DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE

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

PERAMBALUR - 621212

REGULATIONS – 2023

CHOICE BASED CREDIT SYSTEM

B.Tech BIOTECHNOLOGY

CURRICULUM & SYLLABI

DEPARTMENT OF BIOTECHNOLOGY

(Applicable to students admitted from the Academic year 2023 – 2024 and subsequently under Choice Based Credit System)

Discussed in BOS-4 meeting Dated: 13.09.2024 / Biotechnology Ratified & Approved in Academic Council

VISION MISSION OF THE INSTITUTUION

Vision:

An active and committed centre of advanced learning focused on research and training in the fields of Engineering, Technology and Management to serve the nation better.

Mission:

- To develop eminent scholar with a lifelong follow up of global standards by offering UG,PG and Doctoral Programmes.
- To pursue Professional and Career growth by collaborating mutually beneficial partnership with industries and higher institutes of research.
- To promote sustained research and training with emphasis on human values and leadership qualities.
- To contribute solutions for the need based issues of our society by proper ways and means as dutiful citizen.

DEPARTMENT OF BIOTECHNOLOGY

About the Department

The department of Biotechnology is one of the youngest, vibrant and radiant departments of Dhanalakshmi Srinivasan Engineering college. Started in 2022 with the goal of educating the next generation of students to fulfil the technical demands of the biotechnology industry and address the mounting problems in modern biology. With a sanctioned intake of 60, it provides a full-time B.Tech programme in biotechnology. The department is staffed with qualified professors with backgrounds in a variety of fields, including biochemistry, molecular biology, bioinformatics, immunology, bioprocess engineering, chemical engineering, downstream processing, etc.

Vision:

An active and committed centre of advanced learning focused on research and training in the fields of Engineering, Technology and Management to serve the nation better.

Mission:

M1: To provide Biotechnology educational Program with impetus to generate quality workforce.

M2: To create awareness about potentials of Biotechnology with socio-ethical implications.

M3: To instill spirit of innovation and creativity in young minds with sound research aptitude.

M4: To nurture confident individuals who are effective contributors towards growth of the nation.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	Graduates will be knowledgeable and skilled in cutting-edge fields of biotechnology.
PEO 2	Graduates will have the entrepreneurial abilities to launch biotech firms as well as the ability to apply engineering concepts to biological systems for the creation of industrial applications.
PEO 3	Graduates will approach the use of biotechnology to local and global issues critically and creatively. Graduates will think about how their job will affect the environment, health, and safety of the human population.
PEO 4	Graduates will have sufficient understanding in a range of biotechnology-related topics, enabling them to continue their study at a higher level in pertinent domains to further their professionally.

PROGRAM OUTCOMES (POs)

PO	Graduate Attribute
PO1	**Engineering knowledge**: Apply the knowledge ofmathematics, science,engineeringfundamentals, and an engineering specialization to the solution of complex engineeringproblems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problem sreaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**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,andthecultural,societal,andenvironmentalconsiderations.
PO4	**Conductinvestigationsofcomplexproblems**:Useresearch – basedknowledgeandresearchmethodsincludingdesignofexperiments,analysisandinterpretationofdata,andsynthesis oftheinformation toprovide validconclusions.
PO5	**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.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevantt otheprofessional engineering practice.
PO7	**Environmentandsustainability**:Understandtheimpactoftheprofessionalengineeringsolutionsinsocietalandenvironmentalcontexts,anddemonstratetheknowledgeof,andneedforsustainabledevelopment.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individualandteamwork**:Functioneffectivelyasanindividual,andasamember orleaderindiverse teams, andinmultidisciplinarysettings.
PO10	**Communication:**Communicate effectively on complex engineering activities with theengineering community and with society at large, such as, being able to comprehend andwriteeffectivereportsanddesigndocumentation,makeeffectivepresentations,andgive andreceiveclear instructions.
PO11	**Projectmanagementandfinance:**Demonstrateknowledgeandunderstandingofthe engineering and management principles and apply these to one's own work, as a memberandleaderinateam,to manageprojectsandinmultidisciplinary environments.
PO12	**Life-long-learning**:Recognizetheneedfor,andhavethepreparationandabilityto engageinindependentandlife – longlearninginthebroadestcontextoftechnologicalchange.

PROGRAMSPECIFICOUTCOMES(PSOs)

PSO 1	To provide students with better understandings of the principles of biotechnology themes and to acquaint them with many emerging and difficult areas related to the biotechnology sector.
PSO 2	Analyses and perform the experimental procedures to address the societal problems through modern tools and techniques in biotechnology.
PSO 3	Apply the interdisciplinary knowledge acquired through the program to solve problems in the biotechnology industry.

PEO's – PO's & PSO's MAPPING:

PEO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
I.						3	3		3		3				3
II.	3		3		3			3					3		3
III.		3	3	3		3	3			3	3	3		3	
IV.						3	3	3		3			3	3	

DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE (AUTONOMOUS)
PERAMBALUR – 621 212.
B.TECH. BIOTECHNOLOGY
REGULATIONS 2023 (Updated September 2024)
CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABI FOR SEMESTERS I TO VIII

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IP3151	Induction Programme	-	-	-	-	-	-
2.	U23HST11	Communicative English	HSC	3	0	0	3	3
3.	U23MAT12	Matrices and Calculus	BSC	3	1	0	4	4
4.	U23PHT13	Physics for Engineers and Technologists	BSC	3	0	0	3	3
5.	U23CYT14	Chemistry for Engineering and Technology	BSC	3	0	0	3	3
6.	U23GET16	Engineering Graphics	ESC	2	0	4	6	4
7.	GE3152	Heritage of Tamils/ தமிழர் மரபு	HSC	1	0	0	1	1
PRACTICALS								
8.	U23BSP11	Physics and chemistry laboratory	BSC	0	0	4	4	2
9.	U23HSP12	English laboratory	HSC	0	0	2	2	1
10.	U23GEP14	Engineering Practices Laboratory	ESC	0	0	4	4	2
TOTAL				**15**	**1**	**14**	**30**	**23**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23HST21	Professional English	HSC	3	0	0	3	2
2.	U23MAT22	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	U23GET15	Problem Solving and Python Programming	ESC	3	0	0	3	3
4.	U23EET25	Basic Electrical, Electronics and Instrumentation Engineering	ESC	3	0	0	3	3
5.	U23BTT31	Fundamentals of Biochemistry	PCC	3	0	0	3	3
6.	U23PHT26	Physics of Materials	BSC	3	0	0	3	3
7.	GE3252	Tamils and Technology/ தமிழரும் தொழில்நுட்பமும்	HSC	1	0	0	1	1
8.		NCC Credit Course Level 1*	-					2*
PRACTICALS								
9.	U23HSP22	Communication Laboratory	EEC	0	0	2	2	2
10.	U23GEP13	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
11.	U23BTP32	Fundamentals of Biochemistry Laboratory	PCC	0	0	3	3	2
TOTAL				**19**	**1**	**9**	**29**	**25**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23MAT31	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2.	U23BTT21	Bioorganic Chemistry	PCC	3	0	0	3	3
3.	U23BTT32	Essentials of Microbiology	PCC	3	0	0	3	3
4.	U23BTT33	Industrial Biotechnology Products	PCC	3	0	0	3	3
5.	U23BTT34	Cell Biology	PCC	3	0	0	3	3
6.	U23BTT35	Applied Thermodynamics for Biotechnologists	PCC	3	0	0	3	3
PRACTICALS								
7.	U23BTP31	Cell and Microbiology Laboratory	PCC	0	0	4	4	1.5
8.	U23BTP21	Bioorganic Chemistry Laboratory	PCC	0	0	4	4	1.5
9.	U23GE3361	Professional Development	EEC	0	0	2	2	1
TOTAL				**18**	**1**	**10**	**29**	**23**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTT41	Molecular Biology	PCC	3	0	0	3	3
2.	U23BTT42	Heat and Mass Transfer Operations for Biotechnologists	PCC	3	1	0	4	4
3.	U23BTT43	Analytical instrumentation methods of Analysis	PCC	3	0	0	3	3
4.	U23BTT44	Chemical Process Calculations in Biotechnology	PCC	3	0	0	3	3
5.	U23BTT45	Enzyme Technology	PCC	3	0	0	3	3
6.	U23BTT46	Bioprocess Principles	PCC	3	0	0	3	3
PRACTICALS								
7.	U23BTP41	Chemical Engineering Laboratory for Biotechnologists	PCC	0	0	3	3	1.5
8.	U23BTP42	Analytical Instrumentation Laboratory	PCC	0	0	3	3	1.5
9.	U23BTP43	Molecular Biology Laboratory	PCC	0	0	3	3	1.5
10.	U23BTP53	Industrial Training/ Internship* I	EEC	-	-	-	-	-
TOTAL				**18**	**1**	**9**	**28**	**23.5**

***Two week (10 – 12 working days) industrial training / workshop during IV semester vacation will be evaluated in V semester.**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTT51	Immunology	PCC	3	0	0	3	3
2.	U23BTT52	Principles of Genetic Engineering	PCC	3	0	0	3	3
3.	U23GET41	Environmental Science and Engineering	HSMC	3	0	0	3	2
4.		Professional Elective – I	PEC	3	0	0	3	3
5.		Professional Elective – II	PEC	3	0	0	3	3
6.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
7.	U23BTP51	Immunology Laboratory	PCC	0	0	3	3	1.5
8.	U23BTP52	Genetic Engineering Laboratory	PCC	0	0	3	3	1.5
9.	U23BTP53	Industrial Training/ Internship* I	EEC	-	-	-	-	1
TOTAL				**18**	**0**	**6**	**24**	**21**

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTT61	Essentials of Bioinformatics	PCC	3	0	0	3	3
2.	U23BTT62	Bioprocess Engineering	PCC	3	0	0	3	3
3.	U23BTT63	Chemical Reaction Engineering	PCC	3	0	0	3	3
4.	U23GET61	Human values and Ethics	HSMC	3	0	0	3	2
5.		Professional Elective – III	PEC	3	0	0	3	3
6.		Professional Elective – IV	PEC	3	0	0	3	3
7.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
8.	U23BTP61	Bioinformatics Laboratory	PCC	0	0	3	3	1.5
9.	U23BTP62	Bioprocess Laboratory	PCC	0	0	3	3	1.5
10.	U23BTP73	Industrial Training II*	EEC	0	-	-	-	0
TOTAL				21	0	6	27	23

*** Two week (10 – 12 working days) industrial training /internship during VI semester vacation will be evaluated in VII semester.**

SEMESTER VII

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTT71	Downstream Processing	PCC	3	0	0	3	3
2.		Professional Elective – V	PEC	3	0	0	3	3
3.		Elective Management*	HSMC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
5.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
6.	U23BTP71	Downstream Processing Laboratory	PCC	0	0	3	3	1.5
7.	U23BTP72	Mini Project	EEC	0	0	3	3	2
8.	U23BTP73	Industrial Training II*	EEC	0	-	-	-	1
TOTAL				15	0	6	21	19.5

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTP81	Project Work/Internship	EEC	0	0	20	20	10
TOTAL				0	0	20	20	10

ELECTIVE – MANAGEMENT COURSES

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23GET71	Principles of Management	HSMC	3	0	0	3	3
2.	U23GET72	Total Quality Management	HSMC	3	0	0	3	3
3.	U23GET73	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	U23GET74	Human Resource Management	HSMC	3	0	0	3	3
5.	U23GET75	Knowledge Management	HSMC	3	0	0	3	3
6.	U23GET76	Industrial Management	HSMC	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I: BIOPROCESS AND BIOCHEMICAL

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTV11	Bioprocess Control and Instrumentation	PEC	3	0	0	3	3
2.	U23BTV12	Bioprocess Modelling and Simulation	PEC	3	0	0	3	3
3.	U23BTV13	Bioreactor Design and Scale up process	PEC	3	0	0	3	3
4.	U23BTV14	Transport Phenomena in Biological System	PEC	3	0	0	3	3
5.	U23BTV15	Bioenergy and Biofuels	PEC	3	0	0	3	3

VERTICAL II: MEDICAL BIOTECHNOLOGY

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTV21	Stem Cell Technology and Tissue Engineering	PEC	3	0	0	3	3
2.	U23BTV22	Modern Bioanalytical Techniques	PEC	3	0	0	3	3
3.	U23BTV23	Human Genetics and Cancer Biology	PEC	3	0	0	3	3
4.	U23BTV24	Biopharmaceuticals and Biosimilars	PEC	3	0	0	3	3
5.	U23BTV25	Biosensors and Biomaterials	PEC	3	0	0	3	3

VERTICAL III: COMPUTATIONAL BIOTECHNOLOGY

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTV31	Fundamentals of Algorithms for Bioinformatics	PEC	3	0	0	3	3
2.	U23BTV32	Molecular Modelling	PEC	3	0	0	3	3
3.	U23PTV14	Computer Aided Drug Design	PEC	3	0	0	3	3
4.	U23BTV34	Data Mining and Machine Learning Techniques for Bioinformatics	PEC	3	0	0	3	3
5.	U23BTV35	Genomics and Proteomics	PEC	3	0	0	3	3

VERTICAL IV: QUALITY AND REGULATORY AFFAIRS

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTV41	Clinical Trials and Health care policies in Biotechnology	PEC	3	0	0	3	3
2.	U23BTV42	Quality assurance and quality control in Biotechnology	PEC	3	0	0	3	3
3.	U23BTV43	Entrepreneurship and patent of design	PEC	3	0	0	3	3
4.	U23BTV44	Intellectual property rights in Biotechnology	PEC	3	0	0	3	3
5.	U23BTV45	Biosafety and Hazard Management	PEC	3	0	0	3	3

OPEN ELECTIVES

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23BTO11	Immuno-technology	OEC	3	0	0	3	3
2.	U23BTO12	Basics of Microbial Technology	OEC	3	0	0	3	3
3.	U23BTO13	Introduction to Cell Biology	OEC	3	0	0	3	3
4.	U23BTO14	Life Style Disease	OEC	3	0	0	3	3
5.	U23BTO15	Bio-Economics	OEC	3	0	0	3	3
6.	U23BTO16	Molecular Pathogenesis of Infectious Disease	OEC	3	0	0	3	3
7.	U23BTO17	Principles of Virology	OEC	3	0	0	3	3
8.	U23BTO18	Fundamentals and Applications of Nanotechnology	OEC	3	0	0	3	3
9.	U23BTO19	Biology For Engineers	OEC	3	0	0	3	3
10.	U23BTO20	Hydroponics	OEC	3	0	0	3	3
11.	U23BTO21	Bio Microfluidics	OEC	3	0	0	3	3
12.	U23BTO22	Bioresource Technology	OEC	3	0	0	3	3
13.	U23BTO23	Fundamentals of Biochemical Engineering	OEC	3	0	0	3	3
14.	U23BTO24	Biotechnology for Human Welfare	OEC	3	0	0	3	3
15.	U23BTV31	Fundamentals of Algorithms for Bioinformatics	OEC	3	0	0	3	3
16.	U23BTV34	Data Mining and Machine Learning Techniques for Bioinformatics	OEC	3	0	0	3	3
17.	U23BTT61	Essentials of Bioinformatics	OEC	3	0	0	3	3

	Vertical – I Bioprocess and Biochemical	Vertical – II Medical Biotechnology	Vertical – III Computational Biology	Vertical – IV Quality and Regulatory affairs
Professional Elective I	Bioprocess Control and Instrumentations	Stem cell Technology and Tissue Engineering	Fundamentals of algorithms for Bioinformatics	Clinical trails and Health care policies in Biotechnology
Professional Elective II	Bioprocess Modelling	Modern Analytical Techniques	Molecular Modelling	Quality Assurance and Quality control in Biotechnology
Professional Elective III	Bioreactor design and scale up process	Human Genetics and Cancer Biology	Computer Aided Drug Design	Entrepreneurship, IPR and Biosafety
Professional Elective IV	Transport phenomenon for biological system	Biopharmaceutical and Biosimilars	Data Mining and Machine Learning techniques for Bioinformatics	Intellectual property rights in Biotechnology
Professional Elective V	Bioenergy and fuels	Biomaterials and Biosensors	Genomics and Proteomics	Biosafety and Hazard Management

SUMMARY OF CREDITS

B.TECH. BIOTECHNOLOGY											
S. No.	**SUBJECT AREA**	**CREDITS PER SEMESTER**								**CREDIT TOTAL**	**%**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
1.	**HSMC**	**5**	**3**	**-**	**-**	**2**	**2**	**3**	**-**	**15**	**9.46**
2.	**BSC**	**12**	**7**	**4**	**-**	**-**	**-**	**-**	**-**	**23**	**13.6**
3.	**ESC**	**6**	**8**	**-**	**-**	**-**	**-**	**-**	**-**	**14**	**8.28**
4.	**PCC**	**-**	**5**	**18**	**23.5**	**9**	**12**	**4.5**	**-**	**72**	**42.6**
5.	**PEC**	**-**	**-**	**-**	**-**	**6**	**6**	**3**	**-**	**15**	**8.87**
6.	**OEC**	**-**	**-**	**-**	**-**	**3**	**3**	**6**	**-**	**12**	**7.10**
7.	**EEC**	**-**	**2**	**1**	**-**	**1**	**-**	**3**	**10**	**17**	**10.05**
Total		**23**	**25**	**23**	**23.5**	**21**	**23**	**19.5**	**10**	**168**	**100**

IP3151 **INDUCTION PROGRAMME**

This is a mandatory 2-week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch / department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfil his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character".

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts.

Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it every day for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base.

Methodology of teaching this content is extremely important. It must not be through do's and don'ts but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real-life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix)Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering / Technology / Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Program is totally an activity-based program and therefore there shall be no tests / assessments during this program.

REFERENCES: Guide to Induction program from AICTE

SEMESTER I

U23HST11	COMMUNICATIVE ENGLISH (COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To enhance students listening ability for academic and Professional purposes.
2.	To learn to use basic grammatical structures in suitable contexts
3	To help students acquire the ability to speak effectively in English in real -life situations.
4	To help learners use language effectively in professional contexts.
5	To develop students' ability to read and write complex texts, summaries, articles, definitions,\ Paragraph user manuals.

UNIT I	INTRODUCTION TO EFFECTIVE COMMUNICATION	9

Define communication. Kinds of communication. Quintessential of communication in technical progression. Key characteristics of an effective communicator- listening, attitude modification, way of response with appropriate language, tone modulation.
Listening- Listening to TV news, Guest lectures. Speaking- Answering the Questions.
Reading - Reading brochures and technical magazines (technical context), telephone messages / social media messages relevant to technical contexts and emails, **Writing**-Reading comprehension, Parts of Speech.

UNIT II	READING QUEST	9

Listening- listening and responding to video lectures/talks. **Speaking**- Day today conversations. **Reading** –Edison of India-GD Naidu "The Great Inventor". **Writing-** Emails / Informal Letters - Inviting, Congratulating & Thanking, Punctuations.

UNIT III	LANGUAGE RESOURCE GROWS CRITICAL JUDGEMENT	9

Listening- listening to specific task-focused audio tracks. Speaking- summary of Robert Frost "Stopping by woods on a snowy evening". Reading – Reading advertisements, gadget reviews; user manuals. Writing – Essay Writing: Analytical essay: Narrative Essay, Developing Hints, Usage of tenses in sentence formation. Voices.

UNIT IV	LANGUAGE IN LIFE SKILL	9

Reading – Newspaper articles; Journal reports –and Non Verbal Communication (tables, pie charts etc,). Writing – Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non-verbal (chart, graph etc, to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

UNITV	IMPROVING SPEAKING &READING	9

Listening- listening to situational based dialogues; **Speaking-** Stating intention to do something- Expressing opinion-asking people to repeat themselves**. Reading** – Summary of O. Henry's "The last Leaf". **Writing** – Dialogue Writing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Remember appropriate words in a situational conversation.
CO2:	Gain understanding of basic grammatical structures and use them in right context.
CO3:	Read and infer the denotative and connotative meanings of technical texts.
CO4:	Write Dialogue, Letter and paragraphs on various topics.
CO5:	Make the students prepare effective notes for the main sources available.

CO6:	Enhance them to give operational talk.
TEXTBOOKS:	
1.	English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2	English for Science & Technology Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
REFERENCE BOOKS:	
1.	Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2	A Course Book on Technical English by Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3	English For Technical Communication (With CD) By Aysha Viswa Mohan, McGraw Hill Education.
4	Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.

U23MAT12	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
2.	To familiarize the students with differential calculus.
3.	To familiarize the student with functions of several variables
4.	To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
5.	To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems

UNIT I	MATRICES	12

Introduction – Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors – Cayley Hamilton theorem – Diagonalization of the matrices by Orthogonal Transformations – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II	DIFFERENTIAL CALCULUS	12

Limit of a function – Continuity – Derivatives – Differentiation rules – Implicit differentiation – Logarithmic differentiation – Maxima and Minima of functions of one variable.

UNIT III	MULTIVARIABLE CALCULUS	12

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative –Jacobians – Taylor's series for functions of two variables – Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV	MULTIPLE INTEGRAL AND THEIR APPLICATIONS	12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

UNIT V	ORDINARY DIFFERENTIAL EQUATIONS	12

Higher order linear differential equations with constant coefficients– Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients – Method of undetermined coefficients.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Use the matrix algebra methods for solving practical problems.
CO2:	Use both the limit definition and rules of differentiation to differentiate functions.
CO3:	Apply differential calculus tools in solving various application problems.
CO4:	Able to use differential calculus ideas on several variable functions.
CO5:	Apply multiple integral ideas in solving areas, volumes and other practical problems.
CO6:	Solve the ordinary differential equations using different techniques for that model engineering problems.

TEXTBOOKS:	
1.	Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2.	Grewal. B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2018.
3.	James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].
REFERENCE BOOKS:	
1.	Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2.	Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, NewDelhi, 5th Edition,2016.
3.	Narayanan. S. and Manicavachagom Pillai. T. K., "Calculus" Volume I and II, Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
4.	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016
5.	Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.

U23PHT13	PHYSICS FOR ENGINEERS AND TECHNOLOGISTS (COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To make the students to gain the knowledge in elastics and plastic nature of the materials in the presence and absence of load.
2.	To understand the application of the sound waves in different fields by students.
3.	To motivate the students towards the applications of photo electric phenomena.
4.	To know the physical principle of LASER, the working of LASER and its applications.
5.	To understand the propagation of light in optical fibres and its applications.

UNIT I	ELASTICITY	9

Introduction- Elasticity - plasticity– Hooke's law - relationship between three Moduli of elasticity (Qualitative) – stress & strain diagram and its uses -Poisson's ratio - factors affecting elasticity - twisting couple of wire - Torsion Pendulum: theory and experiment.

Beam: Internal bending moment – Cantilever: theory and experiment – Young's Modulus: uniform and non – uniform bending (Qualitative) – I-shaped girders- advantages and applications.

UNIT II	ULTRASONICS	9

Introduction – classification of sound- properties of infrasonic, audible and ultrasonics - production: Magnetostriction and Piezoelectric methods – determination of velocity of sound in liquid (Acoustic Grating Method) – general applications – industrial application: Non - Destructive Testing: pulse echo system through transmission and reflection modes. ultrasonic scanning methods – medical application: sonogram.

UNIT III	MODERN PHYSICS	9

Introduction –Black Body Radiation – Classical and Quantum Laws of Black Body Radiation - Photon and its Properties - Wave Particle Duality and Matter waves – De - Broglie Wavelength - Schrodinger's Time Independent and Time Dependent Wave Equations - Physical Significance of The Wave Function. Application: Particle in One Dimensional Box - Normalization Process –
Photo Electric Effect – Laws Governing the Photoelectric Effect – Einstein's Formula - Derivation – Applications: Solar Cell – Solar Water Heater – Photo resistor (LDR).

UNIT IV	LASERS	9

Lasers: Introduction - Properties of Laser-Spontaneous and Stimulated Emission Process – Einstein's Theory of Matter Radiation Interaction & A and B Coefficients; Amplification of Light by Population Inversion – Pumping Methods - Types of Lasers: Solid-State Laser (Homo and Hetero Junction Semiconductor Lasers), Gas Laser (CO_2), Applications: Laser Cutting and Welding, LIDAR and Barcode Scanner.

