEW OF FERMENTATION PROCESS **9**

Overview of fermentation industry - General requirements of fermentation processes - Basic configuration of Fermentor (CSTR) and ancillaries - Main parameters to be monitored and controlled in fermentation processes.

RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS **9**

Criteria for good medium - Medium requirements for fermentation processes - Carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements - Medium formulation of optimal growth and product formation - Examples of simple and complex media - Design of various commercial media for industrial fermentations – Medium optimization methods

STERLIZATION KINETICS **9**

Thermal death kinetics of microorganisms - Batch and continuous heat sterilization of liquid media - Filter sterilization of liquid media - Air sterilization and design of sterilization equipment - Batch and continuous.

METABOLIC STOCHIOMETRY AND ENERGETICS **9**

Stoichiometry of cell growth and product formation, Elemental balances- Degrees of reduction of substrate and biomass, available electron balances - Yield coefficients of biomass and product formation - Maintenance coefficients energetic analysis of microbial growth and product formation - Oxygen consumption and heat evolution in aerobic cultures - Thermodynamic efficiency of growth.

KINTEICS OF MICROBIAL GROWTH AND PRODUCT FERMENTATION **9**

Modes of operation - Batch, fed batch and continuous cultivation - Simple unstructured kinetic models for microbial growth - Monod model - Growth of filamentous organisms - Product formation kinetics – Leudeking -Piret models, substrate and product inhibition on cell growth and product formation, biomass estimation– Direct and Indirect methods.

Total Periods: 45

Text Books:

1. Shuler and Kargi., “Bioprocess Engineering”, Prentice Hall, 2nd Edition. (2002)
2. Bailey, J.E. and Ollis, D.F., “Biochemical Engineering Fundamentals”, McGraw Hill, 2nd Edition. (2010)

References:

1. Schugerl K., Bellgardt K.H., “Bioreaction Engineering”, Springer publications. (2000)
2. Peter F. Stanbury., Stephen J. Hall & A. Whitaker., “Principles of Fermentation Technology”, Science & Technology Books. (2009)
3. Pauline Doran., “Bioprocess Engineering Calculation”, Blackwell Scientific Publications. (2012)
4. Harvey W. Blanch., Douglas S. Clark., “Biochemical Engineering”, Marcel Dekker, Inc. (2015

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	1	2	3						1		2	3			
CO2	1	1	3	2							1					2
CO3	1	1	2	3					1						3	
CO4	1	2	3	2								1		2		
CO5	1	2	1	1					1	2	2		2	1	2	
CO6	1	3	2	1					1	1	3		2	1		

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT54	PROTEIN ENGINEERING			L-T-P	C
				3-0-0	3
Programme:	**B.Tech**	**Sem**	5	**Category**	**PC**
Aim:	This course aims to deliver students a wide knowledge about structure, basic working, activity of various proteins and their role in the field of biotechnology				

Course Outcomes:

At the end of the course the student will be able to

CO1. Describe the organization of protein structure.
CO2. Identify various chemical interactions that stabilize protein structure.
CO3. Understand the interactions in the protein core important for stability.
CO4. Inspect topology diagram of protein secondary structures.
CO5. Analyze various data to determine the binding affinity.
CO6. Protein design principles and database analysis

Unit-I	**BONDS AND ENERGIES IN PROTEIN MAKEUP**	**9**

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vanderwalls interactions in protein structure - Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure.

Unit-II	**PROTEIN ARCHITECTURE**	**9**

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 – Topology diagrams, up and down & TIM barrel structures – Tertiary structure : Domains, folding, Denaturation and renaturation - Quaternary structure : Modular nature, formation of complexes.

Unit-III	**PROTEIN FOLDING AND STRUCTURE DETERMINATION**	**9**

Protein Denaturation and Renaturation, Protein folding pathways, Stability of folded conformation of proteins, Methods to determine primary,secondary, tertiary and quaternary structure - Peptide mapping, Peptide sequencing, Circular Dichroism, Mass spectroscopy and X-ray diffraction.

Unit-IV	**PROTEIN STRUCTURE-FUNCTION RELATIONSHIP**	**9**

Helix-turn-Helix motifs, Cro, Lamda and Trp repressor, Zn fingers, Tata Box binding proteins, Homeodomain, Leucine zippers, Enzyme - Understanding the catalytic design by engineering trypsin, chymotrypsin and elastase

Unit-V	**PROTEIN ENGINEERING**	**9**

Engineering of T4 Lysozyme and Recombinant Insulin, Protein design -Principles and examples, Application in therapeutics.

Total Periods: 45

Text books:

1. Branden, C. and Tooze,J., 1999.Introduction to Protein structure. 2nd Garland Publishing, NY, USA. Edn.,
2. Daniel C. Liebler, "Introduction to Proteomics –Tools for the New Biology," Humana Press, 2001

References:

1. Moody P.C.E. and Wilkinson A.J., 1990. Protein Engineering. IRL Press,Oxford, UK.
2. DoanaldVoet and Judith Voet, G., 2001. Biochemistry. 3rd Edn., John Wiley and Sons, 2001.
3. Stefan Lutz and Uwe T. Bornscheuer, 2009. Protein Engineering Handbook. Vol 1 & 2, 1st Edn., Wiley Publishers.
4. Berg, J. M., Tymoczko, J. L. and Stryer, L., 2002. Biochemistry. 5th Edn., W.H. Freeman and Company.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	1				1			2		2	
CO2	1	2	2	1	3								1	2		
CO3	1		2		3		3			2		2	2	2	1	3
CO4	1	2		1	1	1					1		1		2	3
CO5	2	1	2		3					2	2	1	2	3		2
CO6	1	2	3	1	3		2			2		1	2	1	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS57	**Business English**	**L**	**T**	**P**	**C**
	(Common to All B.E./B.Tech Degree Programmes)	**0**	**0**	**2**	**MC**

Programme: B.E./ B.Tech. (Common to all Branches) **Sem: 5** **Category: HSMC**

Aim: To Improve learner's Communication Skills in English.

Course Outcomes: The students will be able to

CO1: Familiarize in Language Skills, Soft Skills, Inter Personal Skills, Decision Making and Business Communication

CO2: Competent in Presentation skill.

CO3: Imbibe the knowledge of effective classroom speaking and presentation

CO4: Provide opportunities to learners to practice their communicative skills to become proficient users of English

CO5: Write job applications

CO6: Acquire knowledge about the various principles of communication.

UNIT I **6**

Elements of effective presentation – Structure of presentation – Presentation tools – Voice Modulation – Audience analysis – Body language – Video samples

UNIT II **6**

Time management – Articulateness – Assertiveness – Psychometrics – Innovation and Creativity – Stress Management & Poise – Video Samples

UNIT III **6**

Covering letter – strategies to write, resume and it's various kinds.

Total Periods: 18

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		2	2						3	3	3	3				3
CO2										3		2				2
CO3					2				2	3		2				
CO4									2	3		2			1	
CO5								3		3						

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT57	MOLECULAR BIOLOGY AND GENETIC ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

Programme: B.Tech. Biotechnology **Sem: 5 Category: PC**

Aim: To provide hands on experience in performing basic recombinant DNA techniques.

Course Outcomes: The Students will be able to

CO1: Learn about cloning of genes, how to express them for protein production

CO2: Understand the ethical and biosafety issues and consequences while performing experiments in the laboratory.

CO3: Estimate the quantity and quality of nucleic acids, proteins using gel electrophoresis.

CO4: Know the significance and the power of the recombinant DNA technology.

CO5: Apply the importance of PCR in cloning, Diagnosis & Mutant generation.

CO6: Acquire the knowledge of hazardous chemical and Safety precautions in case of emergency.

LIST OF EXPERIMENTS

1. Isolation of genomic DNA.
2. Isolation of plasmid DNA from bacteria.
3. Elution of DNA from agarose gel electrophoresis.
4. Restriction digestion.
5. Ligation of DNA into expression vector.
6. Expression of protein profiling by SDS – PAGE, 2D-Gel Electrophoresis.
7. Blotting technique: Western Blotting.
8. Preparation of Competent cells – Calcium chloride method.
9. Transformation and selection of recombinants – Blue white screening assay
10. Hybridization techniques.

Text Books:

1. Laboratory Manual of Genetic Engineering 4th Edition, 2009.
2. Sambrook, Joseph and David W. Russell "The Condensed Protocols: From Molecular Cloning; A Laboratory Manual" Cold Spring Harbor Laboratory Press, 2006

References:

1. Frederick M.A., Roger B., Robert E. K.,, David D. M.,, Seidman J.G., John A.S., Kevin S., "Short protocols in molecular biology- Volume I &II", Wiley & sons, 1st Edition, 2002

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1				1	2							2	1		1	
CO2		3			2			1	3			3			3	1
CO3		3	1	3	2								3	3	3	
CO4		3		2	1							1			2	
CO5	1						1									1
CO6	2	3		1									3			2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT58 **BASIC BIOPROCESS LABORATORY** **L T P C**
0 0 4 2

Programme: B.Tech. Biotechnology **Sem: 5 Category: PC**

Aim: To train on methods to investigate the growth of microorganisms in different systems under different conditions.

Course Outcomes: The Students will be able to

CO1: Explain about Enzyme kinetics and characterization and how to use them for practical applications.

CO2: Evaluate the growth kinetics of microorganisms and become adept with medium optimization techniques.

CO3: Determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely.

CO4: Demonstrate good lab citizenry and the ability to work in team.

CO5: Modify the biological material to improve its usefulness by finding optimal formulation materials to facilitate product production.

CO6: Convert the promises Molecular biology and genetic engineering into new process to make bio products in economically feasible way.

LIST OF EXPERIMENTS

1. Determination of optimum pH for an enzyme.
2. Determination of optimum temperature for an enzyme.
3. Enzyme kinetics – Determination of Michaelis Menten parameters.
4. Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient.
5. Growth of Yeast – Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient.
6. Determine the effect of peptone concentration on *E. coli* growth.
7. Enzyme immobilization – Gel entrapment.
8. Enzyme immobilization – Cross linking.
9. Medium optimization – Placket Burman Design.
10. Medium optimization – Response Surface Methodology.

Text Books:

1. Bailey and Ollis, " Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.),1986.
2. Shuler and Kargi, " Bioprocess Engineering ", Prentice Hall, 1992.

References:

1. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications.
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1					3						2	1	1			3
CO2			2						2		3	1		2		1
CO3	1			2					1			2	1		2	
CO4									3		2	2		2		2
CO5	2	2	2	1	2	1			2					1		
CO6	1		2	2			2							2		

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT61	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** 6 **Category:** PC

Aim: To develop the skills of the students in the area of Bioprocess Engineering.Thiswillbeapre-requisiteforafewelectivecoursesandforprojectin Bioprocess Technology.

Course Outcomes: The Students will be able to

CO1: Understand reactor design and mode of operation and required modifications to meet production target.

CO2: Scale up the reactors based on power, oxygen transfers and mixing time.

CO3: Understand the influence of mass transfer resistances in immobilized enzymes and appreciate their significance in design of immobilized enzymes-based reactors.

CO4: Acquire knowledge about the modelling and simulation concepts in bioprocessing.

CO5: Differentiate cultivation systems for recombinant cells.

CO6: Identify problems and seek practical solutions for large scale productions.

ANALYSIS OF STR **9**

Stirred tank reactor - non-ideality, RTD and stability analysis, tanks in series and dispersion models– application to design of continuous sterilizer.

ANALYSIS OF OTHER CONFIGURATIONS **9**

Packed bed reactor, airlift reactor, fluidized bed reactor bubble column reactors–non- ideality, RTD and stability analysis.

BIOREACTOR SCALE–UP **9**

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors – microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed

MODELLING AND SIMULATION OF BIOPROCESSES **9**

Study of structured models for analysis of various bioprocess –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.

BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS **9**

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

Total Periods: 45

Text Books:

1. Shuler and Kargi, Bioprocess Engineering, Prentice Hall, 2001.
2. Pauline D., “Bioprocess Engineering Principles”, Elsevier, 2nd Edition, 2012.

References:

1. Blanch H. W., Clark S. D., “Biochemical Engineering”, Taylor & Francis, 2nd Edition, 1997
2. EMT.EL-Mansi. CFA. Bryce, A.L. Demain, AR. Allman: Fermentation Microbiology and Biotechnology, Second Edition 2007.
3. Bailey, J.E., Ollis, D.F., “Biochemical Engineering Fundamentals”, McGraw Hill, 2nd Edition, 2010.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3						2			2	2	2	
CO2	3	3	2	3						2			2	2	1	3
CO3	3	3	2	2			2			2			2	1	2	
CO4	1	2		1			2		1	3		2	3	3	1	
CO5		2		1	2									2	1	
CO6			2			2		1			2		1			2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT62	BIOPHARMACEUTICAL TECHNOLOGY	L-T-P	C
		3-0-0	3

Programme: B. Tech Bio-Technology **Sem:6** **Category:** **PC**

Prerequisites:

Aim: To familiarize with the biopharmaceutical technology, drug designing, drug formulation, pharmacokinetics and pharmacodynamics. To understand the application of biopharmaceutical technology in living systems.

Course Outcomes:

After completion of this course students

CO1. Able to study the basic concepts of drug discovery and development followed by pharmaceutical industries

CO2. Able to understand the pharmacodynamics and pharmacokinetics of drug

CO3. Able to illustrate and design the requirements for drug manufacture

CO4. Acquiring knowledge about sterile liquid and solid dosage manufacture

CO5. Acquire an idea about different types of biopharmaceuticals.

CO6. Develop a good formulation for biopharmaceutical industry in an effective manner.

INTRODUCTION **9**

Introduction to Biopharmaceuticals and pharmaceutical biotechnology, Biopharmaceuticals: Status and future prospects, generic and branded biopharmaceuticals, overview of life history for development of biopharmaceuticals. Pre-clinical toxicity assessment, Clinical trial phases and design, clinical data management, concept of Pharmacovigilance

DRUG ACTION, METABOLISM AND PHARMACOKINETICS **9**

Mechanism of drug action; physico-chemical principles of drug metabolism; radioactivity; Pharmacokinetics.

MANUFACTURE OF DRUGS, PROCESS AND APPLICATIONS **9**

Types of reaction process and special requirements for bulk drug manufacture.

PRINCIPLES OF DRUG MANUFACTURE **9**

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.

BIOPHARMACEUTICALS **9**

Various categories of therapeutics like vitamins, laxatives, analgesics, contraceptives, antibiotics, hormones and biological.

Total Periods: 45

Text Books:

1. Gareth Thomas. Medicinal Chemistry. An introduction. John Wiley. 2000.
2. Katzung B.G. Basic and Clinical Pharmacology, PrenticeHallofIntl.1995.

References:

1. Michael E.A., “Pharmaceutics, Design and manufacture of Medicines”, Churchille Livingstone, 4th Edition, 2008.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	3	2	3	2		2	1	2	3	3	2
CO2	2	2	2	1			2	3				3	2	3	2	1
CO3	3	3	2	3	2	2	2				3	2	3	2	3	2
CO4	2	3	3	3	2	3	3	3	2	2	2	2	3	3	3	2
CO5	1	3	3	2	3	3	2	3	2			2	3	3	2	1
CO6	3	2	3	2	3	2	2		1			2	3	2	1	1

191BT63	METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology Sem: 6 Category: PC

Aim: The objective of the course is to understand the production of commercially and therapeutically important metabolites and bio products like enzymes, recombinant proteins.

Course Outcomes: The Students will be able to

CO1: Understand the basic concepts of metabolic Engineering in Cellular organisms.
CO2: Acquire knowledge about the primary and secondary metabolites.
CO3: Explain the commercial production of Enzymes and Recombinant Proteins.
CO4: Apply the concepts of metabolic pathway manipulations to improve fermentation products.
CO5: Learn about high through put techniques in metabolic engineering.
CO6: Design the strategies for metabolic engineering using computational biology.

INTRODUCTION OF METABOLIC ENGINEERING 9

Identification of metabolic regulation is a key point in metabolic engineering. Basic concepts of Metabolic Engineering – Overview of cellular metabolism – Different models for cellular reactions, induction – Jacob Monod model and its regulation, Differential regulation by is enzymes, Feedback regulation. Applications in pharmaceuticals, chemical bioprocess, food technology, agriculture, environmental bioremediation and biomass conversion.

PRODUCTION OF PRIMARY & SECONDARY METABOLITES 9

A brief outline of processes for the production of some commercially important Organic acids (e.g. citric acid, lactic acid, acetic acid, gluconic acid,); Amino acids (Glutamic acid, lysine, aspartic acid Phenylalanine); and Alcohols (ethanol, 2,3- butanediol) Study of production processes for various classes of low molecular weight secondary metabolites: Antibiotics beta-lactams (Penicillins), semi synthetic Pencillins and Cephalosporins amino-glycosides (streptomycin), macrolides (erythromycin), quinines, and aromatics. Vitamin (B12) and Steroids, dual or multiple fermentation.

PRODUCTION OF COMMERCIALLY IMPORTANT ENZYMES & RECOMBINANT PROTEINS 9

Proteases, Amylases Lipases, Cellulases, Pectinases, Isomerases and other commercially important. Enzymes for the food & pharmaceutical industries; Production of recombinant proteins (Insulin, Interleukin & Interferon's) having therapeutic and diagnostic applications; production of vaccines.

BIOCONVERSIONS & REGULATION OF ENZYME PRODUCTION 9

Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Co-metabolism, Product inhibition, mixed or sequential bioconversions, Conversion of insoluble substances. Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation, Feedback repression, Catabolite Repression, optimization and control of metabolic activities. The modification of existing – or the introduction of entirely new - metabolic pathways. Natural Biopreservatives (Nisin) and Biopolymers (Xanthan Gum and PHB); Single Cell Protein, Racemically-pure Drug Intermediates, Steroid Bioconversions; High-Fructose Corn syrup; Bioconversion of Vegetable Oils.

METABOLIC ENGINEERING WITH BIOINFORMATICS 9

Metabolic pathway modelling, Analysis of metabolic control and the structure metabolic networks, Metabolic pathway synthesis algorithms. Metabolomics, metabolomics measurements using NMR, Spectrophotometry, LCMS, and metabolic product in fermentation.

Total Periods: 45

Text Books:

1. Wang.D.I.C Cooney C.L., Demain A.L., Dunnil.P. Humphrey, "Fermentation and Enzyme Technology", A.E. Lilly M.D., John Wiley and sons, 1980.
2. Stanbury P.F.and Whitaker A., "Principles of Fermentation Technology", Pergamon Press, 1984.
3. Zubay G., "Biochemistry, Macmillan Publishers", 1989.

References:

1. Gregory N.Stephanopoulos, “Metabolic Engineering Principles and Methodologies” Aristos et al-Elsevier.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		1	2	3	1							2	3			
CO2	1		3	2	2	1					1					2
CO3			2	3	2	2									3	
CO4	1	2	3	2	1	2						1		2		
CO5	1	2	1			1					2		2	1	2	
CO6		3	2	1		2					3		2	1		

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT64 BIOINFORMATICS & COMPUTATIONAL BIOLOGY

L	T	P	C
3	0	2	4

Programme: B.Tech. Biotechnology Sem: 6 Category: PC

Aim: To introduce the student to biological data resources, algorithms and alignment tools. Understand about machine learning techniques and neural networks in the analysis of biological data.

Course Outcomes: The Students will be able to

CO1: Get acquainted with database management system and algorithms for biological sequences.
CO2: Perform various Biological sequence alignment tools with its machine learning algorithms.
CO3: Analyse the evolutionary relationship between species by mutations and to construct the phylogenetic tree.
CO4: Develop different protein structure by computational modelling.
CO5: Apply the Bioinformatics tools in the field of proteomics to predict and develop drug.
CO6: Implement the computational based solutions for future biological perspectives.

BIOLOGICAL DATABASES AND SEQUENCE ANALYSIS 9

Introduction to Bioinformatics and Computational Biology, Biological sequences, Biological databases, Genome specific databases, Data file formats, Data life cycle, Sequence Analysis, Pair wise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment.

ALGORITHMS FOR SEQUENCE ALIGNMENT 9

Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms, Functional annotation.

PHYLOGENETICS AND MOLECULAR DOCKING 9

Introduction to phylogenetics, Distance based trees UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure prediction methods, Homology modeling, abinitio approaches, Threading, Critical Assessment of Structure Prediction, Molecular docking principles and applications.

PROTEIN FOLDING AND PROTEIN STRUCTURE MODELING 9

Anfinsen thermodynamic hypothesis; Molecular dynamics simulation for protein folding-CHARMM, AMBER; Knowledge-based free modeling (FM) - Bowie-Eisenberg approach, ROSETTA; Contact-map prediction.

DNA MICROARRAY AND PROTEOMICS 9

Concept of microarrays, Two-color microarray experiments, Tools for microarray analysis - xCluster, MADAM; Applications of microarray technology; Protein Micro array in protein expression, profiling and diagnostics, drug target discovery.

Total Periods: 45

COMPONENT LAB – LIST OF EXPERIMENTS

1. Nucleic acid sequence databases - GenBank/EMBL/DDBJ.
2. Protein sequence databases - UniProtKB, Swiss – Model.
3. Sequence Analysis Tools - Perform BLAST, FASTA (Nucleic Acids & Protiens).
4. Phylogenetic Analysis – PHYLIP.
5. Molecular Modeling - Homology Modeling - Swiss modeller.
6. Perform Multiple Sequence Alignment tools - ClustalW, EMBOSS.

Text Books:

1. Introduction to Bioinformatics by Arthur K. Lesk, Oxford University Press. ,4th edition 2014
2. Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press. 1999
3. Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy, A.Krogh, G.Mitchison, Cambridge University Press. 2013

4. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press. 2nd edition, 2004.

References:

1. Bioinformatics The Machine Learning Approach by Pierre Baldi and Soren Brunak, Cambridge University Press 2001
2. RNA-seq Data Analysis: A Practical Approach, by EijaKorpelainen, JarnoTuimala, PanuSomervuo, Mikael Huss and Garry Wong. CRC Press 2014
3. Next Generation Sequencing Data Analysis, by Xinkun Wang CRC Press 2016

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2		2				1				1	3			
CO2		1	3		2									1		
CO3	2	1	1		1	2									2	
CO4		1				1		2				2				2
CO5		2	1	2		1	1	2		2	2				2	1
CO6			1			1				1					2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT67 **BIOPROCESS ENGINEERING LABORATORY** **L T P C**
0 0 2 1

Programme: B.Tech. Biotechnology **Sem: 4 Category: PC**

Aim: The course aim to expose the students in the area of bioprocess engineering basics that involving in fermenter or reactor.

Course Outcomes: The Students will be able to

CO1: Learn how to experimentally calculate thermal death kinetic of biological liquid
CO2: Find out the RTD of fermenter or reactor.
CO3: Recognize the Enzyme kinetics– Micheles-Menton parameters and immobilization.
CO4: Estimate mass transfer coefficient with different methods
CO5: Study growth kinetics of bacteria
CO6: Perform the analysis of bioreactor for bioproducts production.

LIST OF EXPERIMENTS

1. Thermal death kinetics.
2. Batch sterilization design.
3. Batch cultivation, estimation of kla–dynamic gassing method, exhaust gas analysis–carbon balancing, gas balancing.
4. Batch and Fed batch cultivation, exhaust gas analysis–carbon balancing, gas balancing
5. Total cell retention cultivation, exhaust gas analysis – carbon balancing, gas balancing
6. Estimation of kLa–sulphite oxidation method.
7. Estimation of kLa–power correlation method.
8. Residence time distribution.
9. Estimation of overall heat transfer coefficient.
10. Continuous cultivation–x-diagram, pulse and shift method, evaluation of kinetic parameters, exhaust gas analysis–carbon balancing, gas balancing.
11. Enzyme kinetics– Micheles Menton parameters.
12. Enzyme immobilization–gel entrapment & cross linking methods.

References:

1. Stanbury, P.F., Stephen J.H., Whitaker A., "Principles of Fermentation Technology", Elsevier, 2nd Edt., 2009.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1				1	2							2	1			
CO2	2	3		2								1		1		
CO3		3			2				3			3			3	
CO4	1						1									1
CO5			2			2				2				2		1
CO6	1			1				2			1				1	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS67	CAREER ENGLISH	L-T-P 0-0-2	C MC

Programme: Common to all branches **Sem:** 6 **Category:** HSMC

Aim: To practice English for Enhancing Employability skills

Course Outcomes: The students will be able to

CO1: Enlarge their aptitude and reasoning skills.

CO2: Deal with the barriers that affect communication in a professional set up.

CO3: Understand various stages of communication and the role of audience and purpose.

CO4: Practice English for Enhancing Employability skills.

CO5: Develop their job prospects through oral communication.

CO6: Enhance the performance of learners at placement interviews and group discussions and other recruitment procedures.

UNIT I **6**

Verbal analogy, verbal reasoning, error spotting, sentence completion

UNIT II **6**

Why is GD part of selection process? – Structure of GD – Moderator – Strategies in GD – Team work – Body Language – Mock GD – Video samples

UNIT III **6**

Kinds of interviews – Required Key Skills – Corporate culture – Mock interviews – Video samples

1. Resume / Report Preparation
2. Presentation Skills: Students make presentations on given topics. (8)
3. Group Discussion: Students participate in group discussions. (6)
4. Interview Skills: Students participate in Mock Interviews (8)

Total Periods: 18

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2								3	3	3	2				2
CO2						2			3	3	3	2			1	
CO3									2	3	2	2				1
CO4										3						
CO5									3	2			1			

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT69 **MINI PROJECT** **L T P C**
0 0 4 2

Programme: B.Tech. Biotechnology **Sem 6 Category PROJ**

Aim: To develop students' knowledge for solving technical problems through structured project research study in order to produce competent and sound engineers.

Course Outcomes: The Students will be able to

CO1 Identify and describe the problem and scope of project clearly.

CO2 Collect, analyze and present data into meaningful information using relevant tools.

CO3 Select, plan and execute a proper methodology in problem solving.

CO4 Work independently and ethically.

CO5 Present the results in written and oral format effectively.

CO6 Identify basic entrepreneurship skills in project management.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2					2				2	2	3	
CO2		3	2	2					2			2	3	2	2	
CO3	2	3	2						3				3	3	3	
CO4						3		3	2		3	2	2	2	2	
CO5						3		2	2		2			2	2	
CO6						2			3		3					3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191ME71	TOTAL QUALITY MANAGMENT	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem: 7** **Category: PC**

Aim: To understand the various principles, practices of TQM to achieve quality and to learn the various statistical approaches for quality control.

Course Outcomes: The Students will be able to

CO1: Know the basics of TQM
CO2: Understand the principles of TQM.
CO3: Improve their workplace with the help of 5S.
CO4: Learn the six sigma and bench marking techniques.
CO5: Familiarize Quality circles and QFD
CO6: Study the various quality systems.

EVALUATION OF TQM **9**

Introduction – Need for quality – Evolution of quality – Definition of quality – Dimensions of manufacturing and service quality – Basic concepts of TQM – Definition of TQM – TQM Framework – Contributions of Deming, Juran and Crosby – Barriers to TQM.

TQM PRINCIPLES **9**

Leadership – Strategic quality planning, Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal – Continuous process improvement – PDSA cycle, 5S, Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating

TQM TOOLS & 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.

TQM TOOLS & TECHNIQUES II **9**

Quality circles – Quality Function Deployment – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

QUALITY SYSTEMS **9**

Need for ISO 9000 – ISO 9000:2000 Quality System – Elements, Documentation, Quality auditing – QS 9000 – ISO 14000 – TS1600 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

Total Periods: 45

Text Books:

1. Dale H. Besterfiled et al., “Total Quality Management”, Pearson Education Asia, (2014)
2. Shridhara Bhat K., “Total Quality Management”, Himalaya Publishing House, (2013)

References:

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, Thomson South-Western, (2010)
2. Oakland J.S., “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, (2003)
3. Suganthi L., Anand Samuel, “Total Quality Management”, PHI Pvt. Ltd., (2011)
4. Janakiraman B. and Gopal R.K., “Total Quality Management – Text and Cases”, PHI Pvt. Ltd., (2012)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		2							3	2	3	1		2		3
CO2								2	3			2				2
CO3								2	3			2		2		3
CO4	2			3					2		2	2		2	2	3
CO5	1			3						2	2	1		1		2
CO6								1		2	3	1				3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT71	BIOSEPARATION ENGINEERING	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem: 7 Category: PC**

Aim: The course provides fundamental concepts of various downstream purification steps involved in a bioprocess industry.

Course Outcomes: The Students will be able to

CO1: Know the advanced downstream processing methods for product recovery.

CO2: Describe the components of downstream equipment and to understand the requirements for successful operations.

CO3: Apply different techniques such as precipitation, coagulation and flocculation in downstream processing.

CO4: Learn the separation and purification of biological macromolecules.

CO5: Enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.

CO6: Design recovery outline in polishing of a product employing crystallization and drying methods.

INTRODUCTION TO BIOSEPARATION PROCESS **9**

Basic concepts of separation technology, overview of major upstream and downstream processes, importance of downstream processing in biotechnology, economic evaluation of downstream processing, separation characteristics of biological molecules, generic scheme of bio separation, modern separation technology in bioprocessing.

PRIMARY ISOLATION AND RECOVERY **9**

Selection of purification methodologies, biomolecule separation – Cell disruption - physical, chemical and biological methods, Filtration- Batch & Continuous filtration , Centrifugation- Types of centrifuge (tubular bowl centrifuge, basket centrifuge, ultracentrifuge), Precipitation, Coagulation and flocculation.

MEMBRANE BASED SEPARATION **9**

Membrane separation process - ultrafiltration, Nano filtration, reverse osmosis, dialysis & Electrodialysis. Case study: Sewage treatment using membrane bioreactors.

EXTRACTION & ADSORPTION BASED SEPARATION PROCESS **9**

Liquid-liquid extraction, Batch extractions, solvent recovery, applications of extraction. Adsorption, - adsorbents types, their preparation and properties, types of adsorption isotherms.

PRODUCT FORMULATION **9**

Crystallization, Drying, Types of drying (spray drying, vacuum drying, freeze drying. Principles, Operation & Application.

Total Periods: 45

Text Books:

1. Belter, P.A., Gussler, E.L. and Hu, W.S., “Bioseparation: Downstream Processing for Biotechnology”, John Wiley and Sons, 2011.
2. Forciniti, D., “Industrial Bioseparation: Principles & Practice”, Blackwell, 2008.

References:

1. Ghosh, R., “Principles of Bioseparations Engineering”, World Scientific Publishers, 2006.
2. Ladisch, M.R., “Bioseparations Engineering: Principles, Practice, and Economics”, John Wiley & Sons, 2001.
3. Roger, H., “Bioseparations Science and Engineering”, Oxford University Press, 2006

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		1	3	1		1	1			3	2	2	3		
CO2		2		1		3		1		2					2	
CO3	1		3		2					1		1	2			2
CO4		2		1			2		1					2	1	
CO5	1	3	2			1			1		1			2		
CO6	1			2	2		1					1				

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT72	INTELLECTUAL PROPERTY RIGHTS AND BIOETHICS	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** 7 **Category:** HSSM

Aim:

Course Outcomes: The Students will be able to

CO1: Learn an adequate knowledge on patent and copyright.
CO2: Develop the idea and innovations.
CO3: Identify the role of regulatory committees in controlling the risk.
CO4: Recognize the information on ethical issues linked to research on animal models, transgenic, clinical trials.
CO5: Create awareness for the professional responsibilities and rights.
CO6: Understand the ethics and responsibility for safety.