UNIT V	FIBER OPTICS AND APPLICATIONS	9

Optical Fiber: Structure - advantages- Principle [TIR]–Propagation Phenomena in optical fiber - Expression for Acceptance Angle and Numerical Aperture – Relation between Refractive Index of Core, Numerical Aperture and Fractional Index Change – Fabrication: Double Crucible Method -Types: Material, Mode, Refractive Index - Applications: Optical Fiber Communication System – fiber optic sensors (Displacement and pressure sensors) – Medical Endoscope.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Differentiate the elastic and plastic nature of the materials.
CO2:	Know the experimental techniques in both production and applications of ultrasonic waves.
CO3:	Gain knowledge in the basics of quantum mechanics concepts.

CO4:	Develop new devices based on LASER source.
CO5:	Understand the advantages of optical fibre than metal wire.
CO6:	Demonstrate some useful experiments based on optical fibre

TEXTBOOKS:	
1.	Dr. P. Mani, “Engineering Physics”, Dhanam Publications, 2013.
2.	Dr. G. Senthilkumar, “Engineering Physics”, VRB Publishers, 2017.
3.	K. Thyagarajan, Ajoy Ghatak, “Lasers Fundamentals and Applications” II nd Edition, Springer, 2010.
4.	D.K. Bhattacharya, Poonam Tandon,” Engineering Physics”, Oxford HED Publishers, 2017.
REFERENCE BOOKS:	
1.	Mari kani, “Engineering Physics”, PHI, New Delhi, 2013.
2.	Bhattacharya & Bhaskaran, “Engineering Physics”, Oxford Publications, 2012.
3.	R Murugeshan, Kiruthiga, Sivaprasath S, “Modern Physics”, Chand Publishing, 2021.
4.	S. Rajiv Gandhi & A. Ravikumar, “Engineering Physics I”, RK Publications, 2023
5.	Sathyaprakash, “Quantum Mechanics”, Pragati Prakashan, Meerut, 2016.

U23CYT14	CHEMISTRY FOR ENGINEERING & TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To inculcate sound understanding of water quality parameters and water treatment techniques.
2.	Impart knowledge on the basic principles and preparatory methods of nanomaterial.
3.	To introduce the basic concepts and applications of phase rule and composites.
4.	To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
5.	To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I WATER TREATMENT **9**

Water: Sources, impurities, Parameters. Types of water - Hardness of water - types – expression of hardness – units – Estimation of hardness of water by EDTA. Desalination - Reverse Osmosis. Boiler troubles: Internal treatment (phosphate, colloidal, sodium aluminate and Calgon conditioning) and External treatment – Ion exchange demineralisation and zeolite process.

UNIT II ELECTRO AND NANO CHEMISTRY **9**

Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf by Poggendorff's compensation principle. Single electrode potential – Nernst equation – reference electrodes - types–Calomel electrode - electrolysis of water. Nanomaterials: Basics of Nano Chemistry: Distinction between molecules, nanomaterials and bulk materials. Preparation of nanomaterials- laser ablation method and Chemical Vapour Deposition (CVD). Application of Nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III PHASE RULE AND COMPOSITES **9**

Phase rule terms with examples. water system; Reduced phase rule Two component system: lead-silver system – Composites, Need, Constitution: Matrix materials, Applications and Reinforcement and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV FUELS & COMBUSTION **9**

Fuels –Classification-Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel. Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO_2 emission and carbon foot-print.

UNITV ENERGY SOURCES AND STORAGE DEVICES **9**

Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion- battery; Electric vehicles-working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.

CO2:	Apply the basic knowledge of Corrosion and various electrodes.
CO3:	Know the economically and new methods of synthesis nano materials.
CO4:	Apply the knowledge of phase rule and composites for material selection requirements.
CO5:	Understand the concepts of suitable fuels for engineering processes and applications.
CO6:	Have the knowledge of different forms of energy resources and apply them for suitable applications in energy sectors.

TEXTBOOKS:	
1.	P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2.	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3.	S.S. Dara, "A textbook of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.
4.	J. Manivel , "Engineering Chemistry" R.K. Publishers, 1st Edition 2022.
REFERENCE BOOKS:	
1.	B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Textbook of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2.	O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3.	Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4.	Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.

U23GET16	ENGINEERING GRAPHICS	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
2.	To expose them to existing national standards related to technical drawings.
3.	Develop proficiency in 2D drafting using drawing tools.
4.	Learn sectional views and assembly drawing techniques.
5.	Enhance visualization skills for improved problem-solving and communication in engineering.

UNIT I	PLANE CURVES AND ORTHOGRAPHIC PROJECTION	6+12

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensions. Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects.

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

Orthographic projection- principles-Principal Planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method (polygonal and circular surfaces) inclined to both the planes.

UNIT III	PROJECTION OF SOLIDS	6+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES	6+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.
Development of lateral surfaces of simple solids – Prisms, pyramids cylinders and cones.

UNITV	ISOMETRIC PROJECTION	6+12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions-Perspective Projection.

TOTAL: 30+60=90 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Identify the significance of graphics in engineering applications.
CO2:	Project straight lines inclined to both principal planes and determine true lengths and inclinations.
CO3:	Apply orthographic projection techniques to project solids.
CO4:	Apply the principles of development to prisms, pyramids, cylinders, and cones.
CO5:	Combine two solid objects in simple vertical positions using isometric projection.
CO6:	Utilize the isometric scale effectively.

TEXTBOOKS	
1.	Natrajan K.V., ―A textbook of Engineering Graphics‖, Dhanalakshmi Publishers, Chennai, 2009.
2.	Venugopal K. and Prabhu Raja V., ―Engineering Graphics‖, New Age International (P) Limited, 2008
REFERENCE BOOKS:	
1.	Bhatt N.D. and Panchal V.M., ―Engineering Drawing‖, Charo tar Publishing House, 50th Edition, 2010.
2.	Basant Agarwal and Agarwal C.M., ―Engineering Drawing‖, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3.	Gopalakrishna K.R., ―Engineering Drawing‖ (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4.	Luzzader, Warren. J. and Duff, John M., ―Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
6.	N S Parthasarathy and Vela Murali, ―Engineering Graphics‖, Oxford University, Press, New Delhi, 2015.

GE3152	HERITAGE OF TAMILS/ தமிழர் மரபு	L	T	P	C
		1	0	0	1

UNIT I	LANGUAGE AND LITERATURE	3

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

UNIT II	HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE	3

Hero stone to modern sculpture - bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III	FOLK AND MARTIAL ARTS	3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV	THINAI CONCEPT OF TAMILS	3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V	CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE	3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL:15 PERIODS

REFERENCE BOOKS:

1.	Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2.	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.
3.	Historical Heritage of the Tamils (Dr. S. V. Subatamanian, Dr. K. D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4.	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
5.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Textbook and Educational Services Corporation, Tamil Nadu)
6.	Studies in the History of India with Special Reference to Tamil Nadu (Dr. K. K. Pillay) (Published by: The Author)
7.	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8.	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

U23BSP11	PHYSICS AND CHEMISTRY LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To learn the proper use of various kinds of physics laboratory equipment.
2.	To learn how data can be collected, presented and interpreted in a clear and concise manner.
3.	To learn problem solving skills related to physics principles and interpretation of experimental data.
4.	To determine error in experimental measurements and techniques used to minimize such error.
5.	To make the student an active participant in each part of all lab exercises.
6.	To inculcate experimental skills to test basic understanding of water quality parameters, as, acidity, alkalinity, chloride.
7.	To Induce the students to analyze the hardness of water
8.	To induce the students to familiarize themselves with electro analytical techniques such as, pH Metry, conductometry in the determination of impurities in aqueous solutions.

LIST OF EXPERIMENTS

1.	Torsion pendulum - Determination of rigidity modulus of wire and moment of inertia of regular disc.
2.	Non - Uniform bending–Determination of Young's modulus.
3.	Laser – (i) Determination of the wavelength of the laser using grating. (ii) Determination of size of the particles using laser source.
4.	Air wedge – Determination of thickness of a thin sheet/wire.
5.	Determination of Band gap of a semiconductor using PN junction kit.
6.	To study the V-I Characteristics of Light Dependent Resistor (LDR).
7.	Determination of types and amount of alkalinity in water sample.
8.	Determination of total, temporary & permanent hardness of water by EDTA method.
9.	Determination of chloride content of water sample by Argentometric method.
10.	Determination of strength of given hydrochloric acid using pH meter.
11.	Determination of strength of acids in a mixture of acids using conductivity meter.
12.	Conductometric titration of barium chloride against sodium sulphate (precipitation titration)

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S/N	Name of the Equipment	Quantity
1.	Torsion pendulum set up (Metal Disc, Symmetrical Mass(2x100g), Stop Clock, Screw Gauge)	**5**
2.	Non – Uniform bending set up (Travelling Microscope, Knife Edges, Weight Hanger with Mass(5x50g), Screw Gauge, Vernier Caliper, Meter Scale)	**5**
3.	Laser set up (Semiconductor Laser, Screen, Grating Stand, Wooden Stand with Meter Scale)	**5**
4.	Air wedge (Air Wedge Set Up, Travelling Microscope, Sodium Vapour Lamp, Transformer)	**5**
5.	Band gap of a semiconductor (PN Junction Kit, Thermometer, Heater, Beaker, Oil)	**5**

6.	Light Dependent Resistor (Power Supply, Voltmeter, Ammeter, LDR, Bulb, Resistors)	**5**
7.	PH meter	**5**
8.	Conductivity meter	**10**
9.	Common Apparatus (Pipette, Burette, Conical Flask, Porcelain tile, Dropper)	**15**

COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1:	Understand the functioning of various physics laboratory equipment.
CO2:	Observe and tabulate experimental data.
CO3:	Solve problems individually and collaboratively.
CO4:	Analyze the quality of water samples with respect to their acidity, alkalinity
CO5:	Determine the amount of hardness in the water
CO6:	Analyze quantitatively the impurities in solution by electro analytical techniques

U23HSP12	ENGLISH LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To improve the communicative competence of learners.
2.	To help learners use language effectively in academic /work contexts.
3.	To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
4.	To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
5.	To use language efficiently in expressing their opinions via various media.

LIST OF EXPERIMENTS

1	Listening for general information-specific details.
2	Conversation: Introduction to classmates.
3	Speaking - making telephone calls-Self Introduction.
4	Talking about current and temporary situations & permanent and regular situations.
5	Listening to podcasts, anecdotes / stories / event narration.
6	Event narration; documentaries and interviews with celebrities.
7	Events-Talking about current and temporary situations & permanent and regular situations.
8	Engaging in small talk.
9	Describing requirements and abilities- Picture description.
10	Discussing and making plans.
11	Talking about tasks- progress- positions -directions of movement.
12	Talking about travel preparations and transportation.
13	Listening to debates/ discussions.
14	Making predictions talking about a given topic.
15	Describing processes.

TOTAL: 30 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S/N	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Identify and comprehend complex academic texts.
CO2:	Interpret accurately and fluently in formal and informal communicative contexts.
CO3:	Demonstrate their opinions effectively in both oral and written medium of communication.

CO4:	Plan travelogue and construct paragraphs on various aspects.
CO5:	Develop journal reading skills and small talk.
CO6:	Utilizing technical terms and making power point presentations.

U23GEP14	ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

The main learning objective of this course is to provide hands on training to the students in:

1	Drawing pipeline plan; laying and connecting various pipe fittings used in common house-hold plumbing work; Sawing; planning; making joints in wood materials used in common house hold wood work.
2	Wiring various electrical joints in common household electrical wire work.
3	Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts;
4	Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.
5	Assembling simple mechanical assembly of common household equipment; Making a tray out of metal sheet using sheet metal work.

GROUP – A (CIVIL AND MECHANICAL)

PART I	**CIVIL ENGINEERING PRACTICES PLUMBING WORK:**	**30**
	a. Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in house-hold. b. Preparing plumbing line sketches. c. Laying pipe connection to the suction side of a pump d. Laying pipe connection to the delivery side of a pump. e. Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.	
	MECHANICAL ENGINEERING PRACTICES	**30**
	WELDING WORK: a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding. b) Practicing gas welding. **BASIC MACHINING WORK:** a) Turning b) Drilling	

	c) Tapping **ASSEMBLY WORK:** a) Assembling a centrifugal pump. b) Assembling a household mixer. **SHEET METAL WORK:** a) Making of a square tray **WOOD WORK:** a. Sawing, b. Planning and c. Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.	
PART II	**ELECTRICAL & ELECTRONICS**	**30**
	1. Residential house wiring using switches, fuse, indicator, lamp and energy meter. 2. Fluorescent lamp wiring. 3. Staircase wiring 4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit. 5. Measurement of energy using single phase energy meter. 6. Measurement of resistance to earth of electrical equipment. **ELECTRONICS** 1. Study of Electronic components and equipment's – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR. 2. Study of logic gates AND, OR, EX-OR and NOT. 3. Generation of Clock Signal. 4. Soldering practice – Components Devices and Circuits Using general pur-pose PCB. 5. Measurement of ripple factor of HWR and FWR.	
		TOTAL = 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15Sets.
2. Carpentry vice (fitted to work bench) 15Nos.
3. Standard woodworking tools 15 Sets.
4. Models of industrial trusses, door joints, furniture joints 5each
5. Power Tools: (a) Rotary Hammer 2 Nos (b) Demolition Hammer 2 Nos (c) Circular Saw 2 No
6. s (d) Planer 2 Nos (e) Hand Drilling Machine 2 Nos (f) Jigsaw 2Nos

MECHANICAL

Arc welding transformer with cables and holders 5 Nos.

1. Welding booth with exhaust facility 5Nos.
2. Welding accessories like welding shield, chipping hammer, wire brush, etc. 5Sets.
3. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2Nos.
4. Centre lathe 2Nos.
5. Hearth furnace, anvil and smithy tools 2Sets.
6. Moulding table, foundry tools 2Sets.
7. Power Tool: Angle Grinder 2Nos
8. Study-purpose items: centrifugal pump, air-conditioner one each.

ELECTRICAL

1. Assorted electrical components for house wiring 15Sets
2. Electrical measuring instruments 10Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each
4. Megger (250V/500V) 1No.
5. Power Tools:
    a) Range Finder 2Nos

b) Digital Live-wire detector 2Nos

ELECTRONICS

1. Soldering guns 10Nos.
2. Assorted electronic components for making circuits 50Nos.
3. Small PCBs 10Nos.
4. Multimeters 10Nos.

Study purpose items: Telephone, FM radio, low-voltage power supply.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1:	Draw pipeline plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household woodwork.
CO2:	Wire various electrical joints in common household electrical wire work.
CO3:	Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common Household equipment; Make a tray out of metal sheet using sheet metal work.
CO4:	Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.
CO5:	Apply fundamental engineering principles to analyze and solve real-world problems.
CO6:	Demonstrate proficiency in using engineering tools and equipment.

SEMESTER II

U23HST21	PROFESSIONAL ENGLISH (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To engage learners in meaningful language activities to improve their reading and writing skills.
2.	To learn various reading strategies and apply in comprehending documents in professional context.
3.	To help learners understand the purpose, audience, contexts of different types of writing.
4.	To enable students write letters and reports effectively in formal and business situations.
5.	To demonstrate an understanding of job applications and interviews for internship and placements.

UNIT I	PREPARATORY DOCUMENTATIONS	9

Listening- Listening to formal conversations and participating. Speaking- speaking about one's family. Reading – Summary of W.W Jacobs "The monkey's paw". Writing – Subject verb Agreement, Numerical -Adjectives, Kinds of sentences, writing reviews (book / film), writing Instructions, Writing Recommendation.

UNIT II	LECTURA ENRICHMENT AND PASSAGE COMPOSE	9

Listening- listening to lectures on academic topics; Speaking- Asking for and giving directions. Reading - Reading longer technical texts; Writing - Compound words, Homophones and Homonyms, Cause and Effect expressions. Essay Writing, Writing Letter to the Editor (complaint, acceptance, Requesting, Thanking).

UNIT III	ANALYTICAL SKILL	9

Listening- Watching videos/documentaries and responding to questions based on them. Speaking – Speaking about one's favourite place. Reading – Summary of the poem – John Keats "Ode to a Nightingale". Writing- Purpose statement, Extended Definitions. Writing Job/ Internship application – Cover letter & Resume.

UNIT IV	REPORT WRITING	9

Listening- Listening to class room lectures/talks on engineering/technology. Speaking– Introduction to technical presentations. Reading – Newspaper articles; Writing – Comparative Adjectives Direct and Indirect speech. Report Writing- Fire Accident Report, Road Accident, Feasibility Report).

UNITV	ENABLING LINGUA IDEALITY & INFORMATION	9

Listening- TED/Ink talks. Speaking – Making presentation on a given topic. Reading –Company profiles, Statement of Purpose, (SOP), Writing – Relative Clauses, If conditions, Cause and Effect. Chart Interpretations - Bar Chart, Pie Chart, Flow Chart & Tables.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Compare and contrast products and ideas in technical texts.
CO2:	Identify cause and effects in events, industrial processes through technical texts.
CO3:	Analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.
CO4:	Motivate students to write reports and winning job applications.
CO5:	Recall and comprehend different discourses and genres of texts.
CO6:	Making the students to become virtuous presenters.

TEXTBOOKS	
1.	English for Engineers & Technologists (2020 edition) Orient Black Swan Private Ltd. Department of English, Anna University.
2.	English for Science & Technology Cambridge University Press 2021.
3.	Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
REFERENCE BOOKS:	
1.	Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2.	Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
3.	Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4.	Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5.	Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

U23MAT22	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	This course aims at providing the necessary basic concepts of a few statistical tools and give procedures for solving different kinds of problems occurring in engineering and technology.
2.	To acquaint the knowledge of classifications of design of experiments in the field of Bio-technology.
3	To introduce the basic concepts of solving algebraic and transcendental equations.
4	To introduce the numerical techniques of interpolation in various intervals and
5	numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.

UNIT I	TESTING OF HYPOTHESIS	12

Introduction – Sampling distributions – Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II	DESIGN OF EXPERIMENTS	12

Introduction – Analysis of variance – One way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT III	SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS	12

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations – Gauss elimination method – Gauss Jordan method — Iterative methods of Gauss Jacobi and Gauss Seidel - Eigen Value of a matrices by power method and Jacobi's method for Symmetric matrices.

UNIT IV	INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION	12

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V	NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS	12

Single step methods: Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge – Kutta method for solving first order differential equations – Multi step methods: Milne's and Adams Bashforth predictor corrector methods for solving first order differential equations.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Apply the concept of testing of hypothesis for small and large samples in real life problems.
CO2:	Apply the basic concepts of classifications of design of experiments in the field of agriculture.
CO3:	Solve the algebraic and transcendental equations.
CO4:	Understand the knowledge of numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
CO5:	Solve the ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

TEXTBOOKS

1.	Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2	Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
REFERENCE BOOKS:	
1.	Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2	Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3	Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4	Gupta S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi,12th Edition, 2020.

U23GET15	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the basics of algorithmic problem solving
2.	To learn to solve problems using Python conditionals and loops.
3.	To define Python functions and use function calls to solve problems.
4.	To use Python data structures - lists, tuples, dictionaries to represent complex data.
5.	To do input/output with files in Python

UNIT I	COMPUTATIONAL THINKING AND PROBLEM SOLVING	9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II	DATA TYPES, EXPRESSIONS, STATEMENTS	9

Python interpreter and interactive mode, debugging; values and types: int, float, Boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III	CONTROL FLOW, FUNCTIONS, STRINGS	9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-Elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV	LISTS, TUPLES, DICTIONARIES	9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT V	FILES, MODULES, PACKAGES	9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Develop algorithmic solutions to simple computational problems
CO2:	Develop and execute simple Python programs
CO3:	Write simple Python programs using conditionals and looping for solving problems.
CO4:	Decompose a Python program into functions
CO5:	Represent compound data using Python lists, tuples, dictionaries etc.
CO6:	Read and write data from/to files in Python programs

TEXTBOOKS

1.	Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.

2.	Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and programming”, 1st Edition, BCS Learning & Development Limited, 2017.
REFERENCE BOOKS:	
1.	Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2.	G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3.	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, Third Edition, MIT Press , 2021.
4.	Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.

U23EET25	BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	The basics of electric circuits and analysis
2.	Impart knowledge in domestic wiring
3.	Impart knowledge in the basics of working principles and application of electrical machines
4.	Analog devices and their characteristics
5.	The functional elements and working of sensors and transducers

UNIT I	ELECTRICAL CIRCUITS	9

Basic circuit components -Ohms Law Kirchhoff's Law – Instantaneous Power –Inductors - Capacitors– Independent and Dependent Sources-steady state solution of DC circuits-Nodal analysis, Mesh analysis-Thevenin's Theorem, Norton 's Theorem, Maximum Power transfer theorem- Linearity and Superposition Theorem.

UNIT II	AC CIRCUITS	9

Introduction to AC circuits–waveforms and RMS value–power and power factor, single phase and three-phase balanced circuits–Three phase loads-housing wiring, industrial wiring, and materials of wiring. safety precautions and First Aid.

UNIT III	ELECTRICAL MACHINES	9

Construction and Working principle- DC Separately Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Synchronous motor and Three Phase Induction Motor.

UNIT IV	ANALOG ELECTRONICS	9

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET, IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters, harmonics

UNITV	SENSORS AND TRANSDUCERS	9

Sensors, solenoids, pneumatic controls with electrical actuator, mechatronics, types of valves and its applications, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors, Strain gauge, LVDT, differential pressure transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Compute the electric circuit parameters for simple problems.
CO2:	Explain the concepts of domestics wiring.
CO3:	Explain the concepts of protective devices.
CO4:	Explain the working principle and applications of electrical machines.
CO5:	Analyse the characteristics of analog electronic devices.
CO6:	Explain the types and operating principles of sensors and transducers

TEXTBOOKS

1.	D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Second Edition, 2020.
2.	A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements &Instrumentation', Dhanpat Rai and Co, 2015.
3.	S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019

4.	James A Svoboda, Richard C. Dorf, Dorf's Introduction to Electric Circuits, Wiley,2018
REFERENCE BOOKS:	
1.	John Bird, "Electrical Circuit theory and technology", Routledge; 2017.
2.	Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
3.	Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017
4.	Muhammad H. Rashid, "Spice for Circuits and electronics", 4th Edition., Cengage India,2019.
5.	H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010.

U23BTT31	FUNDAMENTALS OF BIOCHEMISTRY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

Basic knowledge in fundamentals of Organic chemistry and Biology

1.	Understand the basics of biochemistry
2.	Understand the properties and functions of biomolecules
3	Comprehend the Central Dogma of Life
4	Understand the basic chemistry involved in biological process by the biomolecules
5	Understand the process involved in metabolism

UNIT I	INTRODUCTION TO BIOMOLECULES	9

Basic principles of organic chemistry, role of carbon, types of functional groups, chemical nature and properties of water, weak acid and weak base, pH, Handerson - Hasselbalch equation, buffers in living system buffers,

UNIT II	STRUCTURE AND PROPERTIES OF CARBOHYDRATES	9

basics of macromolecules, structure and properties of Carbohydrates (mono, di, oligo & polysaccharides) Proteoglycans, glycosaminoglycans. mutarotation, glycosidic bond, reactions of monosaccharides, reducing sugars. Starch, glycogen, cellulose and chitin. Proteoglycans, glycosaminoglycans, hyaluronic acid, chondroitin sulfate.

UNIT III	STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES	9

Structure and properties of Important Biomolecules**. Lipids**: fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins. **Protein**: Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determine of primary structure.

UNIT IV	STRUCTURE AND PROPERTIES OF NUCLEIC ACID	9

Nucleic acids: purines, pyrimidines, nucleoside, nucleotide, RNA, DNA-Watson-Crick structure of DNA, reactions, properties, measurement, nucleoprotein complexes

UNITV	METABOLISM CONCEPTS AND CARBOHYDRATE METABOLISM	9

Functions of Proteins, Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Interconnection of pathways and metabolic regulation. Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt & glyoxylate shunt, Bioenergetics - High energy compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Ensure students have a strong foundation in the structure and properties of biomolecules and nature of Carbohydrate.
CO2:	The students will acquire knowledge in structure and properties of all macromolecules.
CO3:	Introduce them to metabolic pathways of the major biomolecules and relevance to clinical conditions.
CO4:	Understand in detail about structures, types and classifications of amino acid and regulatory metabolism of biomolecules.
CO5:	Understand the protein structural formation, and protein metabolism.
CO6:	Understand the structure and functions of carbohydrates.

TEXTBOOKS

1.	Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H. Freeman and Company 2017

2	Satyanarayana, U. and U. Chakerapani, “Biochemistry” 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
REFERENCE BOOKS:	
1.	Berg, Jeremy M. et al. “Biochemistry”, 6th Edition, W.H. Freeman & Co., 2006.
2	Murray, R.K., et al., “Harper’s Illustrated Biochemistry”, 31st Edition, McGraw-Hill, 2018.
3	Voet, D. and Voet, J.G., “Biochemistry”, 4th Edition, John Wiley & Sons Inc.,2010.
4	Rastogi, S.C. “Biochemistry” 2nd Edition, Tata McGraw-Hill, 2003.

U23PHT26	PHYSICS OF MATERIALS (COMMON TO AGRI, BME, BIOTECH, CHEM, FOOD PHARMA PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To make the students to understand the basics of crystallography and its importance in studying materials properties.
2.	To expand their knowledge in applications of magnetic and superconducting materials in small scale industries.
3.	To inculcate an idea of significance of new materials, nanostructures ensuing nano device applications.

UNIT I	CONDENSED MATTER PHYSICS	9

Introduction - Lattice - Unit Cell - Seven Crystal Systems -Bravai's Lattices - Lattice Planes - Calculation of Number of Atoms per Unit Cell, Atomic Radius, Coordination Number and Packing Factor for SC, BCC, FCC and HCP Structures. Miller Indices – Derivation for Inter-Planar Spacing in terms of Miller Indices-Crystal Growth Techniques: Melt Growth Technique (Bridgman and Czochralski Techniques).

UNIT II	MAGNETIC AND SUPER CONDUCTING MATERIALS	9

Magnetic Materials: Dia, Para and Ferromagnetic Materials and Its Properties – Ferromagnetic Domains – Wiess Theory of Ferromagnetism – Hysteresis - B-H Curve Studies – Soft and Hard Magnetic Materials- Applications. Super Conducting Materials: Properties – Type I and Type II Super Conductors – London equations – Applications: Magnetic Levitated Train – Magnetic Resonance Imaging.

UNIT III	MODERN ENGINEERING MATERIALS	9

Shape Memory Alloys – Structures – Properties – Applications. Metallic Glasses – Preparation and Applications. Ceramics – Types - Properties and Applications.

Nano Materials – Types – Properties and Applications – Preparation Techniques: Electrodeposition – Pulsed Laser Deposition. CNT – Structure – Types – Properties - Applications

UNIT IV	INSTRUMENTATION PHYSICS	9

X – rays – Production – Diffraction of X – rays – Laue'e experiment – Bragg's law – Bragg's X – ray Spectrometer – Diffraction methods – Laue method – Rotating Crystal method – Powder Crystal method. Optical microscope – Electron microscope – Scanning electron microscope – Transmission electron microscope – EDAX – FTIR.

UNITV	RADIOACTIVE MATERIALS	9

Nucleus: Classification, Properties – Radioactivity – Alpha, Beta and Gamma rays – Properties – Laws of disintegration – Half-life period – Mean life -Neutron and its properties.

Artificial radioactivity – Applications and hazards of nuclear radiations – Detectors of Nuclear radiations: Solid State detectors – Proportional Counter – Geiger-Muller Counter.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Know basics of crystallography and its importance for varied materials properties.
CO2:	Gain knowledge on the magnetic and superconductor properties of materials and their applications.
CO3:	Illustrate the SMA and metallic glasses.
CO4:	Gain knowledge in the development of instruments.
CO5:	Get knowledge about radioactive materials.
CO6:	Understand the concept of detectors and counters.

TEXTBOOKS	
1.	Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019
2.	G. W. Hanson. Fundamentals of Nano electronics. Pearson Education (Indian Edition), 2009.
3.	Dr. P. Mani, “Physics for Electronics Engineering” Dhanam Publications, 2017.
4.	Dr. G. Senthilkumar, “Engineering Physics II” VRB Publishers, 2013.
REFERENCE BOOKS:	
1.	Robert F. Pierret, Semiconductor Device Fundamentals, Pearson, 2006
2.	S. Rajivgandhi, Dr. I. Cicil Ignatius & A. Ravikumar, “Engineering Physics II”, RK Publications, 2023
3.	Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.
4.	Dr. G. Senthilkumar, A. Ravikumar & S. Rajivgandhi, “Engineering Physics II”, VRB Publishers, 2023

GE3252	TAMILS AND TECHNOLOGY/தமிழரும் தொழில்நுட்பமும்	L	T	P	C
		1	0	0	1

UNIT I	WEAVING AND CERAMIC TECHNOLOGY	3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II	DESIGN AND CONSTRUCTION TECHNOLOGY	3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III	MANUFACTURING TECHNOLOGY	3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV	AGRICULTURE AND IRRIGATION TECHNOLOGY	3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNITV	SCIENTIFIC TAMIL & TAMIL COMPUTING	3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.
3. Historical Heritage of the Tamils (Dr. S. V. Subramanian, Dr. K. D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
5. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Textbook and Educational Services Corporation, Tamil Nadu)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K. Pillay) (Published by: The Author)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Textbook and Educational Services Corporation, Tamil Nadu)
8. 12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

U23HSP22	COMMUNICATION LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		0	0	2	2

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1.	To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
2.	To be able to communicate effectively through writing.
3.	Encouraging plan designing and decision making.
4.	Understanding and writing technical instruction.
5.	To understand the value of letter writing with correct format.

LIST OF EXPERIMENTS:

1.	Speaking-Role Play Exercises Based on Workplace Contexts.
2.	Talking about competition.
3.	Discussing progress toward goals-talking about experiences.
4.	Discussing likes and dislikes.
5.	Discussing feelings about experiences.
6.	Discussing imaginary scenarios.
7.	Writing short essays.
8.	Speaking about the natural environment.
9.	Describing communication system.
10.	Describing position and movement- explaining rules.
11.	Understanding technical instructions-Writing: writing instructions.
12.	Speaking: describing things relatively-describing clothing.
13.	Discussing safety issues (making recommendations) talking about electrical devices.
14.	Describing controlling actions.
15.	Writing a job application (Cover letter + Resume).

TOTAL: 30 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

SI no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	30
2.	Server	1
3.	Head phone	30
4.	Audio mixture	1
5.	Collar mike	1
6.	Television	1
7.	Speaker set with amplifier	1
8.	Power point projector and screen	1
9.	Cordless mike	1

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1:	Distinguish their technical competency through language skill.
CO2:	Predict context effectively in-group discussions held in a formal / semi-formal discussion.
CO3:	Understanding candidates' key characteristics.
CO4:	Finding personality traits by sharing and comparing thoughts and ability.
CO5:	Understanding the value of ethics (rules and regulations).

CO6:	Construct emails and effective job applications.

U23GEP13	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:	
The main learning objective of this course is to prepare the students for:	
1.	To understand the problem-solving approaches.
2.	To learn the basic programming constructs in Python.
3.	To practice various computing strategies for Python-based solutions to real world problems.
4.	To use Python data structures – lists, tuples, dictionaries.
5.	To do input/output with files in Python.
LIST OF EXPERIMENTS:	
1.	Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2.	Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3.	Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4.	Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5.	Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6.	Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7.	Implementing programs using Strings. (Reverse, palindrome, character count, replacing characters)
8.	Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, spicy)
9.	Implementing real-time/technical applications using File handling. (Copy from one file to another, word count, longest word)
10.	Implementing real-time/technical applications using Exception handling. (Divide by zero error, voter's age validity, student mark range validation)
11.	Exploring Py game tool.
12.	Developing a game activity using Py game like bouncing ball, car race etc.
	TOTAL: 60 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to:	
CO1:	Develop algorithmic solutions to simple computational problems
CO2:	Develop and execute simple Python programs.
CO3:	Implement programs in Python using conditionals and loops for solving problems.
CO4:	Deploy functions to decompose a Python program.
CO5:	Process compound data using Python data structures.
CO6:	Utilize Python packages in developing software applications.

U23BTP32	FUNDAMENTAL OF BIOCHEMISTRY LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Learn fundamental approaches for experimentally investigating biochemical problems.
2.	Able to extract living cell samples from plants and animals for genetic research.

LIST OF EXPERIMENTS

1.	General guidelines for working in biochemistry lab.
2.	Units of volume, weight, density and concentration measurements and their range in biological measurements.
3.	Accuracy, precision, sensitivity and specificity (theory)
4.	Preparation of buffer – titration of a weak acid and a weak base.
5.	Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from Aldo sugars
6.	Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from amino acid.
7.	Protein estimation by Biuret and Lowry's methods
8.	Protein estimation by Bradford and spectroscopic methods.
9.	Extraction of lipids and analysis by TLC.
10.	Estimation of nucleic acids by absorbance at 260nm and hyperchromic effect(demo).
11.	Enzymatic assay: phosphatase from potato
12.	Enzymatic assay: estimation of glucose by GOD-POD method after hydrolysis of starch with acid and specificity of the enzymatic method.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S/N	Name of the Equipment	Quantity
1.	Autoclave	1
2.	Hot Air Oven	1
3.	Incubators	2
4.	Light microscope	4
5.	Incubator shaker	1
6.	Colorimeter	2
7.	Laminar Flow Chamber	2
	Glassware	
1.	Test tubes (at least 10 per student)	25
2.	Beakers – 50ml, 100ml, 250ml one each per student, 500ml and 1000ml at least 5 per batch of 20 students	25
3.	Watch glasses one per student	30
4.	Petri dishes as required	10
5.	Glass cuvettes as needed	2
6.	Burette – one per student	
7.	Glass pipette – one each in 0.5ml, 1ml, 5ml and 10ml with suitable pipette acid	

8.	TLC plate as required for the experiment.	
	Chemicals	
	Glucose, fructose, galactose, maltose, starch, amino acids, DNA, RNA, lipids and commercial enzymes as required. Other chemicals as per the requirement of the standard protocol and commercial kit procured from the vendor followed/ utilized by the department.	

COURSE OUTCOMES:	
Upon completion of this course the student will be able to	
CO1:	Analyze current biochemical and molecular techniques to plan and carry out experiments.
CO2:	Perform good biochemical laboratory practices.
CO3:	Adapt methods for biochemical analysis
CO4:	Carry out experiments in biomolecular separations.
CO5:	Learn and understand the principles behind the qualitative and quantitative estimation of biomolecules.
CO6:	Understand the applicability of biochemical methods to realistic solution.
TEXTBOOKS	
1	Practical biochemistry by R.C. Gupta and S. Bhargavan
2	Introduction to practical biochemistry by David T. Phummer. (II Edition)
REFERENCES	
1	Harpers Biochemistry Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V. W. Rodwell, Appleton and Lange, Stanford, Connecticut.
2	Textbook of Biochemistry with clinical correlations. Ed. Thomas M. Devlin. Wiley Liss Publishers.

SEMESTER III

U23MAT31	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce the basic concepts of PDE for solving standard partial differential equations.
2.	To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems
3.	To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations
4.	To acquaint the student with Fourier transform techniques used in wide variety of situations.
5.	To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I	PARTIAL DIFFERENTIAL EQUATIONS	12

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange's linear equation – Solution of homogeneous linear partial differential equations of higher order with constant coefficients of both homogenous and non – homogenous type.

UNIT II	FOURIER SERIES	12

Dirichlet's conditions – General Fourier series – odd and even functions–Half range sine series and cosine series – Parseval's identity – Harmonic analysis.

UNIT III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	12

Classification of PDE – Method of separation of variables - Fourier series solutions of one-dimensional wave equation — One dimensional equation of heat conduction — Steady state solution of two-dimensional equation of heat conduction (Cartesian coordinates only).

UNIT IV	FOURIER TRANSFORMS	12

Statement of Fourier integral theorem – Fourier transform pair –Fourier sine and cosine transforms — Properties — Transforms of simple functions — Convolution theorem — Parseval's identity.

UNITV	LAPLACE TRANSFORMS	12

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems – Transforms of derivatives and integrals - Initial and final value theorems – Inverse transforms – Convolution theorem–Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to:

CO1:	Understand how to solve the given standard partial differential equations.
CO2:	Able to solve various types of partial differential equations.
CO3:	Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
CO4:	Appreciate the physical significance of Fourier series techniques in solving One and two-dimensional heat flow problems and one-dimensional wave equations.
CO5:	Understand the mathematical principles on transforms would provide them the ability to formulate and solve some of the physical problems of engineering.
CO6:	Use the method of Laplace Transform to solve initial value problem for Linear differential equations with constant coefficients.

TEXTBOOKS	
1.	Grewal B.S., “Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi ,2018.
2	Kreyszig E, "Advanced Engineering Mathematics", 10th Edition, John Wiley, New Delhi, India,2016.
REFERENCE BOOKS:	
1.	Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers "SPIE Press,1999.
2	Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd ,2015.
3	James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pears on Education, New Delhi,2016.
4	Narayanan. S., Manicavachagom Pillay. T.K and Ramanaiah. G "Advanced Mathematics for Engineering Students", Vol. II & III, S. Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

U23BTT21	BIOORGANIC CHEMISTRY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

Basic Knowledge in basic chemistry and inorganic chemistry

1.	Enable the students to understand the basics concepts of chemical reactions
2.	Make students understand kinetics and its reaction mechanism.
3	To understand the molecular interactions in microenvironment
4	Students can understand the biochemical mechanisms
5	To understand breakdown of macromolecules to macromolecules

UNIT I	BONDING AND STEREOCHEMISTRY	9

Atoms Electrons and orbitals - Covalent Bonds - Octet rule - Polar covalent Bonds - Electronegativity-formal charge - Resonance Acids and Bases - Arrhenius and Bronsted Lowry Theories - Acid Base equilibria -Types of Hybridisations, SP3 hybridization – Conformation analysis ethane, butane and cyclohexane - Cis- trans isomerism. Stereochemical activity around the tetrahedral carbon – optical activity - Conformation of the peptide bond.

UNIT II	MECHANISMS OF SUBSTITUTION AND ADDITION REACTIONS	9

SN1 and SN2 reactions on tetrahedral carbon- nucleophiles- mechanism steric effects – nucleophilic addition on Acetals and ketals -Aldehyde and ketone groups – reactions of carbonyl group with amines- acid catalyzed ester hydrolysis – Saponification of an ester- hydrolysis of amides. Ester eno-lates - Claisen condensation – Michael condensation.

UNIT III	KINETICS AND MECHANISM	9

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

UNIT IV	CATALYSIS	9

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

UNITV	BIOORGANIC REACTIONS	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Atom, molecule formation, bond formation, and stereochemistry
CO2:	Structure of carbon, reactions of carbon
CO3:	Kinetics and Thermodynamics involved in a reaction
CO4:	Nature of catalysts and catalytic process
CO5:	Formation and Breakdown of biomolecules
CO6:	Energy conservation in molecular system

TEXTBOOKS:

1.	Carey, Francis A.” Organic Chemistry”. VII Edition, Tata McGraw Hill, 2009. 2. Page, M.I. and Andrew Williams “Organic and Bio-organic Mechanisms”. Pearson, 2010.
2	David Van Vranken, Gregory A, Welss Introduction to bioorganic chemistry and chemical biology 2018.

REFERENCE BOOKS:	
1.	Dugas, Hermann “Bioorganic Chemistry: A Chemical Approach to Enzyme Action” 3rd Edition, Springer, 2003
2	John E McMurry, Tadhg P Begley. The Organic Chemistry of Biological Pathways, 2015
3	Richard B Silverman, The Organic Chemistry of Drug Design and Drug Action, 2014
4	Herbert J Fromm, Mark Hargrove. Essentials of Biochemistry. 2016

U23BTT32	ESSENTIALS OF MICROBIOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce students to the primitive forms of life.
2.	Enable students to understand principles of Microbiology to emphasize structure and bio-chemical aspects of various microbes.
3	To impart knowledge to the students to solve the problems in microbial infection and their control.
4	Students should gain knowledge on the environmental and industrial applications of mi-crobes
5	To obtain knowledge of growth, manipulation and metabolism based on the nutrition of mi-crobes

UNIT I	INTRODUCTION	9

Basics of microbial existence; history of microbiology, classification and nomenclature of microor-ganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

UNIT II	MICROBES- STRUCTURE AND MULTIPLICATION	9

Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.

UNIT III	MICROBIAL NUTRITION, GROWTH AND METABOLISM	9

Nutritional requirements of bacteria; different media used for bacterial culture; growth curve, factors affecting growth and different methods to quantify bacterial growth; aerobic and anaerobic bioener-getics and utilization of energy for biosynthesis of important molecules.

UNIT IV	CONTROL OF MICROORGANISMS	9

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

UNITV	INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY	9

Primary metabolites; secondary metabolites and their applications, micro algae cultivation; preserva-tion of food; production of penicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosen-sors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Microorganisms and examination of microorganisms
CO2:	Structural organization of microorganisms and its reproduction
CO3:	Nutritional requirements of microorganisms, their growth and metabolism
CO4:	Control of microorganisms
CO5:	Industrial and environmental application of microbes, metabolites, bioremediation, biofertilizers, biopesticides and biosensors
CO6:	Understand the microbes employed in commercial applications

TEXTBOOKS:

1.	Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India,2009
2	Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996

REFERENCE BOOKS:	
1.	Black, Textbook of microbiology. Freeman Publishers,2016
2	Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
3	Ananthanarayan, CK Jayaram Panikars. Textbook of Microbiology, 2005, Orient Blackswan Publishers.
4	Surinder Kumar. Essential of Microbiology, 2016, The health science publisher.

U23BTT33	INDUSTRIAL BIOTECHNOLOGY PRODUCTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To Understand the overall industrial fermentation process and the process flow sheet.
2.	To Interpret the knowledge on production of commercially important primary metabolites.
3	To Interpret the knowledge on production of commercially important secondary metabolites.
4	To Understand the production process of modern biological products.
5	To Analyse and apply the knowledge on science for the production of therapeutic Products.

UNIT I	INTRODUCTION TO INDUSTRIALBIOPROCESS	9

Fermentation - Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology – A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams.

UNIT II	PRODUCTION OF PRIMARY METABOLITES	9

Primary Metabolites- Production of commercially important primary metabolites like organic acids (citric acid, acetic acid, lactic acid) amino acids (L- cysteine, L- Tryptophan and L-phenylalanine), alcohols (ethanol, butanol, propanol)

UNIT III	PRODUCTION OF SECONDARY METABOLITES	9

Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics natural and semisynthetic penicillin, chloramphenicol Erythromycin, macrolides and Steroids – transformation process and its biological significance

UNIT IV	PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS	9

Production of Industrial Enzymes (protease and lipase), Biopesticides, Biofertilizers, Bio preservatives (Nisin), Biopolymers (PHA, PHB and Xanthaan Gum) Biodiesel – production process, characteristics, merits and demerits, Production process of Cheese, Beer, SCP & Mushroom culture

UNITV	PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS	9

Production of recombinant proteins having therapeutic and diagnostic applications (Insulin, Interferon, Interleukins and Growth stimulating Hormone), Vaccines – Subunit vaccine, recombinant vaccine advantages and disadvantages. Bioprocess strategies in Plant Cell and Animal Cell culture.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Recall the basics of industrial fermentation and other processes.
CO2:	Extend their knowledge on commercial production of primary metabolites.
CO3:	Extend their knowledge on commercial production of antibiotics.
CO4:	Compare the production of enzymes from bacterial and fungal species.
CO5:	Support for the commercial production of modern biological products.
CO6:	Understand the secondary metabolites and primary metabolites as the therapeutic agent.

TEXTBOOKS:

1.	Satyanarayana U, “Biotechnology” Books and Allied (p) Limited, 2013.
2	Dubey R C, “A Textbook of Biotechnology” 5th revised Edition S. Chand Publishing. Ltd, 2014.

REFERENCE BOOKS:

1.	Bryce C F A., and Mansi E L., “Fermentation microbiology & Biotechnology”, 3rd Edition CRC Press, 2011
2	Prescott S C., and Cecil G Dunn., “Industrial Microbiology”, Aerobics (India), 2005.
3	Cruger Wulf., and Anneliese Krueger., “Biotechnology: A Textbook of Industrial Microbiology”, 2nd Edition, Pamina Publishing, 2000.
4	Kumar H D, “A Textbook on Biotechnology” 2nd Edition. Affiliated East West Press Pvt. Ltd, 1998
5	Ratledge Colin and Bjorn Kristiansen, “Basic Biotechnology” 2nd Edition Cambridge University Press,2001.

U23BTT34	CELL BIOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To Familiarize students with the cell structure and functions of both Prokaryotes and Eukaryotes.
2.	To Recall basics of heredity, inheritance and genetics.
3	To Acquire basic fundamental knowledge on cell cycle and cell cycle.
4	To Analyse the cell signalling pathways and signal transduction.
5	To Understands the basic of cell culturing techniques of different cell types

UNIT I	CELL STRUCTURE AND FUNCTIONS OF ORGANELLES	9

Eukaryotic and prokaryotic cells, principles of membrane organization, membrane proteins, cytoskeletal proteins, and organelles - structure and function

UNIT II	CELL DIVISION AND CELL CYCLE	9

Types of cell division, details of cell cycle and molecules that control cell cycle, cell cycle and cancer, Oncogenes, growth hormones and their roles, apoptosis and programmed cell death

UNIT III	TRANSPORT ACROSS CELL MEMBRANES AND RECEPTORS	9

Passive & active transport, permeases, various pump mechanism, co transport, endocytosis and exocytosis, entry of viruses and toxins into cells, cytosolic, nuclear and membrane bound receptors, examples & models of action; quantitation and characterization of receptors

UNIT IV	ION CHANNELS AND SIGNAL TRANSDUCTION	9

Types of Ion-channels; Neurotransmitters- mechanism of action, action potential, depolarization, nerve conduction. Ion-channel - agonists and antagonists, defects; Actin, myosin, excitation - contraction coupling, relaxation; Different models of signal amplifications; Second messengers.

UNITV	CELL CULTURE	9

Techniques for the propagation of eukaryotic and prokaryotic cells. Cell line-generation, maintenance of stock cells, characterization of cells, immunochemistry, ex-plant cultures primary cultures, contamination, differentiation, three dimensional cultures, role of matrix in cell growth.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Describe the basic structure and functions of all the cell organelles.
CO2:	Discuss clearly about the mechanisms and control of cell division and cell cycle.
CO3:	Describe the transport across cell membranes and cell receptors.
CO4:	Understands the regulation of signal transduction at various levels.
CO5:	Articulate applications of cell propagation techniques in biotechnology
CO6:	Understand the basics of the signalling transport and mechanisms

TEXTBOOKS:

1.	Darnell J, Lodish H, Baltimore D, "Molecular Cell Biology", W. H. Freeman;
2	Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P," Molecular Biology of the Cell", Garland Science., New York, 2002.