Intellectual Property Rights **9**

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge, Ethics of Resource Management.

Trade Secret **9**

IPR in India: Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994 India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies.

Regulatory Framework for Agriculture Biotechnology **9**

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBSC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Plant Quarantine Order (2003), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006).

Biosafety and Regulatory Framework for Pharmaceutical and Environment **9**

Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells (Ministry of Environment and Forests Notification, (1989). Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol. Understand the legal steps involved in progressing a new drug to market. Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries.

Bioethics **9**

Patenting live microorganism, Human Genome project and ethical issues, Animal cloning, human cloning and their ethical issues, Experimenting on animals Public education of producing transgenic organism, legal and socioeconomic impacts of biotechnology, testing drugs on human volunteers, Hazardous materials used in biotechnology, their handling and disposal.

Total Periods: 45

Text Books:

1. V Sreekrishna, 2017. Bioethics and Biosafety in Biotechnology by New Age International publishers.

References:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

E-resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf.
2. World Intellectual Property Organization. (2004). WIPO Intellectual Property Handbook. (https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		3	1				3		1				2	1	2
CO2		2		2								1	2		1	
CO3				3		2	1	2		1				1		3
CO4	1		2		3		1	2		2	1		1		2	
CO5	2					3						1		2		1
CO6		2						3						2		1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT77 **BIOSEPARATION LABORATORY** **L T P C**
0 0 4 2

Programme: B.Tech. Biotechnology **Sem: 7 Category: PC**

Aim: Introduce students to the theory behind in each techniques and to describe common applications of each methodology in biological research.

Course Outcomes: The Students will be able to

CO1: Apply the lab scale techniques in large scale operations considering complexity involved in scale up.

CO2: Design and carry out experiments while taking into account product stability, biosafety, accuracy of results and time duration.

CO3: Appreciate the complexity of products of biological origin and design strategy accordingly to purify them.

CO4: Learn the techniques of products purification.

CO5: Perform experiments in product formulation and finishing.

CO6: Acquire knowledge for the separation of whole cells and other insoluble ingredients from the culture broth

LIST OF EXPERIMENTS

1. Solid liquid separation–centrifugation, microfiltration.
2. Cell disruption techniques–ultra sonication, Homogenizer.
3. Cell disruption techniques–Enzyme and chemical method
4. Precipitation–Ammonium sulphite precipitation.
5. Ultrafiltration separation.
6. Aqueous two phase extraction of biologicals.
7. High resolution purification–affinity chromatography.
8. High resolution purification–ion exchange chromatography.
9. Product polishing spray drying.
10. Product polishing freeze drying.

Text Books:

1. P.A. Belter, E.L. CusslerAnd Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun. (1988).

Reference Books:

1. R.O. Jenkins, (Ed.) – Product Recovery in Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
2. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3			1	2							2		2		
CO2				2								1	1			
CO3	3	3					2		3			3		3		
CO4		1			3									2		
CO5	3	2		1		2							2			
CO6	3		2				2			1					3	

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT78	NANO-BIOTECHNOLOGY LABORATORY	L	T	P	C
		0	0	2	1

Programme: **B.Tech. Biotechnology** **Sem: 7** **Category: PC**

Aim: Imparting technical knowledge to synthesis, characterization and application of nanomaterial in biological research.

Course Outcomes:

CO1: Gain the knowledge on nanoparticle preparation.
CO2: Familiarize with characterization of nanomaterial.
CO3: Find the antibacterial and antioxidant action of nanoparticle.
CO4: Learn the techniques of products purification.
CO5: Determining the stability and viability of nanoparticles.
CO6: Acquire knowledge on application process of nanoparticles.

LIST OF EXPERIMENTS

1. Synthesis of nanoparticles (Minimum 2)
2. Characterization of nanoparticle
3. Antibacterial activity of nanoparticle
4. Invitro antioxidant assay of nanoparticle
5. Determination of stability of nanoparticle
6. Viability testing of nanoparticles
7. Drug release studies of nanoparticle

Text Books:

1. "Nanobiotechnology Lab Manual", Department of Biotechnology, PSREC

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2		2				1	2	3		2	
CO2	3	3	1	2	2						1	1	2	1	1	2
CO3	1	2	2	2		1	2					2			3	2
CO4	2	3	2		2	2	2					2	2	2	2	3
CO5	2	3		1		2	2				2		2		3	
CO6	3	3	2	3	2	2	2	1		1	2	2	3	2	3	3

191BT79 **PROJECT - I** **L T P C**
0 0 6 3

Programme: B.Tech. Biotechnology **Sem 7 Category PROJ**

Aim: To develop students' knowledge for solving technical problems through structured project research study in order to produce competent and sound engineers.

Course Outcomes: The Students will be able to

CO1 Identify and describe the problem and scope of project clearly.

CO2 Collect, analyze and present data into meaningful information using relevant tools.

CO3 Select, plan and execute a proper methodology in problem solving.

CO4 Work independently and ethically.

CO5 Present the results in written and oral format effectively.

CO6 Identify basic entrepreneurship skills in project management..

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2					2				2	2	3	
CO2		3	2	2					2			2	3	2	2	
CO3	2	3	2						3				3	3	3	
CO4						3		3	2		3	2	2	2	2	
CO5						3		2	2		2			2	2	
CO6						2			3		3				2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BT89 **PROJECT – II**

L	T	P	C
0	0	12	6

Programme: B.E. Computer Science and Engineering **Sem** 8 **Category** PROJ

Aim: To develop students' knowledge for solving technical problems through structured project research study in order to produce competent and sound engineers.

Course Outcomes: The Students will be able to

CO1 Identify and describe the problem and scope of project clearly

CO2 Collect, analyze and present data into meaningful information using relevant tools

CO3 Select, plan and execute a proper methodology in problem solving

CO4 Work independently and ethically

CO5 Present the results in written and oral format effectively

CO6 Identify basic entrepreneurship skills in project management.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2					2				2	2	3	
CO2		3	2	2					2			2	3	2	2	
CO3	2	3	2						3				3	3	3	
CO4						3		3	2		3	2	2	2	2	
CO5						3		2	2		2			2	2	
CO6						2			3		3				2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BTEA	THERMODYNAMICS FOR BIOTECHNOLOGIST	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: The course aims to expose the students to the area of chemical thermodynamics. This will serve as a prerequisite for courses like bioprocess, enzyme engineering, Downstream processing, etc.

Course Outcomes: The Students will be able to

CO1: Derive the thermodynamics property relations in accordance with laws of thermodynamics.

CO2: Acknowledge the significance of solution thermodynamics

CO3: Expose the phase equilibria and chemical reaction equilibria into binary and multi component system.

CO4: Evaluate the phase equilibria and chemical reaction equilibria means of temperature and pressure.

CO5: Analyse the thermodynamic process by evaluating the concept of work.

CO6: Relate the chemical equilibria and phase equilibria into chemical industries.

THERMODYNAMIC PROPERTIES OF FLUIDS **9**

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.

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.

PHASE EQUILIBRIA **9**

Criteria for phase equilibria; v-l-e calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.

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 conversion and yields for single and multiple reactions

THERMODYNAMIC ANALYSIS OF PROCESSES **9**

Concept of lost work; entropy generation; calculation of real irreversible processes; power cycle; liquefaction.

Total Periods: 45

Text Book:

1. SmithJ.M.,VanNess H.C., Abbot M.M. Chemical Engineering Thermodynamics.7th Edition. McGraw-Hill, 2012.
2. Narayanan K.V. "A Text Book Of Chemical Engineering Thermodynamics", 2nd Edition, Prentice Hall India, 2013.

References:

1. Sandler S.I. "Chemical And Engineering Thermodynamics"JohnWiley,1989

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3						2			2	2	2	
CO2	3	3	2	3						2			2	2	1	
CO3	3	3	2	2			2			2			2	1	2	
CO4	1	2		1			2		1	3		2	3	3	1	
CO5	2			2		1								2		1
CO6	1			2										2		

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BTEB	GREEN BIOTECHNOLOGY AND POLLUTION ABETMENT	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: The course content aims to make the student understand how biotechnology can help in monitoring or removing the pollutants and developing an understanding of new trends such as biofuels, renewable energy sources, or development of stress-tolerant plants which can minimize the harmful impact of pollutants thereby making the planet earth a better dwelling place.

Course Outcomes: The Students will be able to

CO1: Acknowledge the biological waste and the waste treatment principles and design.

CO2: Recognize the fundamental principles and application of biodegradation.

CO3: Evaluate the Bio catalytic reaction, mechanism and stoichiometry.

CO4: Develop the knowledge to use biotechnology for waste management, bioremediation, and green energy.

CO5: Produce eco-friendlier bio products which may protect environment by minimizing pollutant.

CO6: Apply the Biological techniques in the industries to minimize the harmful pollutants.

BIOLOGICAL WASTE TREATMENT **9**

Biological wastewater treatment: Principles and design aspects of various waste treatment methods with advanced bioreactor configuration: Solid waste management: landfills, recycling and processing of organic residues, minimal national standards for waste disposal.

BIODEGRADATION OF XENOBIOTIC COMPOUNDS **9**

Biodegradation of Xenobiotic Compounds: Xenobiotic compounds–Definition, examples and sources. Biodegradation- Introduction, effect of chemical structure on biodegradation, recalcitrance, co metabolism and biotransformation. Factors affecting biodegradation, microbial degradation of hydrocarbons.

BIOTRANSFORMATIONS AND BIOCATALYSTS **9**

Basic organic reaction mechanism- Common prejudices against enzymes, advantages & disadvantages of biocatalysts, isolated enzymes versus whole cell systems, biocatalytic application, catalytic antibodies; stoichiometry

BIOREMEDIATION AND BIORESTORATION **9**

Introduction and types of bioremediation, bioremediation of surface soil and sludge, bioremediation of subsurface material, In situ and Ex-situ technologies, phytoremediation- restoration of coal mines a case study. biorestoration: reforestation through micropropagation, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals.

ECO-FRIENDLY BIOPRODUCTS AND ENVIRONMENTAL PROTECTION **9**

Fundamentals of composting process: scientific aspects and prospects of biofuel production: bioethanol, biohydrogen and biodiesel; biofertilizers and biopesticides. Biotechnology in Environment Protection: Current status of biotechnology in environment protection and its future, release of genetically engineered organisms in the environment.

Total Periods: 45

Text Book:

1. Environmental Processes I-III, J. Winter, 2nd ed., Wiley Publications
2. Introduction to Wastewater Treatment- R. S. Ramalho, Academic Press.
3. Elements of Water Pollution Control Engineering – O.P. Gupta, Khannabooks.
4. Energy Technology – O.P. Gupta, Khannabooks, 2018.
5. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.
6. Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press, 2007

References:

1. Environmental Biotech, Pradipta Krimar, I.K. International Pvt. Ltd., 2006.
2. Environmental Microbiology & Biotechnology, D.P. Singh, S.K. Dwivedi, New Age International Publishers, 2004.
3. Biodegradation and Bioremediation 1999 (2nd edition). Martin Alexander, Elsevier Science & Technology.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1		2		1	2			1		2	3		1	2
CO2		2	3				2		2		1		2	1		3
CO3	3		2	3		2		2				2	1	2		
CO4	2	2		2			2	1				1		3		2
CO5	1	2	2	2				1		1			1	3		
CO6			1		1	2		2						3		1

191BTEC	ENTREPRENEURSHIP & STARTUPS	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: The aim of the course is to acquire Entrepreneurial spirit and resourcefulness. Familiarization with various uses of human resource for earning dignified means of living and understanding the concept and process of entrepreneurship for the contribution in the growth and development of individuals and the nation.

Course Outcomes: The Students will be able to

CO1: Outline to the introduction for Entrepreneurship and Intrapreneurship.
CO2: Organizing innovative business ideas and its implementation.
CO3: Evaluate new ideas for competing Marketing and accounting.
CO4: Build the management of company Recruitment and financial organization.
CO5: Analyse the financing methods and protections like patenting and licenses.
CO6: Acquiring fundamental entrepreneurial knowledge in business to launch new products.

INTRODUCTION TO ENTREPRENEURSHIP AND START – UPS **9**

Definitions, Traits of an entrepreneur, Intrapreneurship, Motivation -Types of Business Structures, Similarities/differences between entrepreneurs and managers.

BUSINESS IDEAS AND THEIR IMPLEMENTATION **9**

Discovering ideas and visualizing the business -Activity map -Business Plan

IDEA TO START-UP **9**

Market Analysis – Identifying the target market- Competition evaluation and Strategy Development- Marketing and accounting-Risk analysis

MANAGEMENT **9**

Company's Organization Structure- Recruitment and management of talent- Financial organization and management

FINANCING AND PROTECTION OF IDEAS **9**

Financing methods available for start-ups in India - Communication of Ideas to potential investors – Investor Pitch - Patenting and Licenses

Total Periods: 45

Text Book:

1. The Startup Owner's Manual: The Stepby-Step Guide for Building a Great Company, Steve Blank and Bob Dorf, K & S Ranch ISBN – 978- 0984999392
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, Penguin UK ISBN – 978- 0670921607.

References:

1. Demand: Creating What People Love Before They Know They Want It, Adrian J. Slywotzky with Karl Weber, Headline Book Publishing ISBN – 978- 0755388974
2. The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business, Clayton M. Christensen, Harvard business ISBN: 978- 142219602

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		2		1		2		1		2	2		1	2
CO2	2		2	1	3		2	1	2			3	1		2	
CO3	2		2		2		1	1	1			3		2		3
CO4	3			1								2	1			2
CO5				1			1	3				2		3	1	2
CO6	1				2			2				3		2	1	

191BTED	BIO WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: To understand the characteristics and valuable usage of Bio-waste management and various aspect of bio-waste collection, segregation, recovery and treatment.

Course Outcomes: The Students will be able to

CO1: Characterize the waste and different features of environmental pollutants.

CO2: Relate the effects of environmental hazard towards the health and prevention.

CO3: Recognize Municipal waste generation and types along with administrative framework operating in the field.

CO4: Handling waste, collection, storage and disposal related to the health measures.

CO5: Acknowledge various ways of nuclear waste generation and its impacts.

CO6: Characterize bio-waste management in various fields of industries.

FUNDAMENTALS OF ENVIRONMNENT AND POLLUTANTS **9**

Features of environment, Bio-magnification, Radiation from the ground, Greenhouse effect and Global warming, Pollution and pollutants; Definition and types and categories of Biowaste, Infection control committee.

INTERRELATIONSHIP OF ENVIRONMENT AND HEALTH **9**

Concept and Definition of health, Dynamics and Development of Disease, Determinants of Health, Causation of disease, Environment and its effect on health, sources of environmental hazards, effects of hazards on health, Prevention and Control of hazards.

WASTE MANAGEMENT **9**

Principles of waste management, Waste around us, Definition and Identification, classification of wastes and its importance, collection and segregation, Recycle, Recovery and Reuse, Transportation and Disposal, Waste Disposal versus Waste Management, Flow of Biomedical waste (Life cycle approach).

HANDLING HEALTH CARE **9**

Source identification, segregation, collection, transportation and disposal, storage, final treatment and disposal including secured landfill, Management of chemical waste, Pharmaceutical waste, cytotoxic waste, Radioactive waste and pressurized containers.

IMPACT OF WASTE ON ENVIRONMENT AND HEALTH **9**

Chemicals in Waste-Mercury, Lead, cadmium, chlorine chromium, disinfectants, gaseous pollutants, impacts on food and livestock, impact on water and aquifer and marine ecosystem. Health risk associated with medical waste, effects of chemical and biological pollutants, safety and precaution.

Total Periods: 45

Text Book:

1. Tchobanoglous G., Theisen H., Viquel S.A., “Integrated Solid Waste Management:
2. Engineering, Principles and Management issues”, Tata McGraw Hill Publishing Company Ltd., New Delhi.
3. CPHEEO Manual on Municipal Solid Waste Management.