REFERENCE BOOKS:

1.	James D. Watson, "Molecular Biology of the Cell".
2	Lodish H, Berk A., Kaiser CA., Krieger M, Bretscher A., Ploegh H, Amon A and Scott MP.
3	Molecular Cell Biology. W H Freeman & Co, New York, 1150p, 2012
4	Nelson D.L and M.M. Cox. Lehniner Principles of Biochemistry, 7th Ed. W. H. Freeman and Company, New York, USA. p.1328, 2017

5	Meyers, R. A, "Molecular Biology and Biotechnology" A comprehensive desk reference VCH Publishers Inc., New York, 1995
6	Krebs, J. E, Goldstein, E. S, Kilpatrick, S.T. Lewin's Genes XII. Jones and Bartlett Publishers, Inc., p.838, 2017

U23BTT35	APPLIED THERMODYNAMICS FOR BIOTECHNOLOGISTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To enable the students to learn about basic concepts of classical and statistical Thermodynamics
2	To understands the equilibrium of thermodynamics
3	To know about thermodynamics of microbial growth and production
4	To enable the students to learn about law of thermodynamics
5	To understand about thermodynamics-based biotechnology

UNIT I	THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS	9

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

UNIT II	SOLUTION THERMODYNAMICS	9

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

UNIT III	PHASE EQUILIBRIA	9

Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid- liquid equilibria and solid-solid equilibria

UNIT IV	CHEMICAL REACTION EQUILIBRIA	9

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

UNITV	THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION	9

Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert –Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Explain the theoretical concepts of thermodynamics and how it applies to energy conversion in technological applications and biological systems
CO2:	Demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems
CO3:	Design and carry out bioprocess engineering experiments, and analyze and interpret fundamental data to do the design and operation of bioprocesses
CO4:	Describe the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations microbial growth and product formation
CO5:	Describe the microbial growth process at Different growth rates.
CO6:	Describe the thermodynamics of microbial manipulation

TEXTBOOKS

1.	Smith J.M., Van Ness H.C., and Abbot M.M. "Introduction to Chemical Engineering Thermodynamics", VI Edition. Tata McGraw-Hill, 2003
2	Narayanan K.V. "A Textbook of Chemical Engineering Thermodynamics", PHI, 2003

REFERENCE BOOKS:	
1.	Sandler S.I. “Chemical and Engineering Thermodynamics”, John Wiley,1989
2	Christiana D. Smolke, “The Metabolic Pathway Engineering Handbook Fundamentals”, CRC Press Taylor & Francis Group, 2010.
3	Donald T. Haynie Biological Thermodynamics. Cambridge university,2001
4	Gordon G. Hammes. Thermodynamics and kinetics for the biological science, 2001

U23BTP31	CELL AND MICROBIOLOGY LABORATORY	L	T	P	C
		0	0	4	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To demonstrate various techniques to learn the morphology, identification and propagation of cells and microbes.
2.	To learn the staining techniques and culturing of microorganism.
3.	To learn the minimum skills to work on several important techniques for the study of microorganisms in the laboratory.
4.	To study the growth of microorganisms by varying the growth conditions.
5.	To identify the various stages of mitosis

LIST OF EXPERIMENTS

1.	Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques
2.	Microscopy–Working and care of Microscope, phase contrast and fluorescent microscopy
3.	Culture Media-Types and Use; Preparation of Nutrient broth and agar
4.	Culture Techniques, Isolation and Preservation of Cultures-Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
5.	Identification of given plant, animal, bacterial cells and yeast/ mold
6.	Staining Techniques Simple, Differential-Gram's Staining, spore / capsule staining, Giemsa, and Leishman Staining
7.	Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in Soil–TVC
8.	Effect of Disinfectants- Phenol Coefficient, Antibiotic Sensitivity Assay
9.	Osmosis and Tonicity and Tryphan Blue Assay
10.	Growth Curve in Bacteria and Yeast
11.	Staining for different stages of mitosis in Allium Cepa (Onion)
12.	Effect of pH, Temperature, UV radiation on Growth Bacteria

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S/N	Name of the Equipment	Quantity
1.	Autoclave	1
2.	Hot Air Oven	1
3	Incubators	1
4	Light Microscopes	2
5	Incubator Shaker	2
6	Colorimeter	2
7	Laminar Flow Chamber	2
	Glassware: Petri dish, Test tubes, microscopic slides, Inoculation, loop, Gas burner	
	Chemicals and media: Bacterial culture media, Yeast culture media, 70% ethanol, antibiotics, Crystal violet, Iodine, Safranin, India ink (capsule staining), Immersion oil	

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Understand the advanced technical information pertaining to laboratory bio-safety and preventive measures from pathogenic microorganism.
CO2:	Know the various aseptic techniques and sterilization methods.
CO3:	Develop the minimum skills to work on several important techniques for the study of microorganisms in the laboratory.

CO4	Learn the various techniques of culturing of microorganisms and media preparation.
CO5	Study the growth of microorganisms by varying the growth conditions.
CO6	Identify the various stages of mitosis
REFERENCES:	
1	Cappuccino, J. G. and N. Sherman "Microbiology: A Laboratory Manual", 4th Edition, Addison-Wesley,1999.
2	Collee, J. G. et al., "Mackie & Mc Cartney Practical Medical Microbiology" 4th Edition, Churchill Livingstone, 1996 Rickwood, D. and J. R. Harris "Cell Biology: Essential Techniques", Johnwiley,1996.
3	Davis, J. M. "Basic Cell Culture: A Practical Approach", IRL, 1994.

U23BTP21	BIOORGANIC CHEMISTRY LABORATORY	L	T	P	C
		0	0	4	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Make the students understand the mechanism of synthesis of different chemical moieties
2.	Familiarize the students with the isolation of biomolecules from natural sources
3.	Understand the basic concepts of preparation of various chemical compounds
4.	Analyses of biochemical compounds of medical importance
5.	Acquire knowledge on mechanism of reactions

LIST OF EXPERIMENTS

1.	Synthesis of aspirin
2.	Hydrolysis of sucrose
3.	Preparation of pyruvic acid from tartaric acid
4.	Preparation of oleic acid from tartaric acid
5.	Preparation of alpha D-glucopyranose pentaacetate
6.	Preparation of1,2,5,6dicyclohexylnoine alpha glucofuranose
7.	Isolation of lycopene from tomato paste
8.	Preparation of L-proline
9.	Preparation of L-cysteine from hair
10.	Preparation of S-ethyl hydroxyl butonate from methyl acetoacetate using yeast
11.	Resolution of S-ethyl hydroxyl butonate using 3, 5 dinitro benzoate.
12.	Preparation of 5,10,15,20-tetrakisphenylporphyrin

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S/N	Name of the Equipment	
1.	Colorimeter	
2.	Soxhlet apparatus	
3.	Distillation unit	
4.	Heating Mantle	
	Glassware, Chemicals as required	

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Comprehend the mechanism of reactions
CO2:	Be able to synthesis various bioorganic compounds.
CO3:	Be able to Perform Chemical preparation individually
CO4:	Able to perform the isolation of biomolecules from natural sources
CO5:	To implement the concepts of preparation of various chemical compounds
CO6:	Interpret the medical importance of biochemical compounds.

REFERENCES:

1	Organic Chemistry, Francis A. Carey, VII Edition, Tata Mc Graw Hill, Fourth reprint 2009.
2	Organic and Bio-organic Mechanisms, M.I. Page and Andrew Williams. Pearson, First Impression, 2010.

U23GE3361	PROFESSIONAL DEVELOPMENT	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWER-POINT.
2.	To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
3.	To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered.
4.	To be able to create and share quality presentations by using the features of MS PowerPoint, including organization of content, presentability, aesthetics, using media Elements.
5.	To enhance the overall quality of presentations.

LIST OF EXPERIMENTS

1.	**MS WORD:** **10 Hours** Create and format a document Working with tables Working with Bullets and Lists Working with styles, shapes, smart art, charts Inserting objects, charts and importing objects from other office tools Creating and Using document templates Inserting equations, symbols and special characters Working with Table of contents and References, citations Insert and review comments Create bookmarks, hyperlinks, endnotes footnote Viewing document in different modes Working with document protection and security Inspect document for accessibility
2.	**MS EXCEL:** **10 Hours** Create worksheets, insert and format data Work with different types of data: text, currency, date, numeric etc. Split, validate, consolidate, Convert data Sort and filter data Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,) Work with Lookup and reference formulae Create and Work with different types of charts Use pivot tables to summarize and Analyse data Perform data analysis using own formulae and functions Combine data from multiple worksheets using own formulae and built-in functions to generate results Export data and sheets to other file formats Working with macros Protecting data and securing the workbook

3.	**MS EXCEL:** Select slide templates, layout and themes Formatting slide content and using bullets and numbering Insert and format images, smart art, tables, charts Using Slide master, notes and handout master Working with animation and transitions Organize and Group slides Import or create and use media objects: audio, video, animation Perform slideshow recording and Record narration and create presentable videos	**10 Hours**
		TOTAL: 30 PERIODS

COURSE OUTCOMES:	
Upon completion of this course the student will be able to	
CO1:	Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements
CO2:	Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding
CO3:	Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.
CO4:	Able to utilize the tools in professional bodies.
CO5:	Able to use media elements in organization of content, presentability, aesthetics
CO6:	To enhance the overall quality of presentations.

SEMESTER IV

U23BTT41	MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes.
2	To analyse the function of the genes at molecular level.
3	To recall basics of heredity, in heritance and genetics.
4	To acquire basic fundamental knowledge and explore skills in molecular biology.
5	To understand the molecular mechanism of DNA replication, repair, transcription and protein synthesis and gene regulation in various organisms.

UNIT I **INTRODUCTION TO NUCLEIC ACIDS** **9**

Nucleic acids as genetic material, Structure and physicochemical properties of elements in DNA and RNA, Biological significance of differences in DNA and RNA. Primary structure of DNA: Chemical and structural qualities of 3', 5'-Phosphodiester bonds. Secondary Structure of DNA: Watson & Crick model, Chargaff's rule, X–ray diffraction analysis of DNA, Forces stabilizes DNA structure, Conformational variants of double helical DNA, Hogsten base pairing, Triple helix, Quadruple helix, Reversible denaturation and hyperchromic effect. Tertiary structure of DNA: DNA supercoiling.

UNIT II **MOLECULAR EVENTS OF REPLICATION & MUTATION** **9**

Central dogma of Molecular Biology. DNA replication- Origin of replication, Enzymes of replication-DNA polymerases, reverse transcriptase, topoisomerases, ligases. Concurrent synthesis and termination-Details in phage, bacteria, and eukaryotes. Polymerase Chain Reaction-Principles and Applications. Mutagens, DNA mutations and their mechanism, various types of repair mechanisms.

UNIT III **MOLECULAR EVENTS OF TRANSCRIPTION AND RNA PROCESSING** **9**

Transcription - prokaryotic RNA polymerase, sigma, promoters, promoters recognition - elongation and termination. Transcription in eukaryotes - enhancers, initiation - transcription factors, elongation and termination. Post – transcriptional modifications - rRNA, tRNA processing. Molecular structure of mRNA, introns, exons-mRNA end modifications — molecular events - 5' Cap formation, 3'polyadenylation - mRNA splicing, alternative splicing, RNA editing.

UNIT IV **MOLECULAR EVENTS OF TRANSLATION** **9**

Genetic code - codons and its properties, Wobble hypothesis - molecular structure of tRNA, Ribosomes - structure, morphology and organization-Translation-initiation –Elongation termination - Post translational modifications in prokaryotes and eukaryotes. Inhibitors of protein synthesis.

UNITV **GENE EXPRESSION & REGULATION** **9**

Gene expression — prokaryotes — operon concept - *lac* and trp operon. Regulation of gene expression in eukaryotes. DNA sequencing - classical and automated DNA sequencing methods. Tools and techniques in molecular biology - Overview. Molecular markers - PCR and hybridization based molecular markers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Describe the basic structure and biochemistry of nucleic acids and proteins and discriminate between them.
CO2:	Identify the principles of DNA replication, transcription and translation and explain how they relate to each other

CO3:	Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.
CO4:	Understand the regulation of gene expression at various levels.
CO5:	Articulate applications of molecular biology in the modern world.
CO6:	Understand the gene expression and molecular mechanisms

TEXTBOOKS:	
1.	Frie Felder, David. "Molecular Biology." Narosa Publications, 1999
2	Allison, L.A. Fundamentals of Molecular Biology. (2nd Edition) JohnWileyandSons,2011.
3	Watson J D, Baker T A, Bell S P, Gann A Levine M, Losick R. Molecular Biology of the Gene.7th Ed. Pearson Education International, 2013.
REFERENCE BOOKS:	
1.	Krebs, J. E, Goldstein, E. S, Kilpatrick, S. T. Lewin's Genes XII. Jones and Bartlett Publishers, Inc., p.838, 2017.
2	Lodish H, Berk A., Kaiser C A., Krieger M, Bretscher A., Ploegh H, Amon A and Scott M P.
3	Molecular Cell Biology. W H Freeman & Co, New York, 1150p, 2012.
4	Nelson D. L and M. M. Cox. Lehniner Principles of Biochemistry, (7th Ed.) W. H. Freeman and Company, New York, USA. p. 1328, 2017.
5	Raineri, D. Introduction to Molecular Biology. Black well Science, Inc., 190p.
6	Robert Weaver. Molecular Biology. (5th Edition.). Mc Graw Hill Inc.,890p, 2011.

U23BTT42	HEAT AND MASS TRANSFER OPERATIONS FOR BIOTECHNOLOGISTS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Introduce the principles of Heat and mass Operations to impart knowledge about various Heat transfer operations equipment's and its design concepts
2	To know about convection heat transfer and their solving related problems and coefficient
3	To understand the instrumentations involving the radiation and heat transfer
4	To understand the mechanisms of heat transfer under steady and transient condition
5	To develop skills in the area of mass transfer operations with emphasis on separation and purification of products.
6	Analyse the design of various industrial heat exchangers, the concept of NTU for higher education in the field of Biotechnology.

UNIT I	CONDUCTION HEAT TRANSFER	9+3

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

UNIT II	CONVECTION HEAT TRANSFER	9+3

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

UNIT III	RADIATION HEAT TRANSFER AND HEAT TRANSFER EQUIPMENTS	9+3

Electromagnetic waves, energy of radiation, Planck's Equation-Blackbody Radiation. Kirchhoff's law, Stefan Boltzmann equation of radiant energy –Wien's law, Radiation exchange between surfaces – black and gray bodies - view factors - sample problems. Heat exchangers - types, boilers, Kettles. Heat exchanger Design concept. Correction Factor Charts and Plate Heat Exchangers. NTU concept

UNIT IV	DIFFUSION AND MASS TRANSFER	9+3

Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients; Analogies in Transport Phenomenon.

UNITV	EXTRACTION AND SOLID FLUID OPERATIONS	9+3

L-L equilibria, Staged and continuous extraction, Solid-liquid equilibria, Leaching Principles. Adsorption equilibria – Batch and fixed bed adsorption; Drying-Mechanism-Drying curves- Time of Drying; Batch and continuous dryers

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	The basics of major heat and mass transfer operations
CO2:	Learn fundamentals of dimensional analysis and dimensionless numbers
CO3:	To recognize and apply analogies among momentum, heat and mass transfer in various types of mass transfer operations.
CO4:	To investigate solid-liquid equilibrium in mass transfer operations and attain the desired products by mass transfer operations.
CO5:	To employ the engineering correlations of diffusion and mass transfer coefficients to model a separation process.

CO6:	Various industrial heat exchangers design, the concept of NTU for higher education in the field of Biotechnology.
TEXTBOOKS	
1.	Kern, D.Q., 'Process Heat Transfer', McGraw-Hill, 1999.
2	Treybal R. E. Mass Transfer Operations. IIIrd edition. McgrawHill,2017.
REFERENCE BOOKS:	
1.	Frank Kreith, Raj M. Manglik, and Mark S. Bohn "Principles of Heat Transfer" VII edition, Cengage Learning Inc., 2018.
2	J.M. Coulson and J. F. Richardson with J.R. Backhurst and J.H. Harker "Coulson and Richardson's Chemical Engineering. Vol - I", VI edition Butterworth - Heinemann, 1999.
3	P.K. Nag "Heat & Mass Transfer", Tata McGraw Hill, III edition,2011.
4	Roop K Khar, SP Vyas, Farhan J Ahmad, Gaurav K Jain "Lachman/Lieberman's The theory and Practice of Industrial Pharmacy", 4th Edition, CBS publishers & distributors,2014.
5	Binay K. Dutta Principles of Mass Transfer and Separation Processes, Prentice Hall India publisher, 2006

U23BTT43	ANALYTICAL INSTRUMENTATION METHODS OF ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the theory of elasticity including strain / displacement and Hooke's law relationships.
2	To solve for stresses and deflections of beams under unsymmetrical loading.
3	To obtain stresses and deflections of beams on elastic foundations.
4	To solve torsion problems in bars thin-walled members.
5	To obtain solutions to column buckling and plate problems.

UNIT I	UV SPECTROSCOPY AND NMR SPECTROSCOPY	9

Characteristics of electromagnetic radiations - Definition-wave length, wave number, frequency, energy. The absorption laws – Theory of electronic spectroscopy - Double beam spectrophotometer. Chromospheres - Auxochrome - Types of absorption bands - Absorption andintensityshifts-Applications.Theory-numberofsignals-Instrumentation-Chemicalshift. Theory and application of Circular Dichroism; Fluorescence, NMR, PMR, ESR and Plasma Emission spectroscopy,

UNIT II	IR SPECTROSCOPY AND MASS SPECTROSCOPY	9

Theory - Vibrational frequency - Number of fundamental vibrations - Hook's law Scanning of IR-spectrum-Applications.Basicprinciples-Theory-Instrumentation-Nitrogenrule-Molecularion McLafferty rearrangement–Applications. Mass spectrometry, components of mass spectrometer, methods of ionization and mass analysis including MALDI-TOF.

UNIT III	SEPARATION METHODS	9

Principles of solvent extraction - Extraction techniques - Analytical applications. Principles of chromatography - Different types - thin layer, column and gas chromatography, paper chromatography, gel filtration, ion exchange, hydrophobic interaction chromatography, affinity chromatography, HPLC. Radio chemical methods - Activation analysis - Isotopic dilution methods.

UNIT IV	THERMAL METHODS AND ELECTROCHEMICAL METHOD	9

Thermogravimetry - Factors influencing the thermogram - TGA instrument - Applications of TGA - DTA-Definition— Instrumentation-Thermal analysis of calcium oxalate monohydrate and calcium acetate monohydrate -Applications of DTA. Principles of polarography – Half wave potential- Factors affecting the limiting current-Applications of polarography.

UNITV	PRINCIPLES OF GRAVIMETRIC ANALYSIS	9

Methods of obtaining the precipitate - Conditions for precipitation - Choice of precipitants - Advantages of using organic precipitants - Disadvantages - Types of organic precipitants - Specific and selective precipitants - Sequestering agents. Theories of precipitation - Co- precipitation - post-precipitation. Effects of digestion - General rules for precipitation - Precipitation from homogeneous medium - Washing of precipitates - Drying of precipitates.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Identifying the structure of the organic compound from the spectroscopic studies.
CO2:	Types of Spectroscopy methods for analysis.
CO3:	The importance of separation methods for chemical analysis.
CO4:	Basic principles of thermal methods.
CO5:	Analysing the various precipitation methods available.
CO6:	The basic knowledge of different kind of analytical techniques for analytical characterization of chemicals

TEXTBOOKS	
1.	Sharma B.K., Instrumental methods of chemical analysis, Eighteenth Edition, GOELpublishingHouse.2002.
2	Ewing G. W., Instrumental methods of Chemical Analysis, Fifth Edition, McGraw Hill, NewYork,1992.
REFERENCE BOOKS:	
1.	Skoog D.A., - Principles of Instrumental Analysis, Sixth Edition, Saunders CollegePublication,2007.
2	Williard H.H., Meritt L. Cand Dean J.H., -Instrumental Methods of Analysis, Sixth Edition
3	Vogel's textbook of Quantitative Chemical Analysis, Fifth Edition. ELBS Publications, 2007.
4	Chatwal, Anand, Instrumental Methods of Chemical Analysis, Seventh Edition, HimalayaPublishingHouse.2005.

U23BTT44	CHEMICAL PROCESS CALCULATIONS IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To enable the students to learn about basic concepts of chemical process and calculations.
2.	The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics.
3.	The course will enable the students to perform calculations pertaining to processes and operations.

UNIT I	FUNDAMENTALS OF BASIC AND DERIVED UNITS, LAW OF GASES	9

Base and derived Units - Composition of Mixture and solutions - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT II	MATERIAL BALANCE WITHOUT CHEMICAL REACTION	9

Introduction, Classification of material balance without chemical reaction, Guidelines for material balance, material balance with unit operation such as distillation, Absorption, Extraction, Crystallization, Drying, Mixing and Evaporation, Bypass, Recycle and Purging operation. Material balance of unsteady state operations.

UNIT III	MATERIAL BALANCE INVOLVING CHEMICAL REACTION	9

Concept of limiting and excess reactants, percentage conversion, yield, selectivity, etc., Material balance with chemical reactions-single and multiple reactions, Material balance in volving reactions with special reference to fertilizers, petrochemicals, dyestuffs, electrochemical industries, metallurgical industries.

UNIT IV	ENERGY BALANCE	9

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy. Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems with and without chemical reaction - Unsteady state energy balances.

UNITV	FUEL AND COMBUSTION	9

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on Sulphur and Sulphur burning compounds- Application of Process simulators in energy and material balance problems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	The fundamentals of units and stoichiometric equations.
CO2:	Material balance for different chemical process.
CO3:	The fundamentals of material balance involving chemical reaction.
CO4:	Knowledge about energy balance in chemical industries.
CO5:	Evaluate and analysis the problems of fuel and combustion of solid.
CO6:	The basic knowledge of chemical proses/reactions involved in the field of biotechnology.

TEXTBOOKS	
1.	Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition, Tata McGraw-Hill (2004).
2	Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Sixth Edition, Prentice Hall Inc., 2003.
REFERENCE BOOKS:	
1.	Hougen OA, Watson KM and Ragatz RA, "Chemical process principles" Part I, CBS publishers.
2	Felder, R. M. and Rousseau, R.W., "Elementary Principles of Chemical Processes" ,3rd Edition., John Wiley & Sons, New York,2000.
3	K.V. Narayanan, B. Lakshmi Kutty, "Stoichiometry and Process Calculations", Prentice-HallofIndiaPvt.Ltd,2006.
4	D.C. Sikdar, "Chemical process Calculation", PHI Learning Private Limited, Delhi,2015.

U23BTT45	ENZYME TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the working of different enzymes and applying the functions in industrial bio-technology.
2	To learn about the mechanism of enzyme substrate reaction
3	To obtain their knowledge enzyme kinetics
4	To understand the bonding and mobilization of enzymes
5	To learn the functions, mechanisms and industrial applications of enzymes

UNIT I	INTRODUCTION TO ENZYMES	9

Nature and function of enzymes, Enzyme nomenclature, classification of enzymes, mechanisms of catalysis - Acid base catalysis, electrostatic catalysis, covalent catalysis and enzyme catalysis., Role of co-enzymes and co-factors.

UNIT II	ENZYME KINETICS	9

Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multi substrate reactions - mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod Changeux Wyman model, pH and temperature effect on enzymes & deactivation kinetics.

UNIT III	ENZYME IMMOBILIZATION	9

Classification of enzyme immobilization, physical and chemical techniques for enzyme immobilization - adsorption, matrix entrapment, encapsulation, cross-linking, covalent bonding, advantages and disadvantages, Application of immobilized enzymes, mass transfer effect on immobilization, properties of immobilized enzymes.

UNIT IV	ENZYME SPECIFICITY AND EXTRACTION	9

Types of specificity, group, bond, absolute and stereo chemical. Active site – Fischer hypothesis and Koshl and hypothesis, Extraction of soluble enzymes- microwave assisted extraction, enzyme assisted extraction, membrane bound enzymes, purification procedures, criteria of purity.

UNITV	CLINICAL AND INDUSTRIAL APPLICATIONS OF ENZYMES	9

Application of enzymes in medicine and industry – Assay of plasma enzyme, enzyme biosensors, design of enzyme electrodes, Synzymes, Abzymes, Enzymes in genetic engineering.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Basic Principles of Enzyme function and Enzyme activity.
CO2:	Relate the enzyme kinetics to various biological functions.
CO3:	Gain knowledge to Innovate useful products to society using enzymes.
CO4:	Work technologically with concepts on Isolation, Purification and characterization of enzymes.
CO5:	Identifying novel applications of enzymes in bioengineering.
CO6:	Implement the characteristic enzymes in bio product development

TEXTBOOKS

1.	Palmer, Enzyme, Horwood Publishing Series, 2001.
2	Price and Stevens, Fundamental of Enzymology, Oxford University Press,2002.

REFERENCE BOOKS:

1.	Prasad N.K., Enzyme Technology: Pacemaker of Biotechnology Paper back,2011.
2	James M. Lee, Biochemical Engineering, PHI, USA

3	James. E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill Education; 2017
4	Khan M. Y. and Farha Khan, Principles of Enzyme Technology,2015.

U23BTT46	BIOPROCESS PRINCIPLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	At the end of the course, the students would have learnt about fermentation processes, Metabolic stoichiometry, Energetics, Kinetics of microbial growth etc.
2	This will serve as an effective course to understand certain specialized electives in Bioprocess related fields.
3	To establish reproducible and robust manufacturing processes for production of therapeutic cells.
4	To understand the life science into practical products and involved processes.
5	To know about bacterial growth in controlled environment for biomass production.

UNIT I	OVERVIEW OF FERMENTATION PROCESSES	9

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of Fermenter and ancillaries, main parameters to be monitored and controlled in Fermentation processes.

UNIT II	RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS	9

Criteria for good medium, medium requirements for fermentation processes, micro and macro 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.

UNIT III	STERILIZATION 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.

UNIT IV	METABOLIC STOICHIOMETRY AND ENERGETICS	9

Stoichiometry of cell growth and product formation, maximum possible yield, theoretical oxygen demand, stoichiometric calculations, 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, Stoichiometry of single-cell protein synthesis.

UNITV	KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION	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. Microbial pellet formation, Kinetics and dynamics of pallet formation. Chemostat with immobilized cells, Chemostat with cell recycle, substrate utilization and product formation in bioreactor, Scale up of Bioreactors

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Apply engineering principles to systems containing biological catalysts to meet the needs of the society.
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.

TEXTBOOKS	
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).
REFERENCE BOOKS:	
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	Najafpour, G.D. Biochemical Engineering and Biotechnology, 1st Ed., Elsevier, 2007.)
4	Harvey W. Blanch., Douglas S. Clark., "Biochemical Engineering", Marcel Dekker, Inc. (2015)

U23BTP41	CHEMICAL ENGINEERING LABORATORY FOR BIOTECHNOLOGISTS	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To provide basic understanding of chemical engineering principles and operations
2.	Course will enable the students to apply the principles in other chemical engineering and biotechnology subjects of fared in higher semesters
3.	Understand the chemical engineering principles and their applications in chemical, mechanical and biological perspectives.
4.	Gain basic knowledge on the design and working principles of fluid moving machinery and transport phenomena in biological systems.
5.	Understand the need for instrumentation studies in technical environment

LIST OF EXPERIMENTS

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

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S/N	Name of the Equipment	Quantity
1.	Colorimeter	**2**
2.	Filter leaf	**1**
3	Orifice meter	**2**
4	Venturi meter	**2**
5	Rotameter	**1**
	Glassware, Chemicals, Media as required	

TOTAL PERIODS : 45

COURSE OUTCOMES:

Upon completion of this course the student will be able to

CO1:	Acquire knowledge on the basic concepts of chemical engineering.
CO2:	Develop the skill of material balance and energy balance in unit operations and unit process.
CO3:	Analyse the chemical engineering principles and their applications in chemical, mechanical and biological perspectives.
CO4:	Realize the design and working principles of fluid moving machinery and transport phenomena in biological systems.
CO5:	Select and apply appropriate techniques used for biological products.
CO6:	Recognize the need for instrumentation studies in technical environment

U23BTP42	ANALYTICAL INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To have a practical hands - on experience on Absorption Spectroscopic methods
2.	To validate and analysis using spectrometric and microscopic techniques.
3	To understand downstream processing in industries.
4.	To estimate various elements using analytical techniques.
5.	To acquire experience in the purification by performing chromatography.

LIST OF EXPERIMENTS

1.	Precision and validity in an experiment using absorption spectroscopy.
2.	Validating Lambert - Beer's law using $KmnO_4$
3.	Finding the molar absorptivity and stoichiometry of the Fe (1,10 phenanthroline)3 using absorption spectrometry.
4.	Finding the pKa of 4-nitrophenol using absorption spectroscopy.
5.	UV spectra of nucleic acids.
6.	Chemical actinometry using potassium ferrioxalate.
7.	Estimation of SO^4 — by nephelometry.
8.	Estimation of Al^{3+} by Fluorimetry.
9.	Limits of detection using aluminum alizarin complex.
10.	Chromatography analysis using TLC.
11.	Chromatography analysis using column chromatography.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S/N	Name of the Equipment	
1.	UV-Spectrophotometer	1
2.	Glassware	As required
3.	Column chromatography	2
4.	TLC plate	2
5.	Chemicals	As required

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	The students would visualize and interpret the theory of spectroscopic methods by practice.
CO2:	Validate specific elements using spectrometric techniques
CO3:	Analysis specific chemical compounds using microscopic techniques
CO4:	Implement downstream process techniques in industries
CO5:	Detection of complex compounds.
CO6:	Demonstrate various Chromatography techniques.

REFERENCES:

1	Skoog, D.A. et al. "Principles of Instrumental Analysis", Vth Edition, Thomson / Brooks – Cole, 1998.
2	Braun, R.D. "Introduction to Instrumental Analysis", Pharma Book Syndicate, 1987.
3	Willard, H.H. et al. "Instrumental Methods of Analysis", VI Edition, CBS, 1986.

U23BTP43	MOLECULAR BIOLOGY LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To provide hands – on experience in performing basic molecular biology techniques.
2.	To introduce students to the theory behind in each technique.
3.	To describe common applications of each methodology in biological research.
4.	To take up specialized project in Molecular biology and will be a pre-requisite for research work.
5.	To learn about transgenic modification in cells.

LIST OF EXPERIMENTS

1.	Isolation of bacterial DNA
2.	Isolation of plant cell and animal cell genomic DNA
3.	Isolation of plasmid DNA
4.	Agarose gel electrophoresis
5.	Restriction enzyme digestion
6.	Competent cells preparation
7.	Transformation
8.	Blue and white selection for recombinants
9.	Plating of λ phage
10	Lambda phage lysis of liquid cultures

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S/N	Name of the Equipment	Quantity
1	Gel electrophoresis	**2**
2	Shaking Incubator	**1**
3	Water bath	**2**
4	Petri plates	**30**
5	Microscope	**2**
6	Micropipette	**5**
7	Laminar Air flow chamber	**1**

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Demonstrate knowledge and understanding of the principles of important techniques in molecular biology.
CO2:	Gain hands-on experience in performing basic molecular biology techniques.
CO3:	Analyse the theory behind each technique
CO4:	Demonstrate common applications of each methodology in molecular level research.
CO5:	Perform specialized project in Molecular biology research work.
CO6:	Implement transgenic modification in cells.

REFERENCE:

1. Sambrook ,Joseph and David Russell "The condensed Protocols: From molecular cloning: A Laboratory Manual" Cold Spring Harbor,2006.

SEMESTER V

U23BTT51	IMMUNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To discuss the structure, functions and integration of immune system.
2	To explain the antigen-antibody interactions and how the immune system is protecting the body from foreign pathogens/germs.
3	To explain various techniques of monoclonal and engineered antibodies (important therapeutic molecules) production, for treating most of the human diseases.
4	To understand how immune system develops
5	To understand the body defends against disease and positive/negative impacts

UNIT I	INTRODUCTION	9

Cells of immune system; innate and acquired immunity; primary and secondary lymphoid organs; Antigens-chemical and molecular nature; Haptens and adjuvants; types of immune responses; theory of clonal selection.

UNIT II	CELLULAR RESPONSES	9

Development, maturation, activation and differentiation of T-cells and B-cells; TCR; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions; monoclonal antibodies: principles and applications; antigen presenting cells; major histocompatibility complex; antigen processing and presentation; regulation of T-cell and B-cell responses

UNIT III	INFECTION AND IMMUNITY	9

Injury and inflammation; immune responses to infections: immunity to viruses, bacteria, fungi and parasites; cytokines; complement; immunosuppression, tolerance; Hypersensitivity; AIDS and Immuno-deficiencies; resistance and immunization; Vaccines.

UNIT IV	TRANSPLANTATION AND TUMOUR IMMUNOLOGY	9

Transplantation: genetics of transplantation; laws of transplantation, Mechanism and clinical manifestation of Graft rejection, Preparation and clinical uses of Monoclonal and Polyclonal antibody, tumour and transplantation immunology.

UNITV	AUTOIMMUNITY	9

Autoimmunity, Organ specific and Systemic autoimmune Disorders, Diagnosis and Treatment. Physiology of acquired immune response – various phases of HI, CMI – cell mediated cytotoxicity, DTH response.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Acknowledge the various types of cells and organs involved in immune system.
CO2:	Illustrate the cellular responses of T- Cells, B Cells and other immune response cells.
CO3:	Apply the concepts of immunology in vaccine development and treatment of infectious diseases.
CO4:	Perform the concept of immune response in Transplantation and Tumor immunology
CO5:	Analyse the various development of autoimmune disorders and treatment of infection disease
CO6:	Understand the critical to human and animal health and survival.

TEXTBOOKS

1.	Roitt I, Male, Brostoff, Immunology, Mosby Publ., 2002
2	Kuby J, Immunology, WH Freeman &Co., 2000.

REFERENCE BOOKS:	
1.	Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 1998.
2	William E. Paul. Fundamental Immunology. 2008
3	Seemi Farhat Basir Textbook Of Immunology. 2012
4	David Male, R. Stokes Peebles, Immunology.2020

U23BTT52	PRINCIPLES OF GENETIC ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To discuss the gene cloning methods, tools and techniques
2	To understand genome analysis and genomics.
3	To learn the manipulation and modify of the genetic materials.
4	To learn the different instruments for cloning, genome analysis and genomics.
5	To explain the heterologous expression of cloned genes in different hosts.

UNIT I	BASICS OF RECOMBINANT DNA TECHNOLOGY	9

Role of genes within cells, genetic elements that control gene expression, restriction and modifying enzymes, safety guidelines of recombinant DNA research.

UNIT II	CREATION OF RECOMBINANT MOLECULES	9

Restriction mapping, linkers and adaptors, Characteristics of plasmid and phage vectors, Types – pBR322, selectable markers, Cosmides, Phagemids, Artificial chromosomes — BAC, & PAC.

UNIT III	CONSTRUCTION OF LIBRARIES	9

Construction of cDNA and genomic libraries, Blotting Techniques: Southern, Northern and Western.

UNIT IV	POLYMERASE CHAIN REACTION	9

PCR: Basic principle, Applications, Types- Nested PCR, Inverse PCR, RACEPCR. Molecular beacons, RFLP, RAPD and Site directed mutagenesis. Nucleic acid sequencing: Sanger's method of DNA sequencing.

UNIT V	APPLICATION OF RECOMBINANT DNA TECHNOLOGY	9

Genetic Transformation implants, Ti plasmid and Agrobacterium mediated transformation, transgenic and knockout animals

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Clone a gene of interest and parameters to be considered while designing a cloning strategy.
CO2:	Demonstrate variety of screening techniques to characterize the clones.
CO3:	Apply PCR in cloning, diagnosis and mutant generation including the development of high value products
CO4:	Describe DNA technology within the constraints of environmental and ethical consequence of practicing Genetic engineering
CO5:	Exploit the benefits of transgenic for societal applications.
CO6:	Obtained their knowledge about the techniques involved in genetic engineering have led the production of medically important products.

TEXTBOOKS

1.	Primrose SB and R. Twyman "Principles of Gene Manipulation & Genomics Blackwell Science Publications, (2006).
2	Gon Grierson "plant Genetic Engineering", Blackie academic & professional, (2013).

REFERENCE BOOKS:

1.	Berger Sl., Kimmer A R., "Methods in Enzymology", Vol.152, Academic Press, (1987).
2	Ansubel FM., Brent R., Kingston R E., Moore DD., "Current Protocols in Molecular Biology", Greene Publishing Associates, NY (1988).
3	Lisa Yount, "Biotechnology and Genetic Engineering" Edition 3, facts on file, (2008).
4	Harry Levine, "Genetic Engineering", (2006).

U23GET41	ENVIRONMENTAL SCIENCES AND ENGINEERING	L	T	P	C
		3	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To the study of nature and the facts about environment.
2.	To finding and implementing scientific, technological, economic and political solutions to environmental problems.
3.	To study the interrelationship between living organism and environment.
4.	To appreciate the importance of environment by assessing its impact on the human world envisions the surrounding environment, its functions and its value.
5.	To study the integrated themes and biodiversity, natural resources, pollution control and waste Management.

UNIT I	ECOSYSTEM AND BIODIVERSITY	9

Definition, Scope and importance of environment – Need for public awareness. Ecosystem Types and Energy flow- Ecological succession. Types of biodiversity: genetic, species and ecosystem diversity – values of biodiversity loss, poaching of wildlife, man - wildlife conflicts, India as a mega – diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II	ENVIRONMENTAL POLLUTION	9

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

UNIT III	RENEWABLE SOURCES OF ENERGY	9

Energy management and conservation, New Energy Sources: Need of new sources. Different typesnew energy sources. Applications of-Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal.

UNIT IV	ENVIRONMENTAL ISSUES	9

Social Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust - Population growth, variation among nations population explosion – family welfare programme – human rights – value education – HIV / AIDS – women and child welfare.

UNITV	SUSTAINABILITY PRACTICES	9

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Development, GDP, Sustainability- Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economic and technological change.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Demonstrate a comprehensive understanding of the world's biodiversity and the importance of its conservation.
CO2:	Discover knowledge in ecological perspective and value of environment
CO3:	Categorize different types of pollutions and their control measures.
CO4:	Understand the significance of various natural resources and its management.
CO5:	Analyse global environmental problems and come out with best possible solutions.
CO6:	Understand environmental laws and sustainable development.

TEXTBOOKS

1.	Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi,

	2016.
2.	Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
3.	Allen, D.T. and Shonnard, D.R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
4.	J. Manivel and A. Arunkumar, "Environmental Science & Engineering" R.K. Publishers, 1st Edition 2023
REFERENCE BOOKS:	
1.	R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, EnviroMedia. 38.
2.	Cunningham, W. P. Cooper, T. H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3.	Rajagopalan, R, 'Environmental Studies – From Crisisto Cure', OxfordUniversityPress,2005.
4.	Erach Bharuch "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt.Ltd.2013.

U23BTP51	IMMUNOLOGY LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To differentiate immune cells.
2.	To give laboratory training in different immunological techniques.
3.	To understand enzyme conjugations.
4.	To identify different types of blood cells.
5.	To learn about antigens in immunology.

LIST OF EXPERIMENTS

1.	Handling of animals, immunization and raising antisera.
2.	Identification of cells in a blood smear.
3.	Identification of blood group.
4.	Immuno diffusion.
5.	Immuno electrophoresis.
6.	Testing for typhoid antigens by Widal test.
7.	Enzyme Linked Immunosorbent Assay (ELISA).
8.	Isolation of peripheral blood mononuclear cells.
9.	Isolation of monocytes from blood.
10	Immuno fluorescence.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S NO	Name of the Equipment	Quantity
1	Centrifuge	2
2	Filtration unit	1
3	Homogenizer	2
4	Chromatography column	1
5	Ultrasonicator	1
6	Spray Drier	1

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Acquire knowledge on animal handling procedures.
CO2:	Perform diagnostics tests like identification of blood cells, ELISA and Electrophoresis
CO3:	Demonstrate ELISA for enzyme conjugations.
CO4:	Interpret different types of blood cells.
CO5:	Assess the Immunoassay to understand complement system and other diseased condtions.
CO6:	Interpret antigens in immunology.

References

1	Roitt I., Brostoff M., “Immunology”, Mosby Publication, 5th Edition, 2002.

U23BTP52	GENETIC ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To know about the DNA, transformation techniques and PCR.
2.	To learn about the isolation of plasmid DNA from bacterial cells.
3.	To understand the setting up of restriction digestion of DNA
4.	To understand the blotting techniques and SDS-PAGE
5.	To develop knowledge on PCR reaction conditions

LIST OF EXPERIMENTS

1.	Preparation of plasmid DNA.
2.	Elution of DNA from agarose gels.
3.	Ligation of DNA into expression vectors.
4.	Transformation.
5.	Optimization of inducer concentration for recombinant protein expression
6.	Optimization of time of inducer for recombinant protein expression.
7.	SDS-PAGE.
8.	Western blotting.
9.	Hybridization with anti-sera.
10	PCR.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S NO	Name of the Equipment	Quantity
1	Agarose gel electrophoresis	3
2	SDS –PAGE electrophoresis	2
3	Cooling Centrifuge	2
4	PCR Machine	1
5	Incubator	2
6	Autoclave	2
7	Laminar Air flow chamber	2
8	Western Blotting Apparatus	1
9	Spectrophotometer	1
10	Deep Freezer/Ice flake machine	1

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Understand basic techniques of DNA isolation and manipulation.
CO2:	Gain experience in selecting genetically transformed organisms for downstream analysis.
CO3:	Aware basic techniques involved in analysis of gene expression at nucleic acids and proteins level.
CO4:	Establish the ability to carry out laboratory experiments and interpret the results.
CO5:	Apply practical knowledge to solve biotechnological problems.
CO6:	Aware of the hazardous chemicals and safety precautions in case of emergency.

U23BTP53	INDUSTRIAL TRAINING/INTERNSHIP - I	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1	Get practical knowledge on production process in the industry and develop skills to solve related problems
2	Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within tendays from the commencement of next semester. The students will be evaluated as per the Regulations.

No. of. days: 10 working days

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1:	Analysis of industrial / research problems and their solutions
CO2:	To find solutions to the research problems
CO3:	Documenting of material specifications
CO4:	Documenting of machine and process parameters
CO5:	Documenting of testing parameters and results
CO6:	Preparing of Technical report and presentation

SEMESTER VI

U23BTT61	ESSENTIALS OF BIOINFORMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the functions of each gene and protein that is essential for creating knowledge database and its annotation**.**
2	To know about principles of computational methods for sequence analyse of the DNA RNA and protein
3	To understand the multiple sequence alignment, phylogenetic tree.
4	To learn the sequence search in database with BLAST and statistical evaluation.
5	To know about the computational drug design.

UNIT I	INTRODUCTION TO BIOINFORMATICS	9

Important contributions — aims and tasks of Bioinformatics — applications of Bioinformatics — challenges and opportunities – Biological databases- Classification of biological databases Primary and Secondary databases, Sequence and structure databases, Specialized databases retrieval system- Entrez- SRS.

UNIT II	COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS	9

Sequence alignment, pairwise alignment, Multiple sequence alignment its applications, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, Database similarity searching — FASTA and BLAST.

UNIT III	PHYLOGENETICS	9

Introduction to Phylogenetics, Molecular Evolution and Molecular Phylogenetics, Phylogenetic tree, Forms of Tree Representation, Rooted and un-rooted trees, Phylogenetic Tree Construction Methods: Distance based methods- NJ, UPGMA, Character based methods – Maximum Parsimony, Phylogenetic programs, Bootstrapping.

UNIT IV	PROTEIN STRUCTURE, MODELLING AND SIMULATIONS	9

Protein structure basics, Protein structural visualization and comparison, Secondary structure prediction- Chau-Fasman, GOR, Neural networks, Protein tertiary structure prediction Homology analysing, Threading and Fold recognition.

UNITV	ROLE OF BIOINFORMATICS IN DRUG DISCOVERY	9

Drug designing- objectives- Rational drug design- Computer assisted drug design and drug development- Molecular docking and its applications- QSAR, In Silico drug design- role of structural bioinformatics in drug design and development- Pharmacogenomics- prospects and uses.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Acquire the basic knowledge of biological databases.
CO2:	Familiarize the biological sequencing using various tools.
CO3:	Understands the concept of phylogenetic.
CO4:	Create and analyse the protein structures using analysing tools.
CO5:	Apply the knowledge of bioinformatics tools in drug discovery.
CO6:	Obtained their basic knowledge about structure of protein and simulation modelling.

TEXTBOOKS	
1.	David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
2	Ghosh, Zhumur, and Bibekanand Mallick. Bioinformatics: Principles and Applications. Oxford University Press, 2008.
REFERENCE BOOKS:	
1.	Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
2	T K Attwood, D J parry-Smith, Introduction to Bioinformatics, Pearson Education, 1st Edition, 11th Reprint 2005.
3	Stephen A. Krawetz, David D. Womble, Introduction to Bioinformatics A Theoretical and Practical Approach, Humana Press, 2003.
4	Marketa J. Zvelebil, Jeremy O. Baum. Understanding Bioinformatics. 2008

U23BTT62	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To study the historical development of bioprocess technology design and construction of fermenter and parameters to be monitored and controlled in fermentation process.
2	To study the kinetics and thermodynamics of enzymatic process.
3	To evaluate the kinetics and mechanism of microbial growth.
4	To understand the biological systems-based products.
5	To study about different stages of bioprocesses preparation, production and purification.

UNIT I	PRINCIPLES OF ENZYME CATALYSIS	9

Proteins as enzymes; Michaelis-Menten kinetics; Kinetics and Statistics; Inhibition; Effect of pH and temperature; Enzymology; Immobilized enzymes: methods, mass transfer considerations; Industrial enzymes

UNIT II	FERMENTATION PROCESS	9

General requirements, basic design and construction of fermenters and ancillaries; various commercial media for industrial fermentation; Sterilization of air, liquid media. Microbial biomass production — enzyme, Antibiotic and steroid fermentations, Aerobic and anaerobic fermentation processes; Solid state and submerged.

UNIT III	PROCESS DESIGN AND OPERATION OF BIOREACTORS	9

Introduction to bioreactors; Operational modes of zerors-Batch and Fed-batch bioreactors, Continuous bioreactors; Immobilized cells; Agitation and Aeration in Bioreactor; bioreactor strategies for maximizing.

UNIT IV	MASS TRANSFER OPERATIONS AND BIOREACTOR SCALE	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 Analyse transfer, power consumption and impeller tip speed.

UNITV	BIOSEPARATIONS	9

Biomass removal; Biomass disruption; Separation techniques; Filtration, Centrifugation, Extraction; Adsorption and Chromatography.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	Ability to investigate, analyse, and solve enzyme complex engineering problems.
CO2:	Design the fermentation process in industries.
CO3:	Create and Analyse various bioreactors.
CO4:	Perform the reactor analysis and the scale up process
CO5:	The multiple biological separations design and principles.
CO6:	The processes for manufacturing product.

TEXTBOOKS

1.	Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2005.
2	Pauline M. Doran, Bioprocess Engineering Principles, 2013

REFERENCE BOOKS:

1.	D.G. Rao, ‖ Introduction to Biochemical Engineering ‖ McGraw-Hill.2005.
2	Pauline M. Doran, Bioprocess Engineering Principles, 2013
3	Shijie Liu, Bioprocess Engineering: Kinetics, Sustainability, and reactor design. 2012

3	Stanbury, P.F. Whitaker, A& Hall, S. J, Principles of fermentation Technology, 2nd Ed, Elsevier Science Publishers, BV, Amsterdam.2005.
4	Kim Gail Clarke. Bioprocess Engineering an Introductory Engineering and Life Science Approach. 2013

U23BTT63	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

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

UNIT I	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.

UNIT II	IDEAL REACTORS	9

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

UNIT III	NON-IDEAL REACTORS	9

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

UNIT IV	GAS-SOLID, GAS-LIQUID REACTIONS	9

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

UNITV	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: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be enabled with knowledge and understanding of

CO1:	To design and conduct an experimental investigation in order to determine rate equations
CO2:	To demonstrate an ability to solve material and energy balances in order to analyze the performance of a reactor
CO3:	To demonstrate an experimental data using standard statistical methods to establish quantitative results.
CO4:	To design a reactor for biobased products to achieve production and yield specifications.
CO5:	To recognize and apply analogies among momentum, heat and mass transfer in various types of chemical reactions.
CO6:	To Appreciate relevance of principles in diverse applications of chemical, biological, engineering.