References:

1. Peavy H.S., Rowe D.R., Tchobanoglous G., “Environmental Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Cunningham W.P., Cunningham M.A., “Principles of Environmental Science”, Tata McGraw Hill Publishing Company Ltd., New Delhi.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3			2				2		1		2		2		1
CO2	2		1			2		1						1		1
CO3	1				1					3		1	1		3	
CO4	2		2			2		1						3		2
CO5	1	1	2	2	1		1	3		2			1	2		1
CO6	1			3	1	2		2		1		2		2		

191BTEE	PROCESS EQUIPMENTS AND PLANT DESIGN	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: This course will provide a knowledge to develop the skills of the students in the area of process equipment and Design. This is a pre-requisite for the higher studies and to understand the industrial equipment's in Biotechnology.

Course Outcomes: The Students will be able to

CO1: Able to understand the basic concepts of process equipment's and designing
CO2: Acquiring knowledge designing the reactor vessels and other equipment
CO3: Acquiring knowledge to construct the product recovery units
CO4: Acquiring ideas to design the basic requirements like pump, valves, pipes and seal
CO5: Develop various piping and construction materials for modern plant unit.
CO6: Create product based plant unit with basic requirement for industrial case studies

HEAT EXCHANGERS, CONDENSERS, EVAPORATORS **9**

Single and multi-process exchangers, double pipe, U tube heat exchangers, combustion details supporting structure. Single and vertical tube evaporation, Single and multi-effect evaporators, forced circulation evaporators.

STORAGE VESSEL FOR VOLATILE AND NONVOLATILE FLUIDS, PRESSURE VESSEL STRUCTURE **9**

Design of the following equipments as per ASME, ISI codes, drawing according to scale; Monoblock and multiplayer vessels, combustion details and supporting structure

EXTRACTOR, DISTILLATION AND ABSORPTION TOWER **9**

Construction details and assembly drawing; Plate and Packed Extraction Towers; Plate and Packed absorption Towers; Plate and Packed Distillation Towers.

PUMPS, MECHANICAL SEALS, VALVES AND SWITCHES **9**

Various types of pumps, Principle of working, construction, usages, advantages and disadvantages; Various types of seals, effectiveness, usages; Pneumatic Seals; Gate, Globe and Butterfly Valves, their material of construction; Pneumatically Controlled Valves.

PIPING, PLANT LAYOUT AND DESIGN **9**

Various types of Piping, material of construction, their usage; Pipe layout; Modern Plant Design and case Studies.

Total Periods: 45

Text Book:

1. Brownbell I.E.,YoungE.H.,ChemicalPlantDesign,1985
2. Kern D.Q. "Heat Transfer", McGraw-Hill,1985.

References:

1. McCabe W.L., Smith J.C. "Unit Operations in Chemical Engineering", McGraw-Hill, 1976.
2. Don W. Green Robert H. Perry, "Perry's Chemical Engineers' Handbook", Eighth Edition .

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	2	2	2		1	2		1	3	2	2	2
CO2	3	3			3		3			3			3	2	2	2
CO3	3	2	2	3	2	2				2		3	3	3	2	3
CO4	3	3	3	3	2	2				2		3	3	3	3	2
CO5	1		2	2				1	1	1	2			3		1
CO6				2		2		2			1			2		1

191BTEF	CANCER THERAPEUTICS	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: This course was designed to develop the fundamental concept of cancer, various carcinogens and advance molecular treatment established for cancer.

Course Outcomes: The Students will be able to

CO1: Be familiar with basic facts of carcinogenesis and understand the cancer causing agents
CO2: Learn about the molecular mechanisms and signaling pathways in cancer
CO3: Obtain a significant knowledge in a detection of cancer using advance technology
CO4: Using fundamental principles and applications of cancer therapy based on its mechanism.
CO5: Recognize personalized therapy for human diseases from the clinical samples.
CO6: Apply the adequate knowledge in therapy to treat cancer cause by different carcinogenesis agents.

FUNDAMENTALS OF CANCER BIOLOGY **9**

Cancer Epidemiology, different forms of cancers, Regulation of cell cycle, Apoptosis, modulation of cell cycle in cancer ,mutations that cause cancer, Hallmarks of cancer, diet and cancer, Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.

MOLECULAR MECHANISMS OF CANCER **9**

Oncogenes- Types and mechanisms, Tumor suppressor genes- types and mechanisms. Tumor Viruses, Cancer-Telomerases. Metastasis - heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion.

DETECTION OF CANCER **9**

Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer. Applications of new technologies in prevention, Monoclonal antibodies in cancer diagnosis, Cancer imaging Technologies.

MECHANISMS OF CANCER THERAPY **9**

Different forms of therapy, chemotherapy, radiation therapy, Immunotherapy, CAR-T therapy, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy. Cancer antigen based vaccines ,cell based therapy against cancer, Hormone Therapy

PERSONALIZED ONCO-THERAPY **9**

Detection of recognized genetic aberrations in clinical samples from cancer patients. Predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma. Targeted therapies with patients and preventing toxicity of standard systemic therapies.

Total Periods: 45

Text Book:

1. Weinberg, R.A. “The Biology of Cancer” Garland Science, 2007
2. McDonald, F et al., “Molecular Biology of Cancer” 2nd Edition. Taylor & Francis, 2004
3. King, Roger J.B. “Cancer Biology” Addison Wesley Longman, 1996.

References:

1. Ruddon, Raymond W.“Cancer Biology” 3rd Edition. Oxford University Press, 1995
2. “An Introduction Top Cellular And Molecular Biology of Cancer”, j Oxford Medical Publications, 1991.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1		2		2		1	2		2	1	1	1	2		1
CO2	2	1		2	3		2			2				3	1	1
CO3				3	2	1		1			1	2	2		2	2
CO4		2	3		3	1	1	1			1	2	1		2	1
CO5	1		2		2		1	2		2	1	1	1	2		1
CO6		2	1	1	1	1		3			1		2		1	

191BTEG	PRINCIPLES OF FOOD PROCESSING	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: To impart knowledge of various areas related to Food Processing in industries, food quality and safety.

Course Outcomes: The Students will be able to

CO1: List of constituents in food and its sensory evaluation and functional properties.

CO2: Analyse the role and significance of microorganism in food processing and food spoilages.

CO3: Develop the biotechnological applications in food fortification and food processing.

CO4: Emphasize the importance of food safety, food quality of food packaging and the properties of packing material.

CO5: Acknowledge food safety, food quality, food plant Sanitation, food laws and regulations.

CO6: Implement these overall concepts in the industries large scale food processing.

INTRODUCTION **9**

Constituents of food–carbohydrates, lipids, proteins, water, vitamins and minerals, role and functional properties in food, sensory evaluation and perception, Food additives- food colourants, food flavours.

MICROORGANISM AND FOOD SPOILAGE **9**

Microorganism in food processing, Kinetics of microbial growth, Intrinsic and extrinsic factors affecting growth and live of microbes, Food fermentation products and beneficial microbes; Microbial Spoilage of Foods; Hurdle Technology- Hurdle effect in fermented foods.

FOOD PROCESSING **9**

Principles and methods of food processing and preservation-freezing, heating, dehydration, canning, additives, fermentation, irradiation, extrusion cooking, dielectric heating. Utilization of By-products and wastes from processing industry.

FOOD PACKAGING **9**

Packaging of foods, Factors affecting shelf life of food material during storage, types and general properties of Packing material, Package testing, CA & MA,

FOOD QUALITY AND SAFETY **9**

Consumer preferences and acceptance, Food Safety Management Systems GAP, GHP, GMP, Hazards and HACCP (Hazard analysis and critical control point); Food Laws and Regulations in India, FSSAI, Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000.

Total Periods: 45

Text Book:

1. Sivasankar, B. (2014). Food processing and preservation: Hall of India Pvt., New Delhi.
2. Microbiology (5thEd) by M. J. Pelczar, E. C. S. Chan and Noel R. Krieg.Tata McGraw-Hill.

References:

1. Coles R, McDowell D and Kirwan MJ, Food Packaging Technology, CRC Press, 2003.
2. Robertson GL, 2012, Food Packaging - Principles and Practice, CRC Press Taylor and Francis.
3. Whitehurst and Law, Enzymes in Food Technology, CRC Press, Canada, 2002

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	3	3	2		2	1	1		2	1				3
CO2			2	2	3	1							2			
CO3			1	3	2	2	1			2				2	1	
CO4		2		2	3		2		1							2
CO5			1	2		2		3		2		1	1	3		
CO6			1	2	1	2		2		1			1	2		

191BTEH	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: This course will provide a combined overview of genetic engineering and molecular cell biology to develop fundamental understanding to manipulate cell and tissue properties rationally to alter, restore, maintain, or improve cell and tissue functions. Tissue engineering is progressively being accepted as beneficial means for lessening global disease burden.

Course Outcomes: The Students will be able to

CO1: Outline the introduction of basic tissues engineering future scope in therapeutics.

CO2: Recognize the tissue types and components to develop the cell matrix for cell migration in tissues engineering.

CO3: Describe design, fabrication and biomaterials selection criteria for tissue engineering scaffolds.

CO4: Relate the basic Biology of stem cells into tissue engineering.

CO5: Describe sources, selection, potential manipulations and challenges of using stem cells for tissue engineering.

CO6: Apply the stem cells and gene therapy into the clinical application of tissue engineered products and its ethical issues.

BASICS TISSUE ENGINEERING **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.

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, Basic properties, Cell-Matrix & Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

BIOMATERIALS AND SCAFFOLDS **9**

Biomaterials: Properties of biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials.

BASIC BIOLOGY OF STEM CELLS **9**

Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow, primordial germ cells. Stem Cell markers.

CLINICAL APPLICATIONS **9**

Stem cell therapy, Molecular therapy, *Invitro* organogenesis, spinal cord injury, burns and skin ulcers, orthopaedic applications, Stem cells and Gene therapy Physiological models, issue engineered therapies, product characterization, components, safety, efficacy. Preservation–freezing and drying. Patent protection and regulation of tissue-engineered products, ethical issues.

Total Periods: 45

Text Book:

1. Bernhard O.Palsson,Sangeeta N.Bhatia,"Tissue Engineering" Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. Fundamentals of Tissue Engineering and Regenerative Medicine.2009.

References:

1. Bernard N. Kennedy (editor). Stem cell transplantation, tissue engineering, and cancer applications, Nova Science Publishers, 2008.
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, Two-Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, Academic Press, 2004

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1		2			1				2		1	3		1	
CO2		2	1					2			1			2		2
CO3			3		2				2			2	2			3
CO4	2			3		1				2		1		2	1	3
CO5	1	2	2	2	1			3					1		1	
CO6	1	3	1	3				3					1		2	

191BTEI	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: The course objectives are imparting the basic knowledge of students about stem cell, culturing and its clinical applications..

Course Outcomes: The Students will be able to

CO1: Acknowledge the overview of stem cell sources, types and its development stages.
CO2: Categorize the different sources of stem cells in plant and animal cells.
CO3: Influence the factors for the development of stem cells and the role of hormones.
CO4: Illustrate the organ regeneration using stem cells and other experimental procedures.
CO5: Examine various transplantation techniques in invitro using fluroscent.
CO6: Apply the stem cell regenerative methods to treat various diseases and also implement it in medicinal field.

STEM CELLS AND TYPES **9**

Stem cells: Definition, Classification, Tissue engineering, 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. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties

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 –tumour stem cells.

STEM CELLS DIFFERENTIATION **9**

Factors influencing proliferation, physical, chemical and molecular methods for differentiation of stem cells – hormonal role in differentiation.

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

APPLICATION AND ETHICAL ISSUES **9**

Stem cells applications in neurodegenerative diseases, cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations, debate, social and ethical concerns.

Total Periods: 45

Text Book:

1. Stem cells by C.S Potten., Elsevier, 2006.
2. Essentials of Stem Cell Biology by Robert Lanza., fourth edition. Elsevier 2014.

References:

1. Stem cell biology and Gene Therapy by Peter Quesenberry., First Edition, Wiley-Liss, 1998
2. Embryonic Stem cells – Protocols by KursadTurksen., Second Edition Humana Press, 2002.
3. Stem Cells: From Bench to Bedside by AriffBongso, EngHinLee., World Scientific Publishing Company, 2005
4. Stem cells in clinic and Research by Ali Gholamrezanezhad., Intech, 2013

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		1	2	2							2	2			
CO2		1	2	3	3	2	2	1		1	1				2	
CO3			1	3	3	1		2	1	1				1		
CO4			3	2	2		1			2	1					2
CO5			2	2	2	1	2	2	2							2
CO6		2	1	3	1	1		3					1		2	

191BTEJ	BIOCONJUGATE TECHNOLOGY	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: The main objective of the course is to develop the skills of the Student in the field of Bio conjugate technology and its industrial applications.

Course Outcomes: The Students will be able to

CO1: Acknowledge the modification of existing biomolecule and their reactions.

CO2: Develop the knowledge of chemical compounds and its active groups.

CO3: Classify various linkers as a Bio conjugate reagent in Genetic engineering.

CO4: Learn technique to modify enzyme action and their application with the help of bio labelling and biomarkers.

CO5: Prepare immunogenic conjugates and its derivatives based on the conjugation technology.

CO6: Apply the Bio conjugate technology into the industrial application and medicinal purposes

FUNCTIONAL TARGETS **9**

Modification of Amino Acids, Peptides and Proteins – Modification of sugars, polysaccharides and glycoconjugates –modification of nucleic acids and oligonucleotides.

CHEMISTRY OF ACIVE GROUPS **9**

Amine reactive chemical reactions–Thiol reactive chemical reactions–carboxylate reactive chemical reactions – hydroxyl reactive chemical reactions – aldehyde and ketone reactive chemical reactions–Photo reactive chemical reactions.

BIOCONJUGATE REAGENTS **9**

Zero length cross linkers–Homo bifunctional cross linkers–Hetero bifunctional cross linkers– Trifunctional cross linkers– Cleavable reagent systems–tag sand probes.

ENZYME AND NUCLEIC ACID MODIFICATION AND CONJUGATION **9**

Properties of common enzymes– Activated enzymes for conjugation –biotinylated enzymes –chemical modification of nucleic acids–biotin labeling of DNA-enzyme conjugation to DNA–Fluorescent of DNA.

BIOCONJUGATE APLICATIONS **9**

Preparation of Hapten-carrier Immunogen conjugates - antibody modification and conjugation – immunotoxin conjugation techniques – liposome conjugated and derivatives- Colloidal–gold-labeled proteins–modification with synthetic polymers.

Total Periods: 45

Text Book:

1. G.T.Hermanson, Bioconjugate Techniques, Academic Press, 2013.

References:

1. Junhua (Alex) Tao and Romas Kazlauskas, Biocatalyst for green chemistry and chemical process development, John Wiley & Sons, 2011.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	3	2	1				1	1	2	3			
CO2			3	3	2	2	2	1								2
CO3			2	2	3		2			2		1		2		
CO4			1	3	3	2	1	2	1						2	
CO5		2	1		2			3					2			1
CO6	1	2	3	1	1	1		2					1	2		

191BTEK	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: To introduce the concept of simultaneous mass, momentum and energy transport.

Course Outcomes: The Students will be able to

CO1: Understand the fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes.
CO2: Equate the changes happened during the fluid flow.
CO3: Relate the different energy transport mechanisms.
CO4: Study the non-isothermal system and temperature distribution in turbulent flows.
CO5: Develop the knowledge of effects and mechanism of mass transport.
CO6: Summarize the concentration distribution of turbulent flow in a multicomponent system.

MOMENTUM TRANSPORT **9**

Viscosity, temperature effect on viscosity of gases and liquids, Newton's law, mechanism of momentum transport, shell balance method, pressure and velocity distributions in falling film, circular tube, annulus, slit

EQUATIONS OF CHANGE AND TURBULENT FLOW **9**

Equation of continuity, motion, mechanical energy, use of equations of change to solve flow problems, dimensional analysis of equations of change, comparison of laminar and turbulent flows, time-smoothed equation of change, empirical expressions.