TEXTBOOKS

1.	Levenspiel O. Chemical Reaction Engineering. IIIrd Edition. John Wiley.2006
2	Fogler H.S. Elements Of Chemical Reaction Engineering. Prentice Hall India.2002

REFERENCE BOOKS:

1.	K.A.Gavhane Chemical Reaction Engineering I, Nirali Publications 23rd Edition,2016
2	K..A.Gavhane Chemical Reaction Engineering II, Nirali Publications 25rd Edition,2014
3	Dawande, S.D., “Principles of Reaction Engineering”, Ist Edition, Central Techno Publications, 2001.
4	Richardson, J.F. and Peacock, D.G., “Coulson Richardson - Chemical Engineering”, Vol.III, IIIrd Edition, Butterworth- Heinemann- Elsevier, 2006.

U23GET61	HUMAN VALUES AND ETHICS	L	T	P	C
		3	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Teach definition and classification of values.
2.	Explain Purusartha.
3.	Describe Sarvodaya idea.
4.	Summarize sustenance of life.
5.	Conclude views of hierarchy of values.

UNIT I	DEFINITION AND CLASSIFICATION OF VALUES	9

Extrinsic values- Universal and Situational values- Physical- Environmental-Sensuous- Economic Social-Aesthetic-Moral and Religious values.

UNIT II	CONCEPTS RELATED TO VALUES	9

Purusartha-Virtue- Right- duty- justice- Equality- Love and Good.

UNIT III	IDEOLOGY OF SARVODAYA	9

Egoism- Altruism and universalism- The Ideal of Sarvodaya and Vasudhaiva Kutumbakam.

UNIT IV	SUSTENANCE OF LIFE	9

The Problem of Sustenance of value in the process of Social, Political and Technological Changes.

UNITV	VIEWS ON HIERARCHY OF VALUES	9

The Problem of hierarchy of values and their choice, The views of Pt. Madan Mohan Malviya and Mahatma Gandhi.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Understand definition and classification of values.
CO2:	Understand purusartha.
CO3:	Understand Sarvodaya idea.
CO4:	Understand sustenance of life.
CO5:	Understand the hierarchy of values.
CO6:	Compare hierarchical views of Pt. Madan Mohan Malviya and Mahatma Gandhi.

TEXTBOOKS

1.	Awadhesh Pradhan: Mahamanake Vichara. (B.H.U., Vanarasi-2007)
2.	Little, William, An Introduction of Ethics (Allied Publisher, Indian Reprint 1955)
3.	William, K Frankina, Ethics (Prentice Hall of India, 1988)

U23BTP61	BIOINFORMATICS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES	
The main learning objective of this course is to prepare the students for:	
1.	Understand the basics of Perl programming
2	Develop skills to retrieve data from biological databases
3	Perform and analyse the results of sequence alignment
4	Analyse and evaluate the protein structure model created using modelling software and tool
5	Interpret phylogenetic relationships among different organisms using molecular phylogeny tools

LIST OF EXPERIMENTS	
1.	Introduction to UNIX basic commands and UNIX Filters.
2.	Perl programming and applications to Bioinformatics.
	• Basic scripting.
	• Regular expressions.
	• File i/o & control statement.
	• Subroutines & functions.
	• Writing scripts for automation.
3.	Types of Biological Databases and Using it
	• Gen bank.
	• Protein Data Bank.
	• Uniport.
4	Sequence Analysis Tools
	• Use of BLAST, FASTA (Nucleic Acids & Proteins).
	• Use of Crustal W.
	• Use of EMBOSS.
5	Phylogenetic Analysis
	• Use of Phyllip.
6	Molecular Modelling
	• Homology Modelling – Swiss modeler.
	• Any Open - Source Software

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS		
S.No	**Name of the Equipment**	**Quantity**
	Computer with free softwares	30

TOTAL: 60 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1:	Develop bioinformatics tools with programming skills
CO2:	Ability to apply computational based solutions for biological perspectives
CO3:	Practice lifelong learning of applied biological sciences using computers.
CO4:	Understand the basics of Perl programming
CO5:	Develop skills to retrieve data from biological databases
CO6:	Analyse and evaluate the protein structure model created using modelling software and tool.

U23BTP62	BIOPROCESS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Provide hands – on training on the operation of fermenters
2	Familiarize the students with microbial growth kinetics
3	Know mass / heat transfer in fermenters
4	Learn about the production of metabolites
5	Study the activity of enzymes and the kinetics of different enzymatic reactions

LIST OF EXPERIMENTS

1.	Growth of Bacteria – estimation of biomass, calculation of specific growth rate, yield coefficient
2.	Growth of Yeast – estimation of biomass, calculation of specific growth rate, yield coefficient
3	Medium optimization – i) Response surface methodology ii) Plackett Burman design
4	Enzyme kinetics – Estimation of Michelis- Menton parameters
5	Enzyme activity – Effect of Temperature
6	Enzyme activity – Effect of pH
7	Enzyme immobilization
8	Estimation of overall heat transfer coefficient
9	Estimation of Kla – power correlation / sulfite oxidation / dynamic gassing method
10	Production of amylase enzyme
11	Production of bioethanol.
12	Micro algal Cultivation, estimation and product development.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S no	Name of the Equipment	Quantity
1	Autoclave	2
2	Shaking Incubator	2
3	Laminar air flow hood	2
4	pH Meter	2
5	Spectrophotometer	2
6	Fermenter	1
7	Magnetic stirrer	1
8	vortex mixer	4
9	Cooling Centrifuge	2

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	To interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.
CO2:	Apply the knowledge on microbial growth kinetics
CO3:	Develop knowledge on factors affecting enzyme activity.
CO4:	Know mass / heat transfer in fermenters

CO5:	Learn about the production of metabolites
CO6:	Study the activity of enzymes and the kinetics of different enzymatic reactions

SEMESTER VII

U23BTT71	DOWNSTREAM PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the basic fundamentals of downstream processing for biochemical product recovery.
2	To understand the basic principle of characterization of biomolecules and various cell disruption process.
3	To Understand the techniques involved in downstream processing
4	To learn about product making by the bioprocess
5	Understand the downstream processes required in multi-factorial manufacturing environment in a structured and logical fashion

UNIT I	INTRODUCTION TO DOWNSTREAM PROCESSING	9

Scope and overview — upstream and downstream processing in biotechnology, various biotechnology products and their biological properties, fundamentals of bio separation. Separation process design criteria - Characteristics of biological mixtures, Morphological features of the cell, Concentration of product of interest and impurities, physical and rheological characteristics.

UNIT II	DOWNSTREAM PROCESSING METHODS	9

Cell disruption Techniques, types of cells, location of products inside the cells and products, cell disruption Methods, Mechanical and Non mechanical methods- Filtration, types of filtrations equipment, filter media and filter aids, basic theory of filtration, principle of rotary drum filter centrifugation - principle of sedimentation, types of centrifuges, flocculation and sedimentation. Economics of downstream processing in Biotechnology, cost-cutting strategies, characteristics of biological mixtures.

UNIT III	PRODUCT IDENTIFICATION TECHNIQUES	9

Characterization of product- Electrophoresis, Principle and methods - Analysis of product purity Chromatography, Enzyme Linked Immunosorbent Assay (ELISA), Ion exchange chromatography, Reverse phase chromatography, Affinity Ligand Technology HPLC Radial Flow Chromatography

UNIT IV	PRODUCT SEPARATION TECHNIQUES	9

Distillation - Principle and types, Extractive distillation, Steam Distillation, Vacuum Distillation Extraction - Solvent extraction principles, Extraction methods, modes of aqueous two-phase extraction, Super critical fluid extraction — Adsorption, principle, Isotherms, different types of adsorptions - Evaporation, principle, factors influencing rate of evaporation, types of evaporators. Cell disruption methods for intracellular products- Cell disruption by homogenizer-mechanism, process design considerations, scale up.

UNITV	PRODUCT PURIFICATION AND RESOLUTION	9

Precipitation methods (with salt, organic solvents, and polymers, extractive separations, aqueous two-phase extraction)- Membrane based separation process, Types of membranes, Membrane process, theory and types of membrane-Application of ultrafiltration — Application of microfiltration — Crystallization, theory of crystallization- Freeze drying- Principle, process and application of freeze-drying integrated bio-processing- product polishing stages

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course the students will be enabled with knowledge and understanding of	
CO1:	Familiar with basic downstream process and their principles.
CO2:	Create and analyse filtration process in industry.
CO3:	Identify various biological products using new technological advancements.
CO4:	Perform the Bio separation techniques with standard methods.
CO5:	Apply their fundamental bio separation knowledge to purify the biological products
CO6:	Understanding the economic importance of the downstream processing
TEXTBOOKS	
1.	Nooralabettu Krishna Prasad, Downstream Process Technology, A New Horizon in Biotechnology, PHI Pvt Ltd,2nd Edition, 2012.
2	Pauline M. Doran, "Bioprocess Engineering Principles, 2nd Edition, Academic Press. 2012.
REFERENCE BOOKS:	
1.	Hatti-Kaul, Rajni, and Bo Mattiasson. "Downstream processing in biotechnology." Basic biotechnology. Cambridge University Press, Cambridge ,2001.
2	Belter, Paul A., Edward Lansing Cussler, and W. Hu. "Bio separations: downstream processing for biotechnology" 1987.
3	Asenjo J.M. Separation processes in Biotechnology, 1993.
4	Venko N. Beschkov, Dragomir Yankov. Downstream Processing in Biotechnology, 2021

U23BTP71	DOWNSTREAM PROCESSING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

Basic knowledge in Bioprocess engineering:

1.	To practice the students to understand the nature of the end product, its concentration, stability and degree of purification required.
2	To design processes for the recovery and subsequent purification of target biological products.

LIST OF EXPERIMENTS

1.	Solid liquid separation – centrifugation, microfiltration
2.	Cell disruption techniques – homogenizer
3	Precipitation – ammonium sulphite precipitation
4	Ultrafiltration separation
5	Aqueous two-phase extraction of biologicals
6	High resolution purification – ion exchange chromatography
7	Product polishing – Gel filtration chromatography
8	Product polishing – spray drying, freeze drying
9	Cell disruption using organic solvent
10	Solid-liquid extraction.
11	Cell disruption technique - ultrasonication

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S no	Name of the Equipment	Quantity
1	Centrifuge	2
2	Filtration unit	1
3	Homogenizer	2
4	Chromatography column	1
5	Ultrasonicator	1
6	Spray drier	1

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would 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, bio safety, 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

U23BTP72	MINI-PROJECT	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

1	To develop their own innovative prototype of ideas.
2	To train the students in preparing mini project reports and examination.

The students in a group of 4 or 5 to do their works on a topic approved by the head of the department and prepares a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The m project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1:	Prepare their final year project work and find solution by formulating proper methodology.
CO2:	Inculcate innovative thinking and thereby preparing students for main project.
CO3:	Learn to make decisions on how to work independently to research and develop their project
CO4:	Find new ideas on various Food processing methods
CO5:	Involve in developing new food products, improving the safety and quality of existing products, or reducing food waste.
CO6:	Able to communicate clearly and consicely the ideas and findings

U23BTP73	INDUSTRIAL TRAINING/INTERNSHIP - II	L	T	P	C
		0	0	0	1

COURSE OBJECTIVES:

1	Get practical knowledge on production process in the industry and develop skills to solve related problems
2	Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within tendays from the commencement of next semester. The students will be evaluated as per the Regulations.

No. of. days: 14 working days

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1:	Analysis of industrial / research problems and their solutions
CO2:	To find solutions to the research problems
CO3:	Documenting of material specifications
CO4:	Documenting of machine and process parameters
CO5:	Documenting of testing parameters and results
CO6:	Preparing of Technical report and presentation

SEMESTER - VIII

U23BTP81	PROJECT WORK	L	T	P	C
		0	0	20	10

COURSE OBJECTIVES:

1.	To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.

To train the students in preparing project report and to face reviews and viva voice examination. The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the head of the department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department

TOTAL: 300 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1:	Take up any challenging practical problems and find solution by formulating proper methodology
CO2:	Design and fabricate food processing equipments
CO3:	Formulate and develop value added food products
CO4:	Apply scientific research tools for design and optimization of food processing operations.
CO5:	Work independently in different areas of food processing
CO6:	To gain knowledge on different aspects related to food processing operations

ELECTIVE – MANAGEMENT COURSES

U23GET71	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Sketch the Evolution of Management.
2.	Extract the functions and principles of management.
3.	Learn the application of the principles in an organization.
4.	Study the various HR related activities.
5.	Analyse the position of self and company goals towards business.

UNIT I	INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	9

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management

UNIT II	PLANNING	9

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT III	ORGANISING	9

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNIT IV	DIRECTING	9

Foundations of individual and group behavior– Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

UNITV	CONTROLLING	9

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.
CO2:	Have same basic knowledge on international aspect of management.
CO3:	Ability to understand management concept of organizing.
CO4:	Ability to understand management concept of directing.
CO5:	Ability to understand management concept of controlling
CO6:	Understand the application of the principles in an organization.

TEXTBOOKS	
1.	Harold Koontz and Heinz Weinrich “Essentials of management” Tata McGraw Hill,1998.
2.	Stephen P. Robbins and Mary Coulter, “Management”, Prentice Hall (India)Pvt. Ltd., 10th
REFERENCE BOOKS:	
1.	Robert Kreitner and Mamata Mohapatra, “Management”, Biztantra, 2008.
2.	Stephen A. Robbins and David A. Decenzo and Mary Coulter, “Fundamentals of
3.	Management” Pearson Education, 7th Edition, 2011.
4.	Tripathy PC and Reddy PN, “Principles of Management”, Tata McGraw Hill, 1999.

U23GET72	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	The need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
2.	Learn the TQM Principles for application.
3.	Define the basics of Six Sigma and apply Traditional tools, new tools, Benchmarking and FMEA.
4.	Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
5.	Illustrate and apply QMS and EMS in any organization.

UNIT I	INTRODUCTION	9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II	TQM PRINCIPLES	9

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III	TQM TOOLS & TECHNIQUES I	9

The seven traditional tools of quality - new management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent, Documentation, Stages: Design FMEA and Process FMEA.

UNIT IV	TQM TOOLS & TECHNIQUES II	9

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

UNITV	QUALITY MANAGEMENT SYSTEM	9

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation-Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Ability to apply TQM concepts in a selected enterprise.
CO2:	Ability to apply TQM principles in a selected enterprise.
CO3:	Ability to understand Six Sigma and apply Traditional tools, new tools, Benchmarking and FMEA.
CO4:	Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
CO5:	Ability to apply QMS and EMS in any organization.
CO6:	Understand the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.

TEXTBOOKS	
1.	Dale H. Besterfiled, Carol B. Michna, Glen H. Bester field, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.
REFERENCE BOOKS:	
1.	Joel. E. Ross, "Total Quality Management – Text and Cases", Routledge., 2017.
2.	Kiran. D. R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3.	Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4.	Suganthi L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006

U23GET73	ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Understanding the concept of Engineering Economics.
2.	Implement various micro economics concept in real life.
3.	Gaining knowledge in the field of macro-economics to enable the students to have better understanding.
4.	Understanding of various components of macro-economics.
5.	Understanding the different procedures of pricing.

UNIT I	DEMAND & SUPPLY ANALYSIS	9

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis. Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function -Supply elasticity.

UNIT II	PRODUCTION AND COST ANALYSIS	9

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function. Cost Concepts - Cost function - Determinants of cost - short run and long run cost curves - Cost Output Decision - Estimation of Cost.

UNIT III	PRICING	9

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

UNIT IV	FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT)	9

Balance sheet and related concepts - Profit & Loss Statement and related concepts – Financial Ratio Analysis - Cash flow analysis - Funds flow analysis – Comparative financial statements - Analysis & Interpretation of financial statements.

UNITV	CAPITAL BUDGETING (ELEMENTARY TREATMENT)	9

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions
CO2:	Evaluate the economic theories, cost concepts and pricing policies
CO3:	Understand the market structures and integration concepts
CO4:	Understand the measures of national income, the functions of banks and concepts of globalization
CO5:	Apply the concepts of financial management for project appraisal
CO6:	Understand the various cost related concepts in micro economics.

TEXTBOOKS

1.	Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi,2001.
2.	Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.

REFERENCE BOOKS:	
1.	Chan S. Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2011.
2.	Donald. G. Newman, Jerome. P. Lavelle, “Engineering Economics and analysis” Engg. Press, Texas, 2010
3.	Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, Macmillan, New York, 2011.
4.	Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
5.	Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009

U23GET74	HUMAN RESOURCE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To provide knowledge about management issues related to staffing,
2.	To provide knowledge about management issues related to training
3.	To provide knowledge about management issues related to performance
4.	To provide knowledge about management issues related to compensation
5.	To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

UNIT I	INTRODUCTION TO HUMAN RESOURCE MANAGEMENT	9

The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.

UNIT II	HUMAN RESOURCE PLANNING	9

Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization.

UNIT III	TRAINING AND EXECUTIVE DEVELOPMENT	9

Types of training and Executive development methods – purpose – benefits

UNIT IV	EMPLOYEE COMPENSATION	9

Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.

UNITV	PERFORMANCE EVALUATION AND CONTROL	9

Performance evaluation – Feedback - The control process – Importance – Methods – grievances – Causes – Redressal methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Gain knowledge on the various aspects of HRM
CO2:	Gain knowledge needed for success as a human resource professional
CO3:	Develop the skills needed for a successful HR manager
CO4:	Prepare to implement the concepts learned in the workplace
CO5:	Aware of the emerging concepts in the field of HRM
CO6:	Gain knowledge on management issues related to human factors consideration and compliance with human resource requirements.

TEXTBOOKS

1.	Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007.
2.	John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, New Delhi.

REFERENCE BOOKS:

1.	Luis R., Gomez-Mejia, David B. Balkin and Robert L. Cardy, “Managing Human Resources", 7th Edition, PHI, 2012.
2.	Dessler, "Human Resource Management", Pearson Education Limited, 2007.

U23GET75	KNOWLEDGE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Learn the Evolution of Knowledge management.
2.	Be familiar with tools.
3.	Be exposed to Applications.
4.	Gain knowledge on the concepts of some case studies.
5.	Gain knowledge on management Applications.

UNIT I	INTRODUCTION	9

Introduction: An Introduction to Knowledge Management -The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

UNIT II	CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING	9

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

UNIT III	KNOWLEDGE MANAGEMENT-THE TOOLS	9

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

UNIT IV	KNOWLEDGE MANAGEMENT APPLICATION	9

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

UNIT V	FUTURE TRENDS AND CASE STUDIES	9

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan – A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Understand the process of acquiring knowledge from experts.
CO2:	Understand the learning organization.
CO3:	Use the knowledge management tools.
CO4:	Develop knowledge management Applications.
CO5:	Design and develop enterprise applications.
CO6:	Understand the Evolution of Knowledge management.

TEXTBOOKS

1.	Srikantaiah, T.K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.

REFERENCE BOOKS:	
1.	1. Nonaka, I., Takeuchi, H., “The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation”, Oxford University Press, 1995.

U23GET76	INDUSTRIAL MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
2.	To study the planning; organizing and staffing functions of management in professional organization.
3.	To study the leading; controlling and decision-making functions of management in professional organization.
4.	To learn the organizational theory in professional organization.
5.	To learn the principles of productivity and modern concepts in management in professional organization.

UNIT I	INTRODUCTION TO MANAGEMENT	9

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

UNIT II	FUNCTIONS OF MANAGEMENT – I	9

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

UNIT III	FUNCTIONS OF MANAGEMENT – II	9

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

UNIT IV	ORGANIZATION THEORY	9

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

UNIT V	PRODUCTIVITY AND MODERN TOPICS	9

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Explain basic concepts of management; approaches to management; contributors to management studies;
CO2:	Discuss the planning; organizing and staffing functions of management in professional organization.

CO3:	Apply the leading; controlling and decision-making functions of management in professional organization.
CO4:	Discuss the organizational theory in professional organization.
CO5:	Apply principles of productivity and modern concepts in management in professional organization.
CO6:	Develop various forms of business organization and trade unions function in professional organizations.

TEXTBOOKS	
1.	M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
2.	Koontz. H. and Weinrich. H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGraw hill, New Delhi, 2010.
REFERENCE BOOKS:	
1.	Joseph J, Massie, "Essentials of Management", 4th Edition, Pearson Education, 1987.
2.	Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.
3.	S. Chandran, "Organizational Behaviors", Vikas Publishing House Pvt. Ltd., 1994.
4.	Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11th Edition, 2012.
5.	S. Trevis Certo, "Modern Management Concepts and Skills", Pearson Education, 2018.

PROFESSIONAL ELECTIVE VERTICAL I- BIOPROCESS AND BIOCHEMICAL

U23BTV11	BIOPROCESS CONTROL AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

Course Objective

The main learning objective of this course is to prepare the students for:

1	Learn about establish reproducible and robust manufacturing processes for the production of therapeutic cells
2	Understanding the biosensors for the field of microbial technology

UNIT I	BIOCHEMICAL PROCESS VARIABLES AND THEIR MEASUREMENTS	9

Temperature, flow measurement and control, Pressure measurement and control, shaft power, rate of stirring, detection and prevention of foam, measurement of cells, measurement and control of dissolved oxygen, inlet and outlet gas analysis, pH measurement and control

UNIT II	OPEN LOOP SYSTEMS	9

Laplace transformation, application to solve ODEs. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

UNIT III	CLOSED LOOP SYSTEMS	9

Closed loop control systems, development of block diagram for feed-back control systems servo and regulatory problems, transfer function for controllers and final control element

UNIT IV	FREQUENCY RESPONSE	9

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, bode diagram, stability criterion, tuning of controller settings.

UNIT V	ADVANCED PROCESS CONTROL AND BIOSENSORS	9

Introduction to advanced control systems, cascade control, feed forward control On-line analysis of process parameters; Introduction to biosensors; Transduction principles used in biosensors; Characteristics of biosensors; Biosensors based on amperometry, potentiometric, thermistor FET, fiber optics and bioluminescence; Microbial biosensors; Fundamentals of digital process control; Use of computer in control and optimization of microbiological processes. Artificial neural networking and use in prediction of bioprocess and control.

TOTAL: 45 PERIODS

Course Outcome

At the end of the course the students would be able to

CO1:	Obtained their basic knowledge of formulation and processes of biological based value-added products
CO2:	Understand the need of controlling bioprocesses for the optimal utilization of chemical and biological materials

TEXTBOOKS

1.	Stephanopoulos, G., “Chemical Process Control”, Prentice Hall of India, 2003.
2	Coughnow D., “Process Systems Analysis and Control”, 3rd ed., McGraw Hill, 2008.
3.	Sensors in Bioprocess Control (Biotechnology and Bioprocessing Series) by John Twork, 2020

REFERENCE BOOKS:

1.	Process Control Instrumentation Technology (8th Edition) by Curtis Johnson, 2008
2	Marlin, T. E., “Process Control”, II Edition, McGraw Hill, New York, 2000.
3	Smith, C. A. and Corripio, A. B., “Principles and Practice of Automatic Process Control”, II Edition., John Wiley, New York, 1997

U23BTV12	BIOPROCESS MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To understand the mathematical models in Biochemical Engineering systems.
2	To learn about different aspects of modelling in Bioprocess system.
3	To learn various techniques to solve and simulate various bioprocess models
4	To understand the basic knowledge of computational based bioprocessing
5	To apply MATLAB and SIMULINK in simulation of bioprocess

UNITI	BASIC MODELLINGPRINCIPLES	9

Introduction, definition of Modelling and simulation, different types of models, application of mathematical modelling. Fundamental laws: continuity equation, energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics with examples.

UNITII	MATHEMATICALMODELSFORBIOREACTORSYSTEMS	9

Batch reactor, CSTR isothermal with cooling / heating jacket or coil, Fed Batch reactor.

UNITIII	MODELLINGAPPROACHESFORBIOLOGICALSYSTEMS	9

Growth kinetic Models – structured and unstructured systems; Compartment models; Cybernetic models; Genetically structured models, Single cell models, morphologically structured models. Thermal death kinetics models, Stochastic Model for thermal sterilization of medium.

UNITIV	MODELLINGAPPROACHES FORBIOLOGICALPROCESSESS	9

Modelling for activated sludge process, Model for anaerobic digestion, Model for lactic acid fermentation, antibiotic production, and ethanol fermentation.

UNITV	SIMULATION OF BIOPROCESSES	9

Software packages for simulation of bioprocesses – MATLAB-SIMULINK, Creating bioprocess models in MATLAB and Simulink environment. Linear and non-linear estimation of the kinetic parameters for types and models.

TOTAL 45 PERIODS

COURSE OUTCOMES

Upon completion of this course the student will be able to

CO1:	To understand the basic modelling principles in Biochemical Engineering systems.
CO2:	Apply the knowledge of modelling concepts for bioreactor design.
CO3:	To formulate model for biological System.
CO4:	To utilize modelling approaches for various bioprocess estimation.
CO5:	To build kinetic simulation models of the cell growth and product formation.
CO6:	To connect different models together to build a bioprocess model

TEXTBOOKS

1	Luyben W.L., “Process Modelling, Simulation and control for Chemical Engineers”, McGrawHill,2ndEdition,2013.
2	Bailey J.A and Ollis D.F., “Biochemical Engineering Fundamentals”, McGraw Hill (New York),2nd Edition,2010.

REFERENCES:

1	Perry R H, “Perry's Chemical Engineers' Handbook”, McGraw-Hill, 8th Edition, 2008
2	Jonathan B. Snape, Irving J. Dunn, John Ingham, Dynamics of Environmental Bioprocesses: Modelling and Simulation, 2008
3	Elmar Heinzle, Arno P. Biwer, Charles L. Cooney, Development of Sustainable Bioprocesses: Modeling and Assessment, 2007
4	Maria Carmo Nicoletti, Computational Intelligence Techniques for Bioprocess Modelling, Supervision and Control, 2009

U23BTV13	BIOREACTOR DESIGN AND SCALE UP PROCESS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the cell growth and development in controlled environment
2.	To learn the establish of the fermentation process from small scale fermenter
3.	To learn the different kind of bioreactors involved in the biomass production
4.	To understand the parameters for ideal bioreactor
5.	To gain knowledge on operations of different bioreactors

UNIT I	BASIC BIOREACTOR CONCEPTS	9

Bioreactor Operation – Batch operation, semi-continuous and fed-batch operation, Continuous Operation – Chemostat, turbidostatic – Microbiological reactors, enzyme reactors – Tank-type, Column-type biological reactors – Case studies – Continuous Fermentation with Biomass Recycle, Tanks-in-series, Tubular plug flow bioreactors.

UNIT II	AERATION AND AGITATION IN BIOPROCESS SYSTEMS	9

Mass transfer in agitated tanks; Power requirement for mixing; Agitation rate studies – Mixing time and residence time distribution; Bioreactor Geometry – Reactor, impeller, sparger and baffle design; shear damage, bubble damage, methods of minimizing cell damage. Case Studies for Aeration and Agitation.

UNIT III	SELECTION AND DESIGN OF BIOPROCESS EQUIPMENT	9

Materials of construction for bioprocess plants – Design considerations for maintaining sterility of process streams processing equipment, selection, specification – Design of heat and mass transfer equipment used in bioprocess industries.

UNIT IV	BIOREACTOR SCALE-UP AND SCALE-DOWN	9

Scale-up Techniques: – Scale up by geometric similitude. Constant power consumption per volume, constant mixing time, constant impeller tip speed, constant volumetric mass transfer co- efficient; Scale–down Related Aspects; Case Studies in Bioreactor Scaleup and Scale-down Aspects

UNIT V	CASE STUDIES	9

Requirements, design and operation of bioreactor for microbial, plant cell and animal cell.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course the student will be able to

CO1:	Understanding the economic importance of large-scale investment in the full-scale manufacturing
CO2:	Design of bioreactors to engineer autologous cell, patient and disuse graft based
CO3:	Understanding the advantages of mass production to learn the marketing of organizations
CO4:	Understanding the different parameters of bioreactor such as temperature, pH, oxygen concentration etc.,
CO5:	Understand the designing, working principle, types of the bioreactor
CO6:	Understanding the industrial purpose of bioreactor

TEXTBOOKS

1.	Michael L, Shuler, Fikret Kargi, Matthew DeLisa, Bioprocess Engineering, 3rd Edition, Prentice Hal, 2017
2	Pauline Doran, Bioprocess Engineering Calculation, 2nd Edition, Blackwell Scientific Publications,2012
3	James M. Lee, Biochemical Engineering, Prentice Hall, 1992

REFERENCE BOOKS:	
1.	Carl-Fredrik Mandenius, Bioreactors: Design, Operation and Novel Applications, 2016
2	S. Liu, Bioprocess Engineering: Kinetics, Biosystems, Sustainability, and Reactor Design, Elsevier, 2016
3	Octave Levenspiel, Chemical Reaction Engineering, Wiley 2016.
4	Aydin Berenjian, Essentials in Fermentation Technology, 2019-

U23BTV14	TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To understand the molecular motion of the transport mechanism
2	To understand the mechanism behind the momentum transport
3	To learn the different types of transfer phenomena
4	To understand the determination of molecular movement
5	To learn about flow systems using transport phenomena

UNIT I	TRANSPORT PHENOMENA BY MOLECULAR MOTION	9

Vectors/Tensors, Newton's law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick's law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.

UNIT II	MOMENTUM TRANSPORT	9

Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems.

UNIT III	HEAT TRANSPORT	9

Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations of change (non-isothermal), equation of motion for forced and free convection, equation of energy (non-isothermal).

UNIT IV	MASS TRANSPORT	9

Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalyst and the effectiveness factor, equation of continuity for binary mixtures, equation of change to set up diffusion problems for simultaneous heat and mass transfer.

UNIT V	TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW	9

Turbulence phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface. Introduction to macroscopic balances for isothermal flow systems, non-isothermal systems and multi component systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Employ shell balance equations to obtain desired profiles for velocity, temperature and concentration.
CO2:	Reduce and solve the appropriate equations of change to obtain desired profiles for velocity, temperature and concentration.
CO3:	Reduce and solve appropriate macroscopic balances for conservation of momentum, energy and mass.
CO4:	Utilize information obtained from solutions of the balance equations to obtain engineering quantities of interest.

CO5:	Recognize and apply analogies among momentum, heat and mass transfer.
CO6:	Appreciate relevance of transport principles in diverse applications of chemical, biological and materials science and engineering.
TEXTBOOKS	
1.	R. B. Bird, W.E. Stewart, E.W. Lightfoot, Transport Phenomena, Revised 2nd Edition, JohnWiley,2021
2	Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena A Unified Approach", Brod key Publishing 2003.
REFERENCE BOOKS:	
1.	C.J. Geankoplis, Transport Processes and Separation Process Principles, Pearson publishers., 4th Edition.
2	C.O. Bennett, J.O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition McGraw Hill,1983.
3	R. Welty, R. W. Wilson, and C. W. Wicks, Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer",5th Edition, John Wiley, New York, 2007.
4	George A. Truskey, Fan Yuan, David F. Katz. Transport Phenomena in Biological Systems, 2009

U23BTV15	BIOENERGY AND BIOFUELS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To learn how to reuse of carbon from biomass and waste streams
2	To know about modern bioenergy
3	To know the economics important of the waste management
4	To learn engineered macromolecules used as the source of ethanol production
5	To gain knowledge on environmental impacts of biofuels

UNIT I	INTRODUCTION	9

Cellulosic Biomass availability and its contents. Lignocellulose as a chemical resource. Physical and chemical pretreatment of lignocellulosic biomass. Cellulases and lignin degrading enzymes.

UNIT II	ETHANOL	9

Ethanol as transportation fuel and additive; bioethanol production from carbohydrates; engineering strains for ethanol production from variety of carbon sources to improved productivity.

UNIT III	BIODIESEL	9

Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissions Expanding biodiesel production.

UNIT IV	OTHER BIOFUELS	9

Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts- Bio butanol, Bio propanol, bio glycerol – Principles, materials and feedstocks-Process technologies and techniques-Advantages and Limitations

UNIT V	APPLICATIONS OF BIOFUELS	9

Life cycle environmental impacts of biofuels and co products – Environmental sustainability of biofuels – Energy security and supply, Economic sustainability of biofuels.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Determine the important properties of biomass.
CO2:	Produce solutions to real world problems related to bioenergy.
CO3:	Analyse bioenergy systems and their potential in future energy supply.
CO4:	Use of biomass an inexpensive feed stock as sustain able and renewable energy.
CO5:	Replace fossil-based products with biodiesel.
CO6:	Source other alternate energy such as biohydrogen and bio refinery.

TEXTBOOKS

1.	Gupta .V.K. and TUOHY.M. g. Biofuel Technologies, Springer,2013.
2	Luque, R., Campelo, J. and Clark, J. Handbook of biofuels production, Wood head Publishing Limited 2011.
3	Moheimani, N.R., Boer, M, P, M, K, Parisa A. And Bahri, Biofuel and Biorefinery Technologies, Volume 2, Springer, 2015.

REFERENCE BOOKS:

1.	Lee, Sunggyu; Shah, Y.T. “Biofuels and Bioenergy”. CRC/Taylor & Francis, 2013.
2	Eckert, C, A. and Trinh, C, Biotechnology for Biofuel Production and Optimization, Elsevier, 2016.
3	Bernardes, M, A, D, S. Biofuelproduction–recent developments and prospects, InTech, 2011.

4	Baskar Gurunathan, Renganathan Sahadevan, Zainul Akmar Zakaria, Biofuels and Bioenergy: Opportunities and Challenges, 2021

PROFESSIONAL ELECTIVE VERTICAL II: MEDICAL BIOTECHNOLOGY

U23BTV21	STEM CELL TECHNOLOGY AND TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To know about stem cell properties types isolation and culturing
2	To learn the stem cells, function and importance of stem cells
3	To understand the factors, influence of stem cells and mechanism of stem cell differentiation
4	To learn the mesenchymal stem cells and their importance in tissue engineering
5	To learn the fundamentals of tissue engineering and tissue repairing.
6	To acquire knowledge on clinical applications of tissue engineering

UNIT I	INTRODUCTION TO STEM CELLS	9

Stem cell Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. – Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties

UNIT II	HUMAN EMBRYONIC AND ADULT STEM CELL	9

Stem cells and their developmental potential. In vitro fertilization-culturing of embryos - blastocyst-inner cell mass-isolation and growing ES cells in lab; Identification and characterization of human ES cells. Somatic stem cells-test for identification of adult stem cells- adult stem cell differentiation-trans differentiation-plasticity-different types of adult stem cells-liver stem cells-skeletal muscle stem cells-bone marrow derived stem cells.

UNIT III	DIFFERENTIATION OF STEM CELLS INTO CELL TYPES	9

Factors influencing cell specialization – internal factors – asymmetric segregation, cell signaling mechanisms – diffusion, direct contact and gap junctions; environmental factors – temperature, drugs and injuries; mechanism of stem cell differentiation – errors in cell differentiation – anaplasia, dysplasia and metaplasia.

UNIT IV	INTRODUCTION TO TISSUSE ENGINEERING	

Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular component, ECM component, mechanical measurements and physical properties.

UNIT V	CLINICAL APPLICATIONS	9

Stem cell therapy, Molecular therapy, In vitro organogenesis, neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, 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: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	To differentiate different types of stem cells and to characterize them
CO2:	To gain knowledge on animal and plant stem cells
CO3:	To develop techniques to program stem cells into specific cell types
CO4:	To determine the factors affecting stem cell differentiation
CO5:	Opportunity to get familiarized with the Stem Cell characteristics and their relevance in tissue engineering

CO6:	Medicine Awareness about the properties and broad applications of biomaterials.
TEXTBOOKS	
1.	Stem cells by C.S Potten., Elsevier, 2006.
2	Essentials of Stem Cell Biology by Robert Lanza., fourth edition. Elsevier 2014.
REFERENCE BOOKS:	
1.	Stem cell biology and Gene Therapy by Peter Quesenberry., First Edition, Wiley-Liss,1998.
2	Embryonic Stem cells — Protocols by Kursad Turksen., Second Edition Humana Press, 2002.
3	Stem Cells: From Bench to Bed side by Ariff Bongso, Eng Hin Lee., World Scientific Publishing Company, 2005.
4	Stem cells in clinic and Research by Ali Gholamrezanezhad., Intech, 2013

U23BTV22	MODERN BIOANALYTICAL TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To study the various analytical techniques used in Biotechnology.
2	To learn the instrumentations involved in the field of biotechnology
3	To understand the principles and functions of instrumentations
4	To understand the medical important of the instrumentations
5	To gain knowledge on analysis the isolated DNA using electrophoretic techniques

UNIT I	SPECTROSCOPY STUDY OF CHEMICAL COMPOUNDS AND BIO-MOLECULES	9

Electromagnetic radiations and interactions with matters: Electromagnetic spectrum. Quantization of energy, Electronic, vibrational and rotational spectroscopy. Franck–Condon principle, Jablonski diagram, radiative, nonradiative pathways, fluorescence and phosphorescence. Absorption of radiation, Beer Lambert's law, deviation of Beer-Lambert's equation and its limitations. Principals, instrumentation, sampling and application of few spectroscopic techniques: UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy.

UNIT II	DIFFRACTION TECHNIQUE	9

Introduction to lattice and lattice systems, Bragg's plane, miller indices, point groups and space groups Principle of diffraction and X-ray diffraction: X-rays production, X- ray spectra, Bragg's law and intensity of X- rays, Mosley's law, powdered XRD, percentage crystallinity, single crystal XRD, macromolecular XRD (protein crystallization, data collection and structure solution).

UNIT III	CHROMATOGRAPHY	9

Classification of chromatographic techniques and their principles, Theory of chromatography, band broadening, rate and plate theory factors responsible for separation. Column chromatography, TLC, Paper chromatography. Liquid Chromatography and HPLC: Instrumentation, pumps, solvent delivery system, isocratic and gradient programming modes, sample introduction system, columns, detectors, reversed phase and normal phase chromatography. Gas Chromatography: Instrumentation, carrier gas supply, injectors, columns, packed and capillary columns, column oven and temperature programming, different detectors. Introduction to hyphenated techniques in chromatography, GC-MS and LC-MS.

UNIT IV	MICROSCOPY	

Microscopy with light and electrons – Electrons and their interaction with the specimen – Electron, diffraction – Instrument, specimen preparation and application of TEM and SEM – Fluorescence microscopy – Laser confocal microscopy – Phase contrast – Video microscopy – Scanning probe microscopy.

UNIT V	ELECTROPHORETIC TECHNIQUES	9

Principle, equipment and process, Agarose gel electrophoresis, horizontal and vertical gel electrophoresis, electrophoresis techniques, Isoelectric focusing, capillary electrophoresis and application of electrophoresis in analyzing macromolecules.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Basic knowledge about the laboratory techniques.
CO2:	They would be able to compare different separation techniques and use them effectively in research work
CO3:	Obtain their knowledge based on the handling and proficiency of instrumentations
CO4:	Obtained their knowledge to enable the screening, extraction and purifications of natural and synthetic chemicals

CO5:	Understand the screening and isolation of microbes and biomaterials characterization
CO6:	Obtained their knowledge to enable the DNA isolation and quantification
TEXTBOOKS	
1.	D. Campbell, Biological spectroscopy (Benjamin / Cummings Pub. Co, Menlo Park, Calif, 1984), Biophysical techniques series.
2	R. F. Boyer, Biochemistry laboratory: modern theory and techniques (Prentice Hall, Boston,2nded.,2012).
3	R. Katoch, Analytical techniques in biochemistry and molecular biology (Springer, New York,2011).
4	D. L. Spector, R. D. Goldman, Eds., Basic methods in microscopy: protocols and concepts from cells: a laboratory manual (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y,2006).
5	R.L. Switzer, Experimental biochemistry (W. H. Freeman and Co, New York,3rded.,1999).
6	Chandler, D. and Roberson, R. W., "Bioimaging: Current Techniques in Light & Electron Microscopy", Jones and Bartlett publishers, 2008.
7	K. Wilson, J. M. Walker, Eds., Principles and techniques of biochemistry and molecular biology (Cambridge University Press, Cambridge, UK: New York,7thed., 2009)
REFERENCE BOOKS:	
1.	R. F. Boyer, Modern experimental biochemistry (Benjamin Cummings, San Francisco, 3rd ed., 2000).
2	J. R. Lakowicz, Principles of fluorescence spectroscopy, Springer, New York, 2006;
3	B. Fultz, Transmission electron microscopy and diffractometry of materials (Springer, Berlin; New York, 2nd ed., 2002).
4	D. B. Williams, C. B. Carter, Transmission electron microscopy a textbook for materials science, Springer, New York,2009
5	R. M. Silverstein, Spectrometric identification of organic compounds (John Wiley & Sons, Hoboken, NJ, 7th ed., 2005).
6	D. Harvey, Modern analytical chemistry (McGraw-Hill, Boston, 2000).
7	Pavia, D. L., Lampman, G. M., Kriz, G. S. and Vyvyan, J. R., "Introduction to Spectroscopy", 4th Edition, Brooks / Cole Cengage Learning, 2008.

U23BTV23	HUMAN GENETICS AND CANCER BIOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To discuss the patterns of inheritance and its relevance in disease and therapy
2	To describe various genetic laws, learn the chromosome structure function and understand methodologies for cytogenetic applications.
3	To learn the basics of the genetics and cytogenetic
4	Understand the basics of cancer and cancerous cells
5	Make understanding On Process of cancer metastasis and their dysregulation factors

UNIT I	INTRODUCTION	9

History of genetics – Mendel's principles and experiments, segregation, multiple alleles – Independent Assortments, Genotypic interactions, epistasis and Sex chromosomes, Sex determination, Dosage compensation, sex linkage and pedigree analysis

UNIT II	COMPLEX TRAITS	9

Approaches to analysis of complex traits- 'Nature vs nurture', role of family and shared environment, monozygotic and dizygotic twins and adoption studies – Polygenic inheritance of continuous (quantitative) traits and discontinuous {dichotomous) traits – Genetic susceptibility in complex traits - Estimation of genetic components of multifactorial traits: Empiric risk, heritability, coefficient of relationship, application of Baye's theorem.

UNIT III	HUMAN CYTOGENETICS	9

Origins and developments in the study of human cytogenetics - Chromosome banding – Human chromosomal pathologies: Numerical and Structural aberrations and their common syndromes – Human karyotype: banding patterns, ideogram, nomenclature of banding – Nomenclature of aberrant karyotypes.

UNIT IV	FUNDAMENTALS OF CANCER BIOLOGY	

Introduction, historical perspective, classification carcinogenesis, cancer initiation, promotion & progression, pathways of spread- Epidemiology Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumor suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.

UNIT V	CANCER METASTASIS	9

Clinical significances of invasion, Molecular genetic of metastasis development, stromal microenvironment and carcinogenesis, dysregulation of cancer, associated genes Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumor cell invasion.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Understand the concept of Mendelian and non-Mendelian genetics.
CO2:	Knowtheconceptsofcomplextraitsinheritanceandmechanismofsexdetermination.
CO3:	Discuss clearly about the chromosomal pathologies.
CO4:	Describe the principles behind DNA finger printing methodologies using molecular markers RFLP, RAPD, STRP, and SNP's.
CO5:	Explain the development and proliferation of cancer with specific causes
CO6:	Outline the steps involved in metastasis and tumor cell invasion

TEXTBOOKS	
1.	Michael Goldberg, Janice Fischer, Leroy Hood and Lel and Hartwell, "Genetics: From Genes to Genomes", 7th Edition.McGraw HillEducation,2020.
2	Anthony Griffiths; John Doebley; Catherine Peichel; David A. Wassarman, "Introduction to Genetic Analysis", 12th Edition. Macmillan Learning, 2020.
REFERENCE BOOKS:	
1.	Benjamin A. Pierce, "Genetics: A Conceptual Approach", 7th Edition, Macmillan Learning, 2020.
2	William S Klug, Michael Cummings, Charlotte A. Spencer, Michael A Palladino & Darrell Killian, "ConceptsofGenetics",12th Edition, Pearson,2019.
3	D. Peter Snustad, Michael J. Simmons, "Principles of Genetics", 7th Edition, published byWiley,2015.
4	Tom Strachan & Andrew Read, "Human molecular genetics" 4th Edition, Taylor & Francis Group, Garland Science,2011.

U23BTV24	BIOPHARMACEUTICALS AND BIOSIMILARS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Toprovidestrongfoundationandadvancedinformationonbiopharmaceuticalaspectsinrelationto drug development.
2	To impart the knowledge of the various dosage forms and its implications in pharmaceutical technology
3	To understand the toxicity study of natural and synthetic chemical derived drugs
4	To understand the different way through the drug delivery
5	To learn about Monoclonal antibodies and engineered antibodies

UNIT I	INTRODUCTION	9

Drug sources – Discovery and Development phases – Drugs and Cosmetics Act and regulatory aspects – Role of patents in the drug industry – Biopharmaceutical classification system – Drug Target – Drug metabolism – Pharmacokinetics – Pharmacodynamics – Bioavailability – Bioequivalence – Toxicity studies – Pharmacogenomics.

UNIT II	DOSAGE FORMS	9

Classification of dosage forms – Excipients – Formulation – Tablets, Capsules, Emulsion, Suspension, Lotion, Liniments, Ointments, Cream, Paste, Suppositories, Parenteral – Pressurized dosage forms – Packaging techniques.

UNIT III	ADVANCED DRUG DELIVERY SYSTEMS	9

Controlled release dosage forms – Rationale – Principle and factor influencing – Design and Fabrication – Microencapsulation – Liposomes – Niosomes – Transdermal drug delivery – Ocular, Vaginal and Uterine controlled release

UNIT IV	BIOSIMILARS	9

Biosimilar medicine – Importance – INN nomenclature system – Key trends in biosimilar product development – Production of biosimilar products – Difficulties with biosimilar drugs – Non clinical and clinical study – Regulation and approval process – Future prospects.

UNIT V	CASE STUDIES ON BIOPHARMACEUTICALS	9

Erythropoietin – Insulin – Somatotropin – Interleukin – Interferon – GMCSF – Blood clotting Factors – Tissue plasminogen activator – Monoclonal antibodies and engineered antibodies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Comprehend the factors influencing the bioavailability and bioequivalence of drugs.
CO2:	Grasp the current regulatory acts and safety norms of the modern pharmaceutical industries.
CO3:	Recognize the formulation concepts and evaluate different dosage forms to meet out the compendial requirements.
CO4:	Acquired knowledge on novel drug delivery systems and their applications in therapeutic fields.
CO5:	Understand the design and analysis of biosimilar drugs.
CO6:	Demonstrate knowledge and understanding of current topical and newly emerging aspects of biopharmaceuticals.

TEXTBOOKS	
1.	Sarfaraz K. Niazi, Biosimilars and Interchangeable Biologics: Strategic Elements2018
2	James Swarbrick, "EncyclopediaofPharmaceuticalTechnology", CRC Press, 4th Edition, 2013.
REFERENCE BOOKS:	
1.	Shayne Cox Gad, "Pharmaceutical Manufacturing Handbook: Production and Processes", Wiley, 2nd Edition, 2011.
2	Gary Walsh, "Pharmaceutical Biotechnology- Concepts and Application", John Wiley and Sons Publishers, 1st Edition, 2007.
3	Shein-Chung Chow, "Biosimilars: Design and Analysis of Follow-on Biologics", CRC Press, 3rd Edition, 2013.
4	Crommelin Dwan J. A., Robert D. Sindelarand Bernd Meibohm, "Pharmaceutical Biotechnology: Fundamentals and application", Springer, 4th Edition,2013.