ENERGY TRANSPORT **9**

Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanism of energy transport, shell energy balance, temperature distribution in solids and laminar flow, with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

EQUATIONS OF CHANGE FOR NON ISOTHERMAL SYSTEM AND TEMPERATURE DISTRIBUTION IN TURBULENT FLOWS **9**

Energy equations, special forms, use of equations of change, dimensional analysis of equations of change, time-smoothed equations of change, empirical expressions, temperature distribution for turbulent flow in tubes, jets.

MASS TRANSPORT, EQUATIONS OF CHANGE FOR MULTICOMPONENT SYSTEMS AND CONCENTRATION DISTRIBUTION IN TURBULENT FLOWS **9**

Diffusivity, temperature and pressure effect, Fick's law, mechanism of mass transport, theory of diffusion in gases and liquids, shell mass balances, concentration distribution in solids and in laminar flow: stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst. The equation of continuity, summary of equations of change and fluxes, use of equations of change, dimensional analysis, time smoothed equations of change, empirical expressions for turbulent mass flux.

Total Periods: 45

Text Book:

1. Bird, R. B., Stewart, W. E. and Lighfoot, E. N., "Transport Phenomena", II edition, John Wiley, 2006
2. Brodkey, R. S., and Hershey, H. C., "Transport Phenomena", McGraw-Hill, 1987.
3. Brodkey, R. S., and Hershey, H. C., "Transport Phenomena: A unified approach", Volume I & II Brodkey publishing, 2003.

References:

1. Welty, J. R., Wilson, R. E., Wicks, C. E., and Rorer,G. L., "Fundamentals of Momentum, Heat and Mass Transfer ", V edition, John Wiley & sons Inc., 2010.
2. Slattery , J. S., "Advanced Transport Phenomena", Cambridge University Press, London, 1999

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		2			1		1				2	2			3
CO2		3	2	1					1	2	1			2	3	
CO3	2				2		1					2	2			2
CO4	3		2		2	2		1		1		3	3		2	1
CO5	2			2	1			1			1			2		1
CO6	1		1	1	2					2			1	3		

191BTEL	BIOPHYSICS	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: To familiarize with the conjugational study between physics and biology in its structural and working principle.

Course Outcomes: The Students will be able to

CO1: Outline of the physical nature and properties of biological molecule.
CO2: Predict the movements of skeletal, ligaments by the Bioforce.
CO3: Analyse the Biophysical properties of biomolecules in conjugational studies.
CO4: Define the intracellular stability based on metabolic interactions and properties of apoptosis.
CO5: Analyze the coordination of physical action with biological action.
CO6: Apply biophysical knowledge in Physiological Approach, that will help in medicinal field.

BIOMOLECULE INTERACTION AND TRANSPORT **9**

Chemical and physical interaction of biomolecules, Physiological diffusion of ions and molecules, Molecular motors, Intracellular cargo transport.

BIOFORCE AND MOVEMENT **9**

Skeletal, Cardiac and Smooth muscle contractions and tension, The Law of Laplace for hollow organ, Non-muscle motility, Load bearing teeth, bone, blood vessels, Tendons, Ligaments and Cartilage.

BIOPHYSICAL PROPERTIES **9**

Membrane potential, Goldman and Nernst equations, The dielectric constant of water and water surface binding, Induced dipole orientation in solution, Membrane electric field complex dissociation, Membrane electrical conductance, The electrocardiogram and Channel ion selectivity.

STABILITY AND CONTROL SYSTEM **9**

Intracellular molecular diffusion and elimination, System control, Negative feedback and metabolic control, Positive feedback, Models of state stability, Non-linear systems: fractals and chaos and physical properties of apoptosis.

BIOPHYSICAL DYNAMICS **9**

Cilia and Flagella: Structure and Movement, Molecular Motors: Kinesin, Dynein and Myosin, and intracellular movement, Microtubule structure. Mechanobiology and its importance in human health.

Total Periods: 45

Text Book:

1. Biophysics- A Physiological Approach: PATRICK F. DILLON. Cambridge University Press, 2012.
2. Biophysics; R.Glaser, Springer Verlag, 2000

References:

1. Voet and voet, biochemistry, 2ndedition, John Wiley and Sons Inc., 1995.
2. Lehninger's Principles of biochemistry David L. Nelson and Micheal Mcox, Macmillon worth publications, 4th edition 2007.
3. Molecular Cell Biology, 4th edition. Lodish H, Berk A, Zipursky SL, et al. New York: W. H. Freeman; 2000.
4. Basic Neurochemistry: Molecular, Cellular and Medical Aspects. 6th edition. Siegel GJ, Agranoff BW, Albers RW, et al., editors. Philadelphia: Lippincott-Raven; 1999

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2		2							3	2			
CO2		2	1	2	3					1				1		
CO3	1		2		2		1								1	
CO4		2	1					1						1		
CO5	2	1	1	2	2	1										2
CO6	2	1	2	1	1	1		1	1				1	1		2

191BTEM **RATIONAL DRUG DISCOVERY** **L T P C**
3 0 0 3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: This course is aimed at imparting knowledge and skill to understand the drug discovery process, rational methods to identify and design molecules for new medications greatly shortening the discovery phase of drug development by computational methods.

Course Outcomes: The Students will be able to

CO1: Explore the various methods of rational drug design using computational approach of molecular modelling.

CO2: Analyze the quantum mechanics and molecular mechanics to develop the novel drug.

CO3: Develop the simple models using molecular dynamic simulation methods and its applications.

CO4: Modelling of protein and target-small molecule interactions, molecular docking, lead optimization.

CO5: Combinatorial chemistry and library design, Virtual screening of drugs.

CO6: Analyze the toxicity (ADMET) property, Pharmacophore and QSAR.

MOLECULAR MODELLING IN DRUG DISCOVERY **9**

Drug discovery process, Role of Bioinformatics in drug design, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand based drug design, modelling of target-small molecule interactions, Molecular simulations. Protein Modelling.

QUANTUM MECHANICS AND MOLECULAR MECHANICS **9**

Features of molecular mechanics force fields; Bond structure and bending angles – electrostatic, van der Waals and non – bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

MOLECULAR DYNAMICS SIMULATION METHODS **9**

Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time – dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

MOLECULAR DOCKING AND LEAD OPTIMIZATION **9**

Molecular Docking; Types of Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Strategy for target identification and Validation, lead identification, optimization and validation. Combinatorial chemistry and library design, virtual screening, drug likeness and compound filtering, Absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer based tools for drug design.

PHARMACOPHORE AND QSAR **9**

Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery; QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principal Components Analysis in the QSAR equations.

Total Periods: 45

Text Book:

1. Computational methods in drug design Fred E. Cohen, Walter Hamilton Moos Publisher: ESCOM Science, 1993.
2. Molecular Modelling for Beginners - Alan Hinchliffe Publisher: John Wiley & Sons Inc, 2008. ISBN: 978-0470513149.
3. Combinatorial Library Design and Evaluation: Principles, Software, Tools, Applications in Drug Discovery , Arup Ghose, Vellarkad Viswanadhan Publisher: CRC Press, 2001. ISBN: 0-8247-0487-8.

References:

1. Molecular Modeling Basics - Jan H. Jensen Publisher: CRC Press, 2010. ISBN 978- 1420075267.
2. 3D QSAR in Drug Design: Recent Advances – Hugo Kubinyi, Gerd Folkers, Yvonne C. Martin Publisher: Springer Science & Business Media. ISBN: 0-306-46858-1.
3. Computational Chemistry and Molecular Modeling - K. I. Ramachandran, Gopakumar Deepa, Krishnan Namboori Publisher: Springer – Verlag Berlin Heidelberg. ISBN: 978- 3540773023.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		2		1	3		1		2			2		2		3
CO2	1	3	2	2	3	2		2		2			2	2	1	
CO3		2	2		2	1		1					1	1		1
CO4			2			1		2		1			2		1	
CO5	2	1	3		2			1			1			1		2
CO6				2		1			2			3	3		2	

191BTEN **NANO BIOTECHNOLOGY** **L T P C**
3 0 0 3

Programme: B.Tech. Biotechnology **Sem:** **Category: PE**

Prerequisites:

Aim: To develop the skills of the students in the area of Nano biotechnology and its applications.

Course Outcomes: The Students will be able to

CO1: Comprehend the concept of "nanotechnology" and its interdisciplinary aspects.
CO2: learn various approaches of synthesizing nanomaterials, their advantages and limitations.
CO3: gain knowledge about various techniques used for characterizing nanomaterials.
CO4: comprehend the importance of engineered nanomaterials for biomedical, therapeutic and environmental applications.
CO5: Students will know about the use of nanotechnology in diagnostic biology.
CO6: To learn about the health and environmental impacts of nanotechnology.

BASICS OF QUANTUM MECHANICS AND ATOMIC STRUCTURE 9

Duality of light, de Broglie waves, electrons in potential well, structure of hydrogen atom, classic atomic bonding, LCAO theory, band theory, energy bands for metals, semi-conductors and insulators, crystal structure, close packed structures – FCC, HCP and BCC, surface structure for close-packed surfaces, surface reconfiguration (surface relaxation & surface reconstruction) adsorption, wetting, surface area in nanomaterials

INTRODUCTION TO NANOSTRUCTURES 9

Carbon nanotubes (CNT), fullerene ('C60'), quantum dots and semiconductor nanoparticles, metal-based nanostructures, nanowires, polymer-based nanostructures, gold nanostructures, DNA-Protein nanostructures – Biomimetic fabrication of DNA based metallic nanowires and networks – DNA-Gold nanoparticle conjugates – Nanoparticles as non-viral transfection agents.

NANO BIOMATERIALS AND CHARACTERIZATION 9

Biomimetic nanotechnology, protein-based nanostructures, Nano motors, bacterial (E. coli) and mammalian (Myosin family), DNA nanotechnology, nanostructures in cells study, microarray platforms, Nano printing of DNA, RNA, and proteins biochips applications in nano scale detection, lab-on-a-chip devices (LOC), tissue engineering, X-ray diffraction, electron microscopy, interaction between electron beam and solids, TEM, SEM, SPM (STM & AFM), AES, XPS, SIMS.

ENGINEERED NANOMATERIALS FOR BIOLOGICAL APPLICATIONS 9

Current status of Nano biotechnology, biogenic synthesis of nanoparticles: microbial and plant mediated, surface functionalization of nanomaterials, biological applications of functionalized nanomaterials, Biological nanomachines: ribosomes, photosynthesis systems, Bionanomotors, Nano-antimicrobials, Immobilized nanoparticles for water disinfection and biopesticides delivery applications.

BIOMEDICAL APPLICATIONS AND NANOTOXICITY 9

Biopolymers, Polymeric biomaterials, lipid nanoparticles for drug delivery applications, magnetic nanoparticles based hyperthermia treatment of cancer, DNA nanotechnology, Nano-biosensors: fabrication, functionalization, applications, Cytotoxic and genotoxic effects of nanomaterials, toxic effects on environment, impact of nanotechnology on society and industry.

Total Periods: 45

Text Book:

1. Fundamentals and applications of nanomaterials by Guo Z and Tan L, Artech house (2009).
2. Nanobiotechnology by Balaji S, MJP Publishers (2010).
3. Nanobiotechnology: concepts, applications and perspectives by Niemeyer CM and Mirkin CA, Wiley-VCH (2004).
4. "Textbook of Nanoscience and Nanotechnology", B. S. Murthy, P. Shankar, B. Raj, B. B. Rath and J. Murday, Universities Press-IIM (2012)
5. "Nano: The Essentials", T. Pradeep, Tata McGraw-Hill Publishing Company Ltd. (2007)

References:

1. "Bionanotechnology", D. S. Goodsell, John Wiley & Sons (2004)
2. "Springer Handbook of Nanotechnology", Eds: Bhushan, 2nd edition.
3. "Encyclopedia of Nanoscience and Nanotechnology", Eds: H. S. Nalwa, American Scientific Publishers (2004)

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1		3										3			
CO2		1		2			2			1		1	1			
CO3	3							1				3		2		
CO4					3		1			2	3				3	
CO5		3	2			1			2					2		1
CO6	1			2								3	2		1	

191BTEO **NEUROBIOLOGY** **L T P C**
3 0 0 3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: To study of the nervous system and their constitutive parts – nerve cells and neural circuits- and the way in which these structures mediate both animal and human behavioral Studies**.**

Course Outcomes: The Students will be able to

CO1: Demonstrate the molecular, cellular and tissue-level organization of the central and peripheral nervous system.

CO2: Explain different pathways of cells that make up the neuronal transmission study.

CO3: Analyse the major components of the sensory systems of the nervous system and predict the consequences of damage to these systems.

CO4: Relate the properties of individual cells to their function in organized neuronal diseases.

CO5: Study various animal behaviour using animal models for clinical investigation.

CO6: Apply the knowledge of animal neuron system to treat various related diseases.

BRAIN ANATOMY **9**

Brain Organisation – CNS, PNS, ANS; Structure of Cerebellum and Basal Ganglia Histology of Brain Sections (Coronal/sagittal) – Normal vs. Diseased Neuro-developmental Biology Blood Brain Barrier, Different Lobes/ Cortex.

NEURONAL STUDY IN CELL BIOLOGY **9**

Structural and functional diversity of neurons - Types of neurons based on their structure and function. Neurons - General morphology of a typical neuron stressing on features relevant to their function – membrane receptors, ion channels, ion pumps Cytoskeletal elements and 'molecular motors' and role in axonal transport Types of glia cells based on their structure and function – Astrocytes, Oligo dendrocytes and Neuronal Transmission.

SENSATION AND SENSORY PROCESSING **9**

Somatic Sensory System: Touch and Proprioception Pain, Vision – The Eye and Central Visual Pathways, Auditory sensory System, Olfactory System, Gustatory System.

NEUROPATHOLOGY **9**

Clinical, Cellular and Molecular Mechanisms of the Neurological Diseases: Alzheimer 's disease, Parkinson's Disease, Huntington Disease, Dystonia, Wilson Disease, Epilepsy, Autism, Multiple Sclerosis, Amyotrophic Lateral Sclerosis (ALS), Attention Deficit Hyperactivity Disorder (ADHD), Schizophrenia, Depression, Dementia, Cerebro-vascular Disease (Stroke). Mutation information on specific neurodegenerative diseases.

BEHAVIORAL STUDIES **9**

Animal behavior: Behavioral studies by using animal model of *C. elegans*, Fruit fly, Zebra Fish, Mouse (Rodents). Testing motor functions – Rotarod Test, Force Swimming Test, Beam Walking Test, Grip Strength Test. Testing Cognitive Functions – Learning and memory related test (Any-arm Maze, Water Maze). Human behavior: Approaches of studies human behavior, Psychological & Physiological tools, Clinical investigation.

Total Periods: 45

Text Book:

1. Text Book of Medical Physiology, Guyton and Hall
2. Principles of Molecular Biology, Burton E. Tropp
3. The Human Nervous System, Mai Paxinos

References:

1. Lehninger Principles of Biochemistry 5th Ed., Nelson and Cox;
2. Biochemistry 7th Ed., Stryer

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1		3	2	1						3		2	1		2

CO2		2	1			1			1			2	1	1	2	1
CO3			3	1	2		1			1		2	3	2		1
CO4	1			2		1		2		1	3		1	2	3	1
CO5		1	2	1				3			2		1		2	
CO6		2	1	3	1			2			1		1		3	

		L	T	P	C
191BTEP	**GENE EXPRESSION AND TRANSGENIC**	**3**	**0**	**0**	**3**

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: The course will provide the technical details and use of different gene expression systems for overexpression of recombinant proteins and protein complexes for different applications. The course will also provide details about the purification of proteins expressed in different expression systems.

Course Outcomes: The Students will be able to

CO1: Overview of recombinant protein expressions inside the vectors.
CO2: Study the gene expression of vectors in different animal cell lines and plant cells.
CO3: Be familiar with fundamental principles of vectors, yeast and chloroplast.
CO4: Apply the safety and ethical measures to the production of transgenic animals.
CO5: Implement the medical research and clinical application by using transgenic model for study.
CO6: Develop the transgenic animals and apply it in grafting techniques.

OVERVIEW OF RECOMBINANT PROTEIN **9**

Overview of recombinant protein expression vectors and promoters: Vectors with tags His, GST, MBP, GFP. Cleavable tag and non-cleavable tags. Vectors for tag free protein expressions. Over-expression of integral membrane proteins.

GENE EXPRESSION OF CELL LINES **9**

Overexpression in E. coli, B. subtilis, Corynebacterium, Pseudomonas fluorescens, yeasts like S. cerevisiae and Pichia pastoris, insect cell lines like Sf21, Sf9 and BTI-TN-5B1-4, Mammalian cell line like Chinese Hamster ovary (CHO) and Human embryonic kidney (HEK), Plant single cell.

TRANSFORMATION **9**

Chloroplast transformation and protein expression in chloroplasts. Cell free protein Expression-Cell free extracts from E. coli, rabbit, wheat germ, insects. Purification of tagged and tag-free proteins. GMP and GLP requirements. Use of transgenic animals.

ETHICS OF TRANSGENIC ANIMALS **9**

History, safety and ethics of transgenic animals. Methods for creation of transgenic animals-DNA microinjection, Embryonic stem cell-mediated gene transfer, Retrovirus-mediated gene transfer.

TRANSGENIC APPLICATION **9**

Use transgenic animals in medical research, in toxicology, in mammalian developmental genetics, in molecular biology in the pharmaceutical industry, in biotechnology, in aquaculture and in xenografting. Humanised animal models

Total Periods: 45

Text Book:

1. Gene Expression Systems, Using Nature for the Art of Expression. Edited by Joseph M. Fernandez and James P. Hoeffler.
2. Regulation of Gene Expression, By Perdew, Gary H., Vanden Heuvel, Jack P., Peters, Jeffrey M. Springer. Prokaryotic Gene Expression. Edited by Simon Baumberg. Oxford Press

Transgenic Animal Technology,3rd Edition, A Laboratory Handbook by Carl Pinkert. Elsevier.

References:

1. Transgenic Animals as Model Systems for Human Diseases. Edited E. F. Wagner F. Theuring. Springer.
2. Ethical Use of Transgenic Animals (English, Paperback, Shah Krunal V). Lambert

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4

CO1	2			1				1	1			2		2		1
CO2	1		2		1					1		1	3	1		2
CO3		1		2		2		3			1		2	1	1	1
CO4	2				2	1	1	3			2	1	1	2		3
CO5	1	2		2	1	1		3		2			3		2	
CO6	1	3	1	2				3					3		2	

191BTEQ **STRUCTURAL BIOLOGY**

L	**T**	**P**	**C**
3	**0**	**0**	**3**

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: This course focuses on relating theoretical concepts and experimental approaches to a wide range of potential research problems in the area of structural biology and have a solid foundation of understanding structural biology that will facilitate application to current and future research problems.

Course Outcomes: The Students will be able to

CO1: Demonstrate the molecular, cellular and tissue-level organization of the central and peripheral nervous system.

CO2: Prediction of protein structure using computational approaches including protein interactions.

CO3: Analyse the biomolecular interactions and its molecular dynamic calculations.

CO4: Relate the structural organization of genome and functional dynamics of proteins.

CO5: List of various protein structure, sequence alignment and protein folding.

CO6: Apply protein structure studies to develop a novel drug and helps to understand protein interactions

BASICS OF STRUCTURAL BIOLOGY 9

Levels of molecular organization, Brief discussions on: effects of Amino acids on protein structure, Nucleic acids, Adenylates, Carbohydrates, Lipids, Cofactors, Vitamins, and Hormones. Structure and conformational properties of cell membranes, Singer and Nicholson model, integral proteins in membranes, conformational variations during ion transport, Signal transduction and molecular reception (qualitative).

PROTEIN STRUCTURE AND ANALYSIS **9**

Principles of soluble and membrane protein purification, Phase diagram and separation, crystallization, Use of robotics in crystallization, Space groups and symmetry, structure determination; NMR sample preparation, Sample preparation for Cryo EM, Protein validation Structure and its uses protein data bank; Protein fold-function relationships,

BIOMOLECULAR INTERACTIONS & MOLECULAR DYNAMICS **9**

Association of macromolecules, molecular conjugates, supramolecular interactions, protein-protein interactions, protein-nucleic acid interactions, lipid/membrane-protein interactions. Molecular mechanics and dynamics (Newtonian and Monte Carlo simulations), theoretical principles and its importance towards Insilco simulations, results of molecular dynamics calculations and their implications to biological function.

STRUCTURAL DYNAMICS OF PROTEIN **9**

Dynamics of Protein-RNA complexes; Structure and organization of genomes, Thermodynamics stability of protein structure interactions. Simulations: Protein functional dynamics, Protein dynamics studies by MD simulations; Protein dynamics studies by biophysical techniques.

METHODS OF STRUCTURAL BIOLOGY **9**

Protein sequences, sequence alignment; basic polypeptide stereochemistry, hierarchy in protein folds: secondary structure, tertiary structure, quaternary structure. Chaperones assisted protein production.

Total Periods: 45

Text Book:

1. Structure and Mechanism in Protein Science by Alan Fersht.Proteins: Structures and Molecular Properties, by Thomas E. Creighton.
2. The Art of Molecular Dynamics Simulation by D. C. Rapaport Cambridge University Press; 2nd edition 2004.

References:

1.Introduction to Protein Structure by Branden and Tooze, Garland Science; 2nd edition 1999.

2. Principles of nucleic acid structure, by Stephen Neidle

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3			1		1		1			2		2			3
CO2		2	3		2					1		2		1	2	1
CO3			3	2	1	1			1				2	3		1
CO4	2				2			1	2		3		1		3	
CO5	2	1		3		1					1			2		3
CO6	1	2		2	3			3		1			1		3	1

191BTER **MARINE BIOTECHNOLOGY** **L T P C**

3 0 0 3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: The course introduces to the micro, macro flora and fauna of the marine environment with an emphasis on the aquaculture and production of marine products

Course Outcomes: The Students will be able to

CO1: Learn the importance of marine ecosystems and microbial biodiversity.

CO2: Formulate the production methodologies for economically from marine organisms.

CO3: Develop pharmaceutically important secondary metabolite products from marine eco-system.

CO4: Generate the techniques in fish genetics and to produce various seaweed and fishery by-products.

CO5: Evaluate the human impacted pollution in the marine environment.

CO6: Categorize the microbes to treat the marine environment from the pollutions.

INTRODUCTION TO MARINE ECOSYSTEMS AND MICROBIAL DIVERSITY **9**

Physical and chemical properties of sea water. Zonation of sea: Euphotic zone, Bathyal zone, Abyssal zone, Benthic zone, Deep sea. Marine ecosystems and biodiversity: Estuary, Seagrass, Seaweed, Salt marsh, Mangroves and Coral reef. Marine microbial diversity: Marine microbial habitats, Microbial distribution in the ocean, Factors that impact marine microbial diversity. Interactions between marine microbes and other living organisms.

AQUACULTURE **9**

Aquaculture: Definition-Site selection, design and construction of aquaculture pond. Criteria for selecting the candidate species for aquaculture. Types and methods: Extensive, Semi-intensive and Intensive culture. Composite fish culture and Integrated fish farming. Types of culture systems: Pen culture, Cage culture, Raft culture and Pond culture. Culture practices of marine Fish, Shrimp, Crab, Lobster, Oyster, and Seaweed.

ECONOMIC IMPORTANCE OF MARINE ORGANISMS **9**

Live feed culture for marine organisms: culture of microalgae, rotifers, copepods and Artemia. Biofuel production. Marine enzymes, Production of omega-3 fatty acids from marine organisms. Marine pharmacology: New and novel antibiotics from marine organisms. Secondary metabolites from marine bacteria, actinomycetes and marine endophytic fungi. Prebiotics and Probiotics for aquaculture.

FISH GENETICS AND MARINE BY-PRODUCTS **9**

Fish genetics: Androgenesis, Gynogenesis, Polyploidy, Artificial insemination, Eye-stalk ablation and Cryopreservation of fish gametes. Marine algal by-products: Chitin, Chitosan, Agar, Alginates, Carrageenan and Heparin. Fishery by-products: Fish oil, Isinglass, Fish glue, Fish silage, Fin rays.

MARINE ENVIRONMENT PROTECTION **9**

Marine Pollution. Human impacts on marine microbial diversity - Usage of marine microbes to ameliorate environmental deterioration. Control of oil spills and bioremediation. Effects of bio-fouling and bio-deterioration on marine structures. Protection methods against corrosion and fouling. Red tides: Causative factors and effects on the organisms of marine environment, Treatment of Aquaculture effluents.

Total Periods: 45

Text Book:

1. Marine Biotechnology. Guest Editors: Song Qin, W.E.G. Muller and Edwin L. Cooper. Hindawi Publishing Corporation, 2011.

2. Grand Challenges in Marine Biotechnology. P.H. Rampelotto, A. Trincone (eds.). Springer International Publishing AG, part of Springer Nature, 2018.

3. Marine Biotechnology I. Advances in Biochemical Engineering/Biotechnology Le Gal, Y., Ulber, R. (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg, 2005, Vol. 96.

4. Marine microbial diversity: The key to earth's habitability: A Report from the American academy of Microbiology, 2005. Jennie Hunter-Cevera, David Karl and Merry Buckley, Published by American Academy of Microbiology, 2005.

References:

1. Advances in Marine and Brackishwater Aquaculture, Santhanam Perumal, Thirunavukkarasu A.R., Perumal Pachiappan. Editors. Springer India. 2005N.
2. Arumugam, Aquaculture, Saras Publication, 2014. FAO.
3. The State of World Fisheries and Aquaculture, Rome, 2018.
4. T.V.R. Pillay & M..N.Kutty, Aquaculture: Principles and Practices, Wiley India Pvt. Ltd., 2nd Edition, 2011

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1			3		2	1	1				2	2		1	2
CO2		2			`		2		1		3	1		1	3	
CO3	2		1		2	1		1	2	1	3		1	2		3
CO4		3		2			1					2			2	
CO5	1			1			1	2				2	1	2		1
CO6	1	1					2	1				2		1		2

191BTES	GENOMICS AND PROTEOMICS	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: This Paper provide a broader knowledge on the structure and function of genomes, the technologies developed for genomics, functional genomics and proteomics.

Course Outcomes: The Students will be able to

CO1: Gain an insight of the basic and advanced concepts and applications of sequencing technologies.

CO2: Be able to use bioinformatics techniques to query examples of genomic and proteomic databases to analyse cell biology

CO3: Apply functional genomics techniques to analyses data for biological system

CO4: Be able to synthesize information to discuss the key technological developments that enabled modern proteomic studies

CO5: To describe the different types of genome variation and their relationship to human diseases

CO6: Implement techniques and database search to analyse complex protein samples

BASIC CONCEPT OF GENOME **9**

Basic concept of Genome: Introduction to genome. Origin of genomes. Genome sequencing; Sequence assembly; Human Genome Project human genome project and its significance in modern biology; DNA fingerprinting.

GENOME SEQUENCING AND MAPPING **9**

Genetic and physical mapping, Linkage analysis, RFLP, SNP, SSLP, Restriction mapping, STS mapping, Top-down and bottom-up sequencing strategies, Whole genome sequencing, HAPPY mapping.

FUNCTIONAL GENOMICS **9**

Genome annotation, ORF and functional prediction, Genefinding, Substractive DNA library screening, Differential display and Representational difference analysis, SAGE, TOGA, Introduction to DNA microarray.

PROTEOMICS **9**

Introduction to proteomics, protein arrays, protein chips and their applications, 2D gel electrophoresis and its application, High throughput solving of protein structures- X-ray crystallography, NMR, homology modeling and protein structure prediction methods, applications of structural proteomics.

PROTEIN PROFILING **9**

Proteomic interactions- Yeast two hybrid systems, Rosetta stone method, multiple sequence alignment, Protein - Protein Interactions and Protein Complexes, Databases and proteomic tools, role of bioinformatics in proteomics.

Total Periods: 45

Text Book:

1. Primrose, S.B. and Twyman. “Principles of Genome Analysis and Genomics”. 7th Edition,Blakwell Publishing, 200
2. Stephen P. Hunt, Frederick J. Livesey. Functional genomics, Oxford
3. Lesk AM, Introduction to Genomics, Oxford University Press (2008).
4. Pennington, S.R. and Dunn, M. J., Proteomics: from protein sequence to function. Viva Books (2001).
5. Mount, D.W., Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press (2001).

References:

1. Suhai, Sandor “Genomics and Proteomics: Functional and Computational Aspects”. Springer, 2000
2. O’Connor, C.D. and B.D.Hames. “ Proteomics”. Scion Publishing, 2008.

3. Liebler, R.C. “Introduction to Proteomics”. Humana Press, 2002
4. Conard, Edward. “Genomics”. Apple Academics, 2010

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1		2		2		1	1		2	1	1	1	2		1
CO2	2			2	3		2			2				3	1	1
CO3				3	2	1		1			1	2	2		2	2
CO4		2	3		3	1	1	1			1	2	1	1	2	1
CO5	1		1	2					3		2			2		1
CO6	1		2		2		1	1		2	1	1	1	2		1

191BTET FUNDAMENTALS OF MOLECULAR PATHOLOGY

L	T	P	C
3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: This course Provide basic information on molecular pathogenesis of infectious diseases and also learn about host defense against pathogens, virulence factors and life cycle in different pathogens

Course Outcomes: The Students will be able to

CO1: Outline the concept of virulence and the evolution of pathogens.
CO2: Develop the host defence mechanism against pathogens and its strategies.
CO3: List out the various pathogens with its molecular pathogenesis and virulence factors.
CO4: Create an experimental study to understand the host and pathogen interactions.
CO5: Listing modern approaches that help to control pathogen virulence.
CO6: Apply molecular techniques to develop new therapeutics.

FUNDAMENTALS OF PATHOLOGY 9

Molecular Koch's postulates, Concepts of disease, Virulence, Optimal virulence, Horizontal and vertical transfer of virulent gene, Virulent factors, Evolution of bacterial pathogens, Biofilms, Quorum sensing molecules, Multidrug resistance mechanisms, Plasmid-mediated resistance.

HOST-DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES 9

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

MOLECULAR PATHOGENESIS 9

Virulence, virulence factors, virulence- associated factors and virulence lifestyle factors, molecular genetics and gene regulation in virulence of Vibrio Cholerae, E.coli pathogens, Plasmodium, Shigella Influenza virus.

EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS 9

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

MODERN APPROACHES TO CONTROL PATHOGENS 9

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 Periods: 45

Text Book:

1. Iglewski B.H and Clark V.L "Molecular basis of Bacterial Pathogenesis ", Academic Press, 1990. Peter Williams, Julian Ketley& George Salmond, "Methods in Microbiology: Bacterial Pathogenesis, Vol. 27", Academic Press, 1998.
2. Nester, Anderson, Roberts, Pearsall, Nester, "Microbiology: A Human Perspective", McGraw Hill, 3rd Edition, 2001

References:

1. Recent reviews in Infect. Immun., Mol. Microbiol., Biochem. J., EMBO etc
2. Eduardo A. Groisman, Principles of Bacterial Pathogenesis, Academic Press, 2001.