U23BTV25	BIOSENSORS AND BIOMATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To learn the basics knowledge of biosensor
2.	To understand the diagnostics and prevention of the disease caused by pathogenic bacteria.
3.	To understand about Affinity sensors principles based on small ligands.
4.	Study the phenomena various metals used in implant applications
5.	Acquire knowledge importance of ceramics and polymer used biomedical diagnostics

UNIT I	FUNDAMENTALS OF BIOSENSOR	9

Biosensors as functional analogs of chemoreceptors, structure and function of transducers, qualitative and quantitative sensors, sensor parameters, transduction methods-optical, calorimetric, electrochemical and piezoelectric sensors Supports and support modifications-synthetic polymers, carbon material supports, metal supports, bifunctional crosslinkers.

UNIT II	METABOLIC SENSORS	9

Methods of enzyme immobilization-adsorption, gel entrapment, covalent coupling, crosslinking immobilization effects in biosensors, characterization of immobilized enzymes in biosensors, effectiveness factor, enzyme loading test, Metabolic sensors-glucose, ascorbic acid, lactate sensors, determination of alcohols, sensors for phenols and amines, coupled enzyme reactors, sequence electrodes for nucleic acid, enzyme sensor for inhibitors

UNIT III	AFFINITY SENSORS AND REAGENTLESS SENSORS	9

Affinity sensors based on small ligands, immunosensors, immunoassay-RIA, ELISA and TELISA, piezoelectric immunosensors, optical immunosensors, electrochemical immunoassay, Biocompatibility of sensors, biomimetic sensors, bio conjugated silica nanoparticles for bioanalysis

UNIT IV	INTRODUCTION TO BIOMETRIALS	

Definition of biomaterials, requirements and classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.

UNIT V	TYPES OF IMPLANT MATERIALS AND ITS APPLICATION	9

Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Synthetic polymeric membranes and their biological applications. Definition of bio ceramics. Common types of bio ceramics: Aluminium oxides, Glass ceramics, Carbons and its applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course the student will be able to

CO1:	Describe how bio specific interaction is used for various applications.
CO2:	Compare different techniques with emphasis on selectivity and sensitivity.
CO3:	Demonstrate knowledge of the general principles of sampling and manipulation of data generated by biosensors.
CO4:	Apply the knowledge to identify the various types of analytical methods.
CO5:	Understand the basic principle and properties of biomaterials:
CO6:	Analyse various types of materials used in implant applications.

TEXTBOOKS	
1.	Frieder Schelfer and Florian Schubert Biosensors Elsevier Science Publications 1992.
2	Challa Kumar Nanomaterials for Biosensors Wiley – VCH Verlag GMBH, Germany2007.
3	Floriner - Gabriel Banica Chemical sensors and Biosensors-Fundamentals and Applications, John – Wiley & Sons Ltd, 2012.
4	Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press, SanDiego,1996.
5	William R Wagner, Shelly E. Sakiyama-Elbert, Guigen Zhang. Biomaterials Science: An Introduction to Materials in Medicine. 2020
REFERENCE BOOKS:	
1.	P. N. Bartlett (Ed.) Bioelectrochemistry- Fundamentals, Experimental techniques and applications, John Wiley & Sons, England 2008.
2	Nalwa (Ed.) Encyclopedia of Nanoscience and Nanotechnology 1 Vol. 5, 2004.
3	Ali A. Ensafi, Electrochemical Biosensors, 2019
4	Chandra Mouli Pandey, Bansi Dhar Malhotra, Biosensors: Fundamentals and Applications 2019
5	JB Park, Biomaterials – Science and Engineering, Plenum Press, 1984.
6	Joonpark, R. S Lakes, “Biomaterials an Introduction” Springer, 2007

PROFESSIONAL ELECTIVE VERTICAL III: COMPUTATIONAL BIOTECHNOLOGY

U23BTV31	FUNDAMENTALS OF ALGORITHMS FOR BIOINFORMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	TostudyvariousAlgorithmdesigntechniquesandapplyingitinbioinformatics.
2	To understand the algorithms such as Dynamic programming, HMM and ANN in Biological applications.
3	To learn the dynamic program and sequence-based modelling
4	To understand the artificial neural networks
5	To learn the algorithms for DNA and RNA

UNIT I	INTRODUCTION TO ALGORITHMS	9

Algorithms-Complexity of algorithms and running time, Polynomial, NP complete problems, Recursion, Linear, Exhaustive search, Branch and Bound, divide and conquer algorithms, Travelling sales man problem, sorting.

UNIT II	DYNAMIC PROGRAMMING AND SEQUENCE BASED ALGORITHMS	9

Dynamic programming Principles and its uses. Local and Global alignment principles, finding longest common subsequence, Heuristics second generation alignment tools for database searching: (Blast, FASTA, & ClustalW), Statistical and Similarity based methods for gene prediction, Models of evolution.

UNIT III	EXACT MATCH AND HIDDEN MARKOV MODELS	9

Knuth-Morris- Pratt and Boyer-Moore algorithm for exact match and graph and maximum likelihood algorithm, Hidden Markov Model: Forward and Backward Algorithms, most probable state path: Viterbi algorithm, Parameter Estimation for HMMs: -Baum-Welch Algorithm, EM Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.

UNIT IV	ARTIFICIAL NEURAL NETWORKS	9

Introduction to Artificial Neural Networks (ANN): A Simple Neuron, Firing rule, Network layers, Architectures of Artificial Neural Network: Feed- Forward networks, Feed-Back networks, Perceptron's, Pattern recognition problems, Back Propagation Algorithm, Applications of Neural Networks.

UNIT V	DNA AND RNA RELATED ALGORITHMS	9

Restriction enzyme mapping algorithms: algorithms for partial digest- double digest problem, Motif finding, finding regulatory motifs in DNA, DNA computing, Genome alignment, Suffix Trees, RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimization and the Zuker folding algorithm, Design of covariance models, Application of RNA Fold.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Understand the basics of algorithms used in Bioinformatics.
CO2:	Apply dynamic programming in sequence analysis.
CO3:	Analysed the macromolecules using HMM, ANN and other related algorithms.
CO4:	Understanding the sequence-based algorithms and dynamic programming
CO5:	Understanding the types of networks in computational biology
CO6:	Obtained their basic knowledge of tools involved in the bioinformatics for the simulations and dynamics

TEXTBOOKS	
1.	Dan Gusfield- Algorthims on Strings, Trees and Sequences Computer Science and Computational Biology (1997) Cambridge University Press.ISBN-10:0521585198.
2	Horowitz, S. Sahini, and Rajasekharan: Fundamentals of Computer Algorithms, Galgotia Publications.
REFERENCE BOOKS:	
1.	Neil C. Jones and Pavel. A Pevzner An introduction to Bioinformatics Algorthims. (computational Molecular Biology) (2004) MIT press. ISBN-10:0262101068.]
2	R. Durbin, S. Eddy, A. Krogh, G. Mitchison Biological sequence analysis: Probabilistic models of Proteins and Nucleic acids (2005) Cambridge University Press 0521540798
3	Michael.S. Waterman Introduction to Computational Biology: Maps, Sequences and Genomes. Waterman. Edition2 (2012) Chapman and Hall / CRC Press ISBN:1439861315.
4	David. C. Young, Computational Drug Design–A Guide for Computational and Medicinal Chemists, John Wiley and Sons Ltd, Hoboken, United States, 2009.

U23BTV32	MOLECULAR MODELLING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Understand the molecular behaviour of proteins, nucleic acids and small molecules in the biological system.
2	Explain the principles involved in molecular modelling
3	To understand the mechanics involved in the molecular modelling
4	To learn the docking and modelling in the field of bioinformatics
5	To learn the statistical mechanics of fluids

UNIT I	INTRODUCTION TO CLASSICAL MECHANICS	9

Newtons laws of motion – time intervals- algorithms

UNIT II	INTRODUCTION TO STATISTICAL MECHANICS	9

Boltzmann's Equation – Ensembles – Distribution law for non-interacting molecules – Statistical mechanics of fluids.

UNIT III	QUANTUM MECHANICS	9

Photoelectric effect – De Broglie's hypothesis – Uncertainty principle – Schrodinger's time independent equation – particle in a one -dimensional box.

UNIT IV	GROMOS, GROMACS, AMBER & DOCK	9

Various forcefields for proteins and nucleic acids – Molecular mechanics – Molecular dynamics– Molecular dynamics simulations in water and organic solvents.

UNIT V	GAUSSIAN	9

Preparing input files – job types – model chemistries – basis sets – molecule specifications running Gaussian – examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Understand the behaviour of Small and macro molecules in biological system.
CO2:	Simulate the biomolecules using molecular modelling software.
CO3:	Assess and utilize various software's and tools which utilizes quantum and molecular mechanics principles.
CO4:	Understand the quantum mechanics in computational biology
CO5:	Obtained their basic knowledge to handling and proficiency of tools for bio informatics.
CO6:	Obtained their basic knowledge of GROMOS, GROMACS, AMBER & DOCK

TEXTBOOKS

1.	Leach, Andrew R. "Molecular Modelling: Principles and Applications" IInd Edition, Pearson, 2010.
2	Cohen, N.C. "Guide Book on Molecular Modelling in Drug Design" Academic Press / Elsevier,1996.

REFERENCE BOOKS:

1.	Statistical Mechanics; D.Mc Quarrie, Narosa, University Science Books; 1st edition 2000
2	Quantum Mechanics; D.McQuarrie, Narosa,1999.
3	GROMOS Handbook www.gromacs.org
4	J. M. Goodman, Chemical Applications of Molecular Modelling, The Royal Society of Chemistry, Cambridge,1998.

U23PTV14	COMPUTER AIDED DRUG DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Find a chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically.
2	To know the informatics approaches to the prediction of chemical properties of new drugs
3	To present the appropriate tools for such a modelling, ranging from electronic Structure
4	Methods, Molecular modelling, Structure Activity Relationships in drug design, QSAR,
5	Understand Principles of Molecular docking and Molecular dynamics

UNIT I	ELECTRONIC STRUCTURE METHODS	9

Quantum chemical methods semi-empirical and ab initio methods. Conformational analysis, energy minimization, predicting the mechanism of organic reactions using electronic structure methods.

UNIT II	MOLECULAR MODELING	9

Bioactive vs. global minimum conformations. Automated methods of conformational search. Advantages and limitations of available software. Molecular graphics. Computer methodologies behind molecular modelling including artificial intelligence methods.

UNIT III	STRUCTURE ACTIVITY RELATIONSHIPS IN DRUG DESIGN	9

Qualitative versus quantitative approaches advantages and disadvantages. Random screening, Non-random screening, rational approaches to lead discovery. Homologation, chain branching, ring-chain transformations. Insights into molecular recognition phenomenon. Structure based drug design, ligand-based drug design.

UNIT IV	QSAR: ELECTRONIC EFFECTS	9

Hammett equation, lipophilicity effects. Hansch equation, steric effects. Taft equation. Experimental and theoretical approaches for the determination of physicochemical parameters, parameter interdependence: Regression analysis, Descriptor calculation. The importance of biological data in the correct form; 2D QSAR; 3D-QSAR examples of CoMFA and CoMSIA.

UNIT V	MOLECULAR DOCKING	9

Rigid docking, flexible docking, manual docking. Advantages and disadvantages of Flex-X, Flex- S, Auto dock and Dock softwares, with successful examples. Dynamics of drugs, biomolecules, drug receptor complexes, Monte Carlo simulations and Molecular dynamics in performing conformational search and docking.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Gain knowledge about fundamental concepts, challenges, and rich opportunities in developing and applying algorithms for structural bioinformatics and healthcare.
CO2:	Interpret and practice the fundamental concepts of Molecular Modelling and Computer aided Drug Design.
CO3:	Develop practical skills in computational approaches to analyse, predict, and engineer biomolecules and biomolecular systems.
CO4:	Finda chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically.
CO5:	Present the appropriate tools for such a modelling, ranging from electronic Structure methods, Molecular modelling, Structure Activity Relationships in drug design, QSAR, Molecular docking and Molecular dynamics
CO6:	Apply the fundamental tools in techniques like docking, modelling, electronic structure methods which leads to new drug target design.

TEXTBOOKS	
1.	Richard B. Silverman, Mark W. Holladay, Organic Chemistry of Drug Design and Drug Action, 3rd Edition, Academic Press, USA, 2014.
2	Paul S. Charifson, Practical Applications of computer aided drug design, 1st Edition, Marcel Dekker, New York,1997.
REFERENCE BOOKS:	
1.	Donald J. Abraham, Burger's Medicinal Chemistry and Drug Discovery, Vol V, 6th Edition, John Wiley and Sons, Inc.,2003.
2	John B. Taylor and David J. Triggle, Comprehensive Medicinal Chemistry II, Vol IV, Elsevier Science, 2006.
3	Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th Edition, Oxford University Press, UK, 2013.
4	Alan Hinchliffe, Molecular Modelling for Beginners, 2nd Edition, Wiley, United University of California, 2008.

U23BTV34	DATA MINING AND MACHINE LEARNING TECHNIQUES FOR BIOINFORMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To learn various data mining techniques used to analyses huge biological data to find the hidden patterns.
2	To familiarize students with a new rapidly evolving filed of machine learning and mining
3	To learn the different types of machine learning techniques in computational biology
4	To understand the data pre-processing and visualizing of the machine learning
5	To learn the types of applications involving the data mining

UNIT I	OVERVIEW OF MACHINE LEARNING TECHNIQUES	9

Supervised and unsupervised techniques. Empirical Risk Minimization, Structural Risk Minimization; Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing.

UNIT II	MACHINE LEARNING TECHNIQUES	9

Classification: Decision tree, Bayesian, Rule based classification, ANN, SVM, HMM; Case based reasoning and Applications in Bioinformatics. Clustering: Partition Methods, Hierarchical methods, Density based methods, Grid based clustering, Model based clustering, clustering of high dimensional data, constraints-based clustering, Analysis of MD trajectories, Protein Array data Analysis

UNIT III	INTRODUCTION TO DATA MINING	9

Introduction to Data mining, Data mining Functionalities, Classification of Data mining Systems, Data Mining Task Primitives, Integration of Data mining systems, Major issues of Data mining.

UNIT IV	DATA PREPROCSSING AND VISUALIZATION	9

Overview of data preprocessing, Data cleaning, Data integration, Data reduction, Data transformation and discretization, Visualization- Visualizing a single attribute, Visualizing pair of attributes, Visualizing several attributes, Visualizing results of machine learning

UNIT V	APPLICATIONS OF DATA MINING	9

Application of Data Mining in Biodata analysis: DNA/protein sequence Analysis, Genome analysis, Protein Structure Analysis, Pathway analysis, microarray data analysis, annotation, gene ontology, gene mapping. Biological data mining tools: Entrez, Blast, sequence retrieval system (SRS).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Know the basic notions and terminology used in Machine learning and Data mining.
CO2:	Understand fundamental principles of modern data analysis.
CO3:	Understand the applications of Machine learning and Data mining in biological data processing and visualization.
CO4:	Understand the techniques involved in the genome biology
CO5:	Understand the pre-processing for the data analysis
CO6:	Obtained their basic knowledge of the overall data analysing, machine learning and genome biology using computational tools

TEXTBOOKS

1.	Witten, H.I., Frank, E. and Hall, M. A. 2011. Data Mining: Practical Machine Learning Tools and Techniques.
2	Hastie, T., Tibshirani,R., Friedman, J.H. 2009. The Elements of Statistical Learning: Data Mining Interface and Prediction.

REFERENCE BOOKS:	
1.	Data Mining: Concepts and Techniques by Jiawei Han and Micheline Kamber, 2000
2	Data Mining Techniques, A. K. Pujari, University Press, Hyderabad, 2006
3	Datamining in bioinformatics by Wang et al, Springer-Verlag,2005
4	Clarke, S.B., Fokoue, E. and Zhang, H.H. 2009 Principles and Theory for Data Mining and Machine Learning.

U23BTV35	GENOMICS AND PROTEOMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Evaluate the comprehensive and concise overview of technologies pertinent to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries.
2	Appreciate the surplus value of combining data from different omics-applications as a systems approach.
3	Identify and analysis the biomarkers responsible for community diseases.
4	Advanced techniques to determine genomic sequencing.
5	Design and discover novel drugs for harmful pathogens.

UNIT I	INTRODUCTION TO GENOMICS	9

Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes, computational analysis of sequences, gene annotation, alignment statistics, genetic variation polymorphism, phylogenetics, tools for genome analysis– PCR, RFLP, DNA fingerprinting, RAPD, automated DNA sequencing, linkage and pedigree analysis, construction of genetic maps, FISH to identify chromosome landmarks.

UNIT II	INTRODUCTION TO PROTEOMICS	9

Identification and analysis of proteins by 2D analysis, tryptic digestion of protein and peptide fingerprinting, mass spectrometry, clinical proteomics and disease biomarkers, protein-protein interactions.

UNIT III	GENE IDENTIFICATION AND EXPRESSION	9

Genome annotation, identifying the function of a new gene, gene ontology, comparative genomics, protein structural genomics, determining gene function by sequence comparison and through conserved protein, global expression profiling, analysis of RNA expression, microarray techniques.

UNIT IV	ANALYSIS OF PROTEOMES	9

Two-dimensional polyacrylamide gel electrophoresis, mass spectrometry-based methods for protein identification, de novo sequencing using mass spectrometric data, correlative mass spectrometric based identification, strategies, 2-D gel electrophoresis coupled with mass spectrometry, case study on proteomic analysis of patient samples

UNIT V	APPLICATIONS OF GENOMICS AND PROTEOMICS	9

Analysis of human genome, application of proteome analysis- drug development and toxicology, pharmaceutical applications, proteomics in drug discovery in humans, phage antibodies as tools, capstone project on genomics and proteomics

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	Explain the current genomics and proteomics technologies and exploit the same in the growing field of omics.
CO2:	Interpret data obtained through high throughput expression studies.
CO3:	Apply the computational skills to plan and execute a biomedical 'omics' project.
CO4:	Analyse the biomarkers responsible for harmful diseases.
CO5:	Evaluate the pharmaceutical techniques in human genome project.
CO6:	Develop targeted drug delivery techniques.

TEXTBOOKS	
1	Wilson and Walker, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, 8th edition, 2018.
2	S. B. Primrose and R.M. Twyman - Principles of Genome Analysis and Genomics, 7th Edition, Blackwell Publishing, 2006.
REFERENCE BOOKS:	
1	Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, 2007.
2	Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
3	S. Sahai - Genomics and Proteomics, Functional and Computational Aspects, Springer Publication, 2009.
4	Rakeeb Ahmad Mir, Sheikh Mansoor Shafi, Sajad Majeed Zargar, Principles of Genomics and Proteomics, Elsevier Inc., 2023.

PROFESSIONAL ELECTIVE VERTICAL IV: QUALITY AND REGULATORY AFFAIRS

U23BTV41	CLINICAL TRIALS AND HEALTH CARE POLICIES IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To high light the epidemiologic methods, study design, protocol preparation
2	To gain knowledge in the basic bio-statistical techniques involved in clinical research.
3	To describe the principles involved in ethical, legal and regulatory issues in clinical trials
4	To understand the handling, maintenance and safety measurement of the clinical trials in *invitro* and *in vivo.*
5	To understand the components, elements and financing role of the healthcare system

UNIT I	REQUIREMENTS IN CLINICAL RESEARCH	9

Good clinical practice (ICH GCP E6), Clinical trial materials (Documentation, Investigational drugs, logistical materials)

UNIT II	TYPES AND DESIGNS IN CLINICAL RESEARCH AND SAFETY MONITORING IN CLINICAL TRIALS	9

Types of research designs based on Controlling Method (Experimental, Quasi experimental, and Observational methods) Randomization techniques (Simple randomization, restricted randomization, blocking method and stratification), Time Sequences (Prospective and Retrospective), Sampling methods (Cohort study, case Control study and cross-sectional study), Health outcome measures (Clinical & Physiological, Humanistic and economic)

UNIT III	CLINICAL TRIAL STUDY AND GOVERNING REGULATIONS	9

Roles and responsibilities of: Investigator, Study Coordinator, Sponsor, Monitor, Contract Research Organization, Site management Organizations Guidelines to the preparation of following documents: Protocols, Investigator's Brochure, Informed Consent Form, Case report forms, Contracts and agreements, Trial Master File preparation and maintenance, Investigator Site File, Pharmacy File, Dairy Cards

UNIT IV	OVERVIEW TO UNDERSTANDING THE HEALTHCARE SYSTEM	9

Health Care System Components, Elements of a Health Care System, The Role and Financing Methods of Third-Party Payers, The Production of Medical Services, An Overview of the U.S. Health Care System, Production of Health Services and Provider Choice in the United States.

UNIT V	HEALTH CARE POLICIES	9

Health care policy- overview- Private health care sectors, Health policy and planning

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Explain key concepts in the design of clinical trials.
CO2:	Describe study designs used; identify key issues in data management for clinical trials.
CO3:	Describe the roles of regulatory affairs in clinical trials.
CO4:	Learning the health care system and financing polices of medical cervices
CO5:	Understand the documentations based on the governing regulations for investigator
CO6:	Obtained the basic knowledge of health care policies and safety measurements of clinical trials

TEXTBOOKS	
1.	Guidance for Industry on Submission of Clinical Trial Application for Evaluating Safety and Efficacy by CDSCO (Central Drug Standard Control Organisation)
2	Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
REFERENCE BOOKS:	
1	Santerre, Rexford E. Health economics.2009.
2	Griffin (1992): Bhat. R1993 The private- public mixing health care in India *Health Policy and Planning.*
3	Liu, M.B. and Davis, K., Clinical trials manual from the Duke Clinical Research Institute: lessons from a horse named Jim., John Wiley & Sons, Ltd., 2nd Edition, 2010.
4	Gallin, J.I. and Ognibene, F.P. Principles and Practice of Clinical Research, Academic Press.

U23BTV42	QUALITY ASSURANCE AND QUALITY CONTROL IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	The student shall be able to understand the scope of quality certifications.
2	Appreciate the importance of documentation.
3	The cGMP aspects in a pharmaceutical industry.
4	To understand the responsibilities of QA & QC departments in biotechnology industries
5	To understand the quality assurance of the clinical trials

UNIT I	INTRODUCTION	9

Quality Assurance, Quality Control, Role of Quality Assurance, QA testing, Role of Quality Control, Test for quality control, Quality assurance – Quality control – Practice of cGMP- Overview of ICH Guidelines - QSEM, with special emphasis on Q-series guidelines. Good Laboratory Practices: Scope of GLP, Definitions, Quality assurance unit, protocol for conduct of non-clinical testing, control on animal house, , scope of quality certifications - responsibilities of QA & QC departments, Analysis of raw materials, finished products, packaging materials, in process quality control (IPQC), Developing specification (ICH Q6 and Q3)

UNIT II	QUALITY ASSURANCE AND QUALITY CONTROL IN CLINICAL TRIALS	9

Audit criteria, Audit process, Responsibilities of stakeholders in audit process, Audit follow-up and documentation, Audit resolution and preparing for FDA inspections, Fraud and misconduct management - Clinical Trial Data Management- Standard Operating Procedures, Data management plan, CRF & Data base design considerations, Study set-up, Data entry, CRF tracking and corrections, Central lab, IVRS, source data. Data cleaning, managing laboratory and ADR data, Data transfer and database lock, Quality Control and Quality Assurance in CDM, Data mining and warehousing

UNIT III	QUALITY ASSURANCE AND QUALITY CONTROL IN PHARMACEUTICAL INDUSTRIES	9

Schedule M – USFDA- Quality audit and self-inspections SOPs – Documentation – Loan license auditing – Common technical documentation (CTD) – Drug master file (DMF).

UNIT IV	QUALITY SYSTEM REGULATIONS AND QUALITY CONTROL OF MEDICAL DEVICES	9

Quality System Requirements 21 CFR Part 820, Labelling requirements 21 CFR Part 801, Post marketing