Course Outcomes	Program Outcomes (POs)	Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		1					1			2	1	1		2	
CO2		3	2	1					2	1				3		2
CO3		1		2	3						2		1		2	
CO4	3	1		2	1				2	1	2		2			3
CO5		1	2		2			1		1					2	
CO6			2		3			2		1					2	1

191BTEV **MOLECULAR MODELLING** **L T P C**

3 0 0 3

Programme: B.Tech. Biotechnology **Sem:** **Category: PE**

Aim: This course gives the detailed information on the recent advances and the limitations of the molecular modelling methods. It also serves as a introduction of molecular modeling to the students which could provide strong basic knowledge as well.

Course Outcomes: The Students will be able to

CO1: Familiarize the concepts of bioinformatics to be implemented in drug design and development.

CO2: Provide brief idea of receptor and receptor-ligand complex, inhibition and inactivation of enzyme, receptor theories.

CO3: Develop simple models for conformational changes using molecular dynamics simulations.

CO4: Outline the concept of molecular modelling, mechanics and interactions for drug design.

CO5: Predict pharmacophore 3D and various QSAR methodologies using genetic algorithms.

CO6: Analyse various web tools to develop novel drugs based on protein structure and functional properties.

INTRODUCTION **9**

Introduction to drug designing, drug design to discovery and development, drug metabolism, toxicity and pharmacokinetics, toxicology considerations, problems and drawbacks on drug discovery and development. Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation.

QUANTUM MECHANICS AND MOLECULAR MECHANICS **9**

Features of molecular mechanics, force fields; Bond structure and bending angles – electrostatic, van der Waals and non – bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

MOLECULAR DYNAMICS **9**

Molecular Dynamics simulation methods – Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time – dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

MOLECULAR DOCKING AND LEAD OPTIMIZATION **9**

Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Strategy for target identification and Validation, lead identification, optimization and validation-computer based tools for drug design.

PHARMACOPHORE AND QSAR **9**

Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery; QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Use of Genetic Algorithms.

Total Periods: 45

Text Book:

1. Principles of Medicinal Chemistry by W.O. Foye, T.L. Lemke, and D.A. Williams. Williams and Wilkins, Seventh Edition 2013.ISBN: 978-0683033236
2. Essentials of Drug Designing by V. Kothekar, Dhruv Publications 2005. .ISBN: 9788182400078.

References:

1. J. M. Haile, “Molecular Dynamics Simulations.” John Wiley & Sons, New York, 1992.
2. M. P. Allen and D. J. Tildesley, “Computer Simulation of Liquids.” Oxford Science Publications, Oxford, 1987.
3. H. Goldstein, “Classical Mechanics.” Addison-Wesley Publishing Company, 1922.
4. T. L. Hill, “An Introduction to Statistical Thermodynamics.” Dover Publications, New York, 1986.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		1					1			2	1	1		2	
CO2		3	2	1					2	1				3		2
CO3		1		2	3						2		1		2	
CO4	3	1		2	1				2	1	2		2			3
CO5		1	2		2			1		1					2	
CO6			2		3			2		1					2	1

191BTEV	HUMAN ANATOMY AND MEDCAL CODING	L	T	P	C

				3	0	0	3
Programme:	B.Tech. Biotechnology	**Sem:**		**Category:**		**PE**	

Aim:	The purpose of this course is to provide the student with basics of anatomy and physiology of human body system. The objective of this course is to emphasis student with coding knowledge related to ICD, CPT for clinical statements.
Course Outcomes: The Students will be able to	
CO1:	To understand structure and functions of various system in human body.
CO2:	To gain knowledge regarding Musculoskeletal system in human body.
CO3:	Relate the functions of central nervous system for clinical considerations.
CO4:	To understand the basics of coding application in diagnosis.
CO5:	Apply CPT coding for various anatomy system.
CO6:	Provide practical application of coding operative reports and evaluation and management services

Unit-I Musculoskeletal system	**9**
Classification, structure and function of tissues- structure, function and clinical considerations of the integumentary system- structure, function and clinical considerations of bone tissue including bone development- structure, function and clinical importance of articulations- structure, function, and clinical considerations muscles and muscle tissue	
Unit-II Nervous system and Circulatory system	**9**
Functional organization of the nervous system- characteristics, components and functions of the central nervous system- peripheral nervous system- autonomic nervous system- structure, function and clinical considerations of sensory organs. Structure of blood, blood vessels and heart. Lymphatic system.	
Unit-III Basics of Respiration, Digestion, Excretion and Endocrine system	**9**
Structure of respiratory organ and muscular respiration. Structure of Alimentary tract and accessory organs of digestion. Structure of organs of urinary system : Kidney, Ureters, Urinary bladder, Urethra. Structure of Pituitary, Pancreas, Thyroid, Parathyroid, Thymus and Adrenal glands	
Unit-IV Medical Coding Theory Introduction to Medical Coding- Medical Coding and terminologies in association with Diseases- Diagnosis Coding- ICD-CM coding- Current Procedural Terminology (CPT)- CPT Coding and Structure- Evaluation and Management (E/M) Coding- Issues with Fraud and Abuse- Health Insurance Portability and Accountability Act (HIPAA) **Unit-V –CPT coding for disease** Introduction to Documentation (Medical History)- Medical Examination, Decision Making, Selecting the Correct Code Surgery and Integumentary System Coding- Anesthesia CPT Codes- Cardiovascular, Respiratory, Musculoskeletal Systems code-	**9**

Radiology and Pathology Coding- Coding of Neoplasm's and diseases- codes for Injuries, Industrial Accidents, and Mental Disorders	
Total periods:	**45**

Text Book:

1. Ross and Wilson, Anatomy and Physiology In Health And Illness, ELSEVIER, 13Ed, 2018

2. A Visual Analogy Guide to Human Anatomy 3rd Edition. Morton Publishing, Englewood, CO.
3. Medical Terminology & Anatomy for CodingAuthor: Betsy J. ShilandEdition: 3rd Edition.

References:

1.2015 Medical Coding Training: CPC®; AAPC; AAPC publisher; ISBN-13: 978-1-626880-900
2. 2015 Medical Coding Training: Practical Application CPC®; AAPC; AAPC publisher; ISBN-13: 978-1-626880-924

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2		1									3	1	
CO2	1	1	2		2								1			3
CO3	1	1	2		1						3				2	
CO4	1	1	3		1								3		1	2
CO5	1	1	2		1						2			2		1
CO6	1	2	3		1						2			3		1

191BTEW	FUNDAMENTALS OF RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **PE**

Prerequisites:

Aim: The aim of the course is to impart the knowledge of various methods of research strategy in Biotechnology.

Course Outcomes: The Students will be able to

CO1: Recognize research process, constraints and its analysis related to laboratory and industries.
CO2: Designing research procedure, facilities, funding and literature.
CO3: List the experiments, experimental design, sampling size and computational approaches.
CO4: Emphasis the Creativity, Innovation and New Product Development.
CO5: Guidelines for publishing scientific and technical publications with writing skills.
CO6: Protection of new product using intellectual property and patents.

RESEARCH AND ITS METHODOLOGIES **9**

Motivation – Objective and significance of research – Research process – Observation – Axiom – Theory – Experimentation – Types of research (basic, applied, qualitative, quantitative, analytical etc). Features of translational research – Concept of laboratory to market (bench to public) – Industrial R&D.

RESEARCH DESIGN **9**

Laboratory policy and procedure of academic research – Types of expertise and facilities required. Technology and product transfer research – Grant funding – Sources of literature – Interdisciplinary nature – Collaboration based research.

EXPERIMENTAL RESEARCH

Research direction – Understanding research by experimentation – Strategies for experimentation – Selecting an experimental design – Sample size – instrumental methods –computational experiments.

RESULTS AND ANALYSIS **9**

Scientific methodology in recording results – Importance of negative results – Ways of recording – Industrial requirement – Artifacts versus true results – Types of analysis (analytical, objective, subjective) and cross verification – Correlation with published results – Discussion – Hypothesis – Concept – Theory and model.

PUBLISHING SCIENTIFIC AND TECHNICAL PAPERS **9**

Guide to publishing scientific papers – Types of scientific and technical publications in biotechnology – Specifications – Ways to protect intellectual property – Patents – Technical writing skills – Importance of impact factor and citation index.

Total Periods: 45

Text Book:

1. Kothari, C.R., "Research Methodology: Methods and Techniques", New Age Publications, 2008
2. Haaland, P.D., "Experimental Design in Biotechnology", Marcel Dekker, 1989.

References:

1. Malinowski, M.J. and Arnold, B.E., "Biotechnology: Law, Business and Regulation", Aspen Publishers, 2004.
2. Marczyk,G.R., DeMatteo, D. and Festinger, D., "Essentials of Research Design and Methodology", John Wiley & Sons Publishers, Inc., 2005.
3. Korner, A.M., "Guide to Publishing a Scientific paper", Taylor & Francis group, 2008

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		2	3	1				1				2		3	1	
CO2	3				2			1					1			3
CO3	3	2		1		1		1		1	3				2	
CO4			3			2		2				2	3		1	2
CO5		2	2	3				2		1	2			2		1
CO6		2	1	1				2			2			3		1

191OE5A	BIOMATERIALS	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem: - Category: OE**

Aim:

Course Outcomes: The Students will be able to

CO1: Know about chemistry and testing of various biomaterials.
CO2: Apply the use of biopolymer in tissue graft and soft tissue application.
CO3: Familiarize with synthesis and manufacturing process of biomaterials.
CO4: Learn the implements in cardiovascular and ophthalmology.
CO5: Find out suitable material for orthopaedic and dental implant.
CO6: Aware about the properties and broad applications of biomaterials.

FUNDAMENTALS OF BIOMATERIALS

Introduction to Materials, General structure and properties. Classification of common materials and applications. Chemical Bonding, Crystalline, Amorphous. Melting, Solidification, Nucleation, Phase diagrams.

SYNTHETIC AND BIOPOLYMERS

Metal and alloys in Medical application: Stainless steel, cobalt based alloys, titanium based alloys (including shape memory alloys). Ceramics and glasses-bio ceramics: Type of Ceramics and their classification, Calcinations, Annealing, Sintering, Nearly inert ceramics, bio-reactive glasses and glass ceramics, Calcium phosphate ceramics.

TISSUE GRAFTS AND SOFT TISSUE APPLICATION

Introductions to polymers: Definition, classification, Polymerization. Rubber, plastics, fibers and resins and structure-properties relationship. Biodegradable polymers; Natural polymers, Composites, Pyrolytic carbon, Carbon nanotubes.

BIOMATERIALS IN CARDIOVASCULAR AND OPTHALMOLOGY

Bulk Properties, Surface properties and modification of surface properties. Basic principles of engineering manufacturing, methods and applications of common manufacturing processes, milling, grinding, finishing, rolling, forging, Concept of biomimetic synthesis, Fabrication of Porous Materials, Different advanced fabrication technique.

ORTHOPAEDIC AND DENTAL MATERIALS

Bone composition and properties, Teeth composition and mechanical properties, filling and restorative materials, metals in dentistry and oral implants

Total Periods: 45

Text Book:

1. Sujata V. Bhat, Biomaterials, 2nd Edition, Narosa Publishing House, 2010
2. Biomaterials Science - An Introduction to Materials in Medicine, Buddy Ratner Allan Hoffman Frederick Schoen Jack Lemons, ISBN: 9780080470368, Academic Press, Published Date: 18th August 2004.

References:

1. Biomaterials: An Introduction- J. Bo. Park.
2. Materials Science and Engineering- Callister.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	1		1			1		2	3			
CO2			2	3	2	1		1			1					2
CO3			2	3	2	2	1		1						2	
CO4		2	1	2	1		2	1		2				2		
CO5		1	3	2	2	1			1		2			2		2
CO6	1		2				1			2		3	2		1	

191OE5B	BIOSENSOR	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **OE**

Aim: To provide a foundation in biology with engineering of living systems and to apply various tools of traditional engineering fields such as material, electrical and chemical to understand and solve biomedical and biological problems and harness potential of living systems for the benefit of human mankind.

Course Outcomes: The Students will be able to

CO1: Demonstrate the importance of using biomolecules as sensors
CO2: Deliver the impact transduction and choice of sensing elements in biosensor design.
CO3: Understand the role of enzymatic sensors and immunosensors
CO4: Apply nano constructs in design of Biosensors
CO5: Study the uses of clinical and non-clinical uses of biosensors.
CO6: Recognize the concepts behind the reagentless biosensors & array-based chips

FUNDAMENTALS OF BIOSENSORS **9**

Biosensors as Functional Analogs of Chemo Receptors-Immobilization and biosensor construction, Biosensor Instrumentation-Transduction principles used in a biosensor, Biocomponent of the sensor. Biological sensing elements and transducer systems-their sensitivity specificity and linearity.

TYPES OF BIOSENSORS **9**

Thermometric Indication with Thermistors, Optical electronic Sensors, Piezoelectric Sensors, Electrochemical Sensors, Potentiometric Electrodes, Conductometric Measurement. Flow injection analysis based biosensors, fiber optics biosensors, Bioluminescence biosensors, Microbial biosensors, Affinity biosensors, Immunosensors. DNA Probes, organic acid probes, antigen-antibodies reaction, biochemical detection of organelles, receptors, sensors for pollution gases stability and reusability of sensors.

BIOSENSORS FOR CLINICAL ANALYSIS **9**

Biosensors for personal diabetes management (Glucose, Galactose, Gluconate, Lactate, Pyruvate Sensors), Noninvasive Biosensors in Clinical analysis and health care.

NON CLINICAL APPLICATION OF BIOSENSORS **9**

Applications in Veterinary, Agriculture, Food production, Environmental control and pollution monitoring, and bioprocess industry.

REAGENTLESS BIOSENSORS & ARRAY-BASED CHIPS **9**

Surface Dielectric Enhancement, Gold nanoparticle enhanced surface plasmon resonance, carbon nanotube and silicon nanowire enhanced conductivity, catalytic activation, electro catalytic detection, catalytically enabled optical and magnetic detection, Reagent less Immunoelectrodes, biomolecule conformational modulated effects, Biosensors based on DNA conformation changes, Biosensors based on protein conformation changes.

Total Periods: 45

Text Book:

1. Turner A.P.F, Karube I and Wilson G.S, (1987) Biosensors-Fundamentals and applications, Oxford Univ.Press.
2. Yang V.C. and T.T.Ngo,(2000) Biosensors and their Applications, Academic/Plenum Publishers.

References:

1. Ashok Mulchandani and Kim R Rogers,(1998)Enzyme and Microbial bio sensors: Techniques and Protocols,Humana Press Totowa, NJ.
2. Turner A.P.F and Wilsons G.S, (1997) Biosensors: Fundamentals and Applications, Oxford Science Publications

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		1	2	3	1		1			1						2
CO2			1	2	2	1		1			2	1		2		
CO3			2	3	2	1			1				3			
CO4			1	2	3	2		1				2			2	
CO5			2	3	2	1			1				3			
CO6			1	2	3	2		1				2			2	

191OE5C	BIOWEAPONS AND SECURITY	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **OE**

Aim: Familiarization of issues involved and threats facing society due to bioterrorism and approaches to tackle it effectively.

Course Outcomes: The Students will be able to

CO1: Overview of historical terrorism era to Bioterrorism.

CO2: Interaction between biological agents and the immune system.

CO3: Develop bioterrorism created by microbes related to the case studies.

CO4: Establish surveillance and detection of bio weapons using advanced technology like sensors.

CO5: Know the preventive measures to control the Bioterrorism and the treatment.

CO6: Apply the ethical view of managing bioterrorism by government safety measures and industry support.

TERRORISM AND BIOTERRORISM

Definition-Traditional Terrorists-New Terrorists-Nuclear, chemical, and radiological weapons-The psychology of Bioterrorism-Historical perspective.

MICROBES AND IMMUNE SYSTEM

Primary classes of Microbes-bacteria, virus, and other Agents-Immune systemInteraction between microbes and the immune system.

BIOTERRORISM WEAPONS AND TECHNIQUES

Characteristics of microbes and the reasons for their Use-Symptoms-PathogenicityEpidemiology-natural and targeted release-The biological, techniques of dispersal, and case studies of Anthrax, Plague-Botulism, Smallpox, and Tularemia and VHF. Characteristics of microbes and the reasons for their Use-Symptoms-PathogenicityEpidemiology-natural and targeted release-The biological, techniques of dispersal, and case studies of Anthrax, Plague-Botulism, Smallpox, and Tularemia and VHF.

PREVENTION AND CONTROL OF BIOTERRORISM

Surveillance and detection- Detection equipment and sensors –Diagnosis-Treatment Vaccinations-Supplies- Effectiveness-Liability-Public Resistance-Response-First Responders-Infectious Control-Hospital-Prevention- Protection-Decontamination Notification-Role of Law Enforcement-Economic impact.

BIOTERRORISM MANAGEMENT

Ethical issues: personal, national, the need to inform the public without creating fear, cost-benefit Rations-Information Management-Government control and industry Support-Microbial forensics.

Total Periods: 45

Text Book:

1. Bioterrorism: Guidelines for Medical and Public Health Management, Henderson, Donald, American Medical Association, 1st Edition, 2002.
2. Biological Weapons: Limiting the Threat (BCSIA Studies in International Security), Lederberg, Joshua (Editor), MIT Press ,1999.
3. Bioterrorism and Infectious Agents: A New Dilemma for the 21st Century (Emerging Infectious Diseases of the 21st Century), I.W. Fong and Kenneth Alibek, Springer, 2005.

References:

1. The Demon in the Freezer: A True Story, Preston, Richard, Fawcett Books, 2003.
2. The Anthrax Letters: A Medical Detective Story, Cole, Leonard A., Joseph Henry Press, 2003.
3. Biotechnology research in an age of terrorism: confronting the dual use dilemma, National Academies of Science, 2003.

4. http://www.centerforhealthsecurity.org/ourwork/pubs_archive/pubspdfs/2012/sloan_book/Preparing%20for%20Bioterrorism_Gigi%20Kwik%20Gron vall_December%202012.pdf

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		1		1			1	2		2			3			
CO2		2		3	1		2	1						2		
CO3			2	2	3	2			2		1					2
CO4		2	1	2	3		1			1					1	
CO5	1	2	2	1	3			2				2			2	1
CO6			1					3			1			2		1

191OE5D	FOOD AND NUTRITION TECHNOLOGY	L	T	P	C
		3	0	0	3

Programme: B.Tech. Biotechnology **Sem:** **Category:** **OE**

Aim:

Course Outcomes: The Students will be able to

CO1: Understand the functions, importance of all nutrients present in Foods.

CO2: Apply the concepts of food classification, nutrition during special conditions and role of special functional food.

CO3: Explain importance of different types of food in balanced diet and diet planning.

CO4: Create advanced aspects of food and nutrition to serve space nutrition, sports nutrition, understand genetically modified food, functional foods etc

CO5: Knowledge of basic terminology and several aspects of nutrition and the functions of food in healthy life sustenance.

CO6: Differentiate the constituents present in food and microorganism involved in processing of food.

INTRODUCTION OF FOOD NUTRITION **9**

Basic concept of Food; Understanding relationship between food, nutrition and health. Food groups and role of nutrients; Classification of Nutrients, Biochemical changes in foods, Elements of nutrition.

HUMAN NUTRITION

Malnutrition and Health, Minimum Nutritional Requirement and RDA, Adult consumption unit, Factors affecting growth and development; Role of Dietician-Diet therapy.

BALANCED DIET

Dietary surveys, Dietary Counselling, Dietetic food product development, Growth & Development from infancy to adulthood, Functions of food-physiological, psychological and social, Concept of Balanced Diet, Food Groups, Food Pyramid.

NUTRITIONAL SCREENING AND ASSESSMENT

Importance of identifying malnutrition, Nutritional Screening and Assessment- methods of screening tools, Measurement of Body Composition-Body Mass Index (BMI), Anthropometric Measurements, bioelectrical impedance analysis (BIA), Nutritional Balance.

NUTRITIONAL LABELLING

Importance, global trends, codex guidelines, nutritional labelling in India, FSSAI guidelines.

Total Periods: 45

Text Book:

1. Lehninger, Principles of Biochemistry, by 4th Ed. By Nelson D.L. and Cox. M.M.
2. West. E.S., Todal, W.R., Mason H.S. and Van Brygen J.T., Text Book of Biochemistry.

References:

1. Biochemistry of Foods:- N.A.M. Eskin, H.M. Henderson, R. J. Townsend.
2. Kale, C.A. and Nail, E Samson Wright's Applied Physiology, Oxford University press, 1994.
3. Michael, J. Gibney, Barrie, M. Margetis, John, M. Kearney. Lenore Arab. Public Health Nutrition. Blackwell science, Blackwell Publishing Company (2004).

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1		3	2	2	1				2		2	3			
CO2			2	3	1		2	1						2		
CO3		2							1						1	
CO4			2	2	3	2			2		1					2
CO5		2	1	2	2		1			1					1	
CO6	3					2						1	2			

191MC01	DESIGN THINKING	L	T	P	C
		2	0	0	0

Programme: B.E., / B. Tech **Category: MC**

Aim: To impart knowledge on design thinking process for understanding complex designs and to provide design skills to analyze design thinking issues and apply the tools and techniques of design.

Course Outcomes: Students will be able to

CO1. Demonstrate knowledge of design thinking process

CO2. Recall design thinking techniques to design relevant products/services

CO3. Apply human centered design (HCD) methodology for product or service design.

CO4. Use ideation techniques for developing innovative products or services

CO5. Analyse the causes for the problems in the design of products or services

CO6. Perform the steps to gain practical knowledge of prototyping, testing and validation.

UNIT-I OVERVIEW OF DESIGN THINKING PROCESS 6

Introduction to design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs Design thinking, Problem solving, Understanding design thinking and its process model, Design thinking tools. Human-Centered Design (HCD) process - Empathize, Define, Ideate, Prototype and Test and Iterate or Empathize, Analyze, Solve and Test.

UNIT-II EMPATHIZE 6

Design thinking phases, How to emphatize, Role of empathy in design thinking, purpose of empathy maps, Things to be done prior to empathy mapping, creation of user personas, customer journey mapping, How might we questions

UNIT-III SOLVE / IDEATE 6

Silent brainstorming, metaphors for ideation, CREATE and What-If tool for ideation, introduction to TRIZ, Inventive principles and their applications

UNIT-IV ANALYZE / DEFINE 6

Root cause analysis, conflict of interest, perspective analysis, big picture thinking through system operator, big picture thinking through function modeling.

UNIT-V TEST (PROTOTYPING AND VALIDATION) 6

Prototyping, Assumptions during the design thinking process, Validation in the market, best practices of presentation.

Total Periods 30

References

1. Dr. Bala Ramadurai, "Karmic Design Thinking", First Edition TRIZ Innovation India, 2020.
2. Karl T. Ulrich, “Design Creation of Artifacts in Society”, Trustees of the University of Pennsylvania Publisher, USA, 2011
3. Alma R. Hoffmann, “Sketching as Design Thinking”, Taylor & Francis, UK, 2019
4. Michael Lewrick, Patrick Link and Larry Leifer, “The Design Thinking Playbook”, Wiley, USA, 2018.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																
CO5																
CO6																

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MC02	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	L	T	P	C
		2	0	0	0

Programme: B.E., / B. Tech **Category:** MC

Aim: To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.

Course Outcomes: Students will be able to

CO1. Identify the concept of Traditional knowledge and its importance

CO2. Explain the need and importance of protecting traditional knowledge.

CO3. Illustrate the various enactments related to the protection of traditional knowledge.

CO4. Interpret the concepts of Intellectual property to protect the traditional knowledge.

CO5. Identify the importance of conservation and sustainable development of environment.

CO6. Explain the importance of Traditional knowledge in Agriculture and Medicine.

UNIT-I INTRODUCTION TO TRADITIONAL KNOWLEDGE 6

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

UNIT-II PROTECTION OF TRADITIONAL KNOWLEDGE 6

The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNIT-III LEGAL FRAME WORK AND TRADITIONAL KNOWLEDGE 6

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.

UNIT-IV TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY 6

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

UNIT-V TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS 6

Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Total Periods 30

References

1. Amit Jha, “Traditional Knowledge System in India”, 2009.
2. Basanta Kumar Mohanta, Vipin Kumar Singh, “Traditional Knowledge System and Technology in India”, Pratibha Prakashan 2012.
3. Amit Jha, “Traditional Knowledge System in India”, Atlantic publishers, 2002
4. Kapil Kapoor, Michel Danino, "Knowledge Traditions anSd Practices of India"

E-Resources:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																
CO5																
CO6																

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MC03	INDIAN CONSTITUTION	L	T	P	C
		2	0	0	0

Programme: B.E., / B. Tech **Category:** MC

Aim: To understand the importance of Indian constitution, Administration, Concept and Development of Human Rights, election commission.

Course Outcomes: Students will be able to

CO1. Know the sources, features and principles of Indian Constitution.

CO2. Learn about Union Government and its administration.

CO3. Learn about State government and its administration.

CO4. Get acquainted with Local administration and Panchayat Raj

CO5. Be aware of basic concepts and developments of Human Rights.

CO6. Gain knowledge on roles and functioning of Election Commission.

UNIT-I INTRODUCTION TO INDIAN CONSTITUTION 6

Constitution' meaning of the term, Indian Constitution- Sources and constitutional history, Features- Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT-II UNION GOVERNMENT AND STATE GOVERNMENT 6

Union Government and its Administration Structure of the Indian Union: Federalism, Centre-State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions;

State Government and its Administration

Governor: Role and Position, CM and Council of ministers, State Secretariat: Organization, Structure and Functions

UNIT-III LOCAL ADMINISTRATION AND PACHAYAT RAJ 6

Local Administration District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation,

Panchayat raj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT-IV CONCEPT AND DEVELOPMENT OF HUMAN RIGHTS 6

Meaning Scope and Development of Human Rights, United Nations and Human Rights – UNHCR, UDHR 1948, ICCPR 1996 and ICESCR 1966, Human Rights in India: Protection of Human Rights Act, 1993 - (NHRC and SHRC), First, Second and Third Generation Human Rights, Judicial Activism and Human Rights.

UNIT-V ELECTION COMMISSION 6

Election Commission- Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women

Total Periods 30

References

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd. New Delhi
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4E, 3 volumes (Universal Law Publication)

6. J.C. Johari, Indian Government and Politics Hans
7. J. Raj Indian Government and Politics
8. M.V. Pylee, Indian Constitution
9. Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd. New Delhi
10. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-Resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																
CO5																
CO6																

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MC04	UNIVERSAL HUMAN VALUES	L	T	P	C
		2	0	0	0

Programme: B.E., / B. Tech **Category:** MC

Aim: To facilitate the competence to understand the harmony in nature/existence and participation of human being in the nature/existence.

Course Outcomes: Students will be able to

CO1. Ensure the clarity about human aspirations, goal, activities and purpose of life.

CO2. Develop the understanding of human tradition and its various components.

CO3. Critically evaluate their preconditioning and present beliefs.

CO4. Begin with, and then to continue within the student leading to continuous self- evolution.

CO5. Verify the truth or reality in their own right, based on their Natural Acceptance and subsequent Experiential Validation.

CO6. Set do's and don'ts related to values.

UNIT-I INTRODUCTION 6

The basic human aspirations and their fulfillment through Right understanding and Resolution; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.

UNIT-II UNDERSTANDING HUMAN BEING AND ITS EXPANSION 6

The domain of right understanding starts from understanding the human being (the knower, the experience and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).

UNIT-III ACTIVITIES OF THE SELF 6

Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Reasons for harmony/contradiction in the self.

UNIT-IV UNDERSTANDING CO-EXISTENCE WITH OTHER ORDERS 6

The need and the process of inner evolution (through self-exploration, self-awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).

UNIT-V EXPANSION OF HARMONY FROM SELF TO ENTIRE EXISTENCE 6

Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence.

Total Periods 30

References

1. A Foundation Course in Human Values and Profession Ethics (Text Book and Teachers' Manual), R. R. Gaur, R. Sangal, G. P. Bagaria (2010), Excel Books, New Delhi [ISBN 978-8- 174-46781-2]
2. Avartansheel Arthshastra, A. Nagraj, Divya Path Sansthan, Amarkantak, India
3. Economy of Permanence – (a quest for social order based on non-violence), J. C. Kumarappa (2010), Sarva-Seva-Sangh-Prakashan, Varansi, India
4. Energy and Equity, Ivan Illich (1974), The Trinity Press, Worcester & Harper Collins, USA
5. Ishandi Nau Upnishad, Shankaracharya, Geeta press, Gorakhpur,
6. Manav Vyavahar Darshan, A. Nagraj, Divya Path Sansthan, Amarkantak, India

7. Manaviya Sanvidhan, A. Nagraj, Divya Path Sansthan, Amarkantak, India

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																
CO5																
CO6																

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MC05	YOGA	L	T	P	C
		2	0	0	0

Programme: B.E., / B. Tech **Category: MC**

Aim: To promote positive health, prevention of stress related health problems and rehabilitation through Yoga.

Course Outcomes: Students will be able to

CO1: Know about the history and evolution of Yoga**.**

CO2: Practice skills in Yoga for health.

CO3: Find out the habits to ensure mental and emotional balance.

CO4: Demonstrate basic skills associated with yoga activities including strength and flexibility, balance and coordination.

CO5: Demonstrate the ability to perform yoga movements in various combination and forms.

CO6: Demonstrate the ability to create and present various yoga sequences.

UNIT-I FOUNDATIONS OF YOGA **5**

Origin of Yoga, History and Development of Yoga; Etymology and Definitions, Misconceptions, Aim and Objectives of Yoga, True Nature and Principles of Yoga.

UNIT-II YOUTH AND YOGA **5**

Youth and yoga- yoga as a tool for healthy lifestyle, Yoga as a preventive, promotive and curative method. Pranayama and Different Yoga traditions and their impacts.

UNIT-III ROLE OF YOGA IN PREVENTIVE HEALTH CARE **5**

Role of Yoga in preventive health care – Yoga as a way of life, Heyam dukham anagatam; Potential causes of Ill-health: Tapatrayas and Kleshas, Physical and Physiological manifestation of Disease: Vyadhi, Alasya, Angamejayatva and Ssvasa-prashvasa.

UNIT-IV METHODS OF TEACHING YOGA **5**

Teaching and Learning: Concepts and Relationship between the two; Principles of Teaching: Levels and Phases of Teaching, Quality of perfect Yoga Guru; Yogic levels of learning, Vidyarthi, Shishya, Mumukshu; Meaning and scope of Teaching methods, and factors influencing them; Sources of Teaching methods;

UNIT-V ASAN AND PRANAYAM **10**

Asan and Pranayam:

- Various yog poses and their benefits for mind & body
- Regularization of breathing techniques and its effects
- Different Phases in Pranayama Pracice:
  - Puraka (Inhalation), Kumbhaka (Retension) and Recaka (Exhalation)
  - Breathing Ratio in Pranayama Practice
  - Application of Bandhas in Pranayama

Total Periods 30

References

1. Yogic Asanas for Group Tarining-Part-I", Janardan Swami Yogabhyasi Mandal, Nagpur.
2. Swami Vivekananda, "Rajayoga or conquering the Internal Nature" Advaita Ashrama Publication, Kolkata.
3. Silva Mehta, Mira Mehta and Shyam Mehta, "Yoga: The Iyengar Way", Knopp publication, 1990.
4. Vishnu-Devananda, "The Complete Illustrated Book of Yoga", 1995.
5. Timothy McCall, "Yoga as Medicine: The Yogic Prescription for Health and Healing", Harmony, 2007.
6. Hathayoga Pradipika of Swatmarama - Kaivalyadhama, Lonavala
7. The Science of Yoga - Taimini - Theosophical Publishing House, Adyar, Madras

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																
CO5																
CO6																

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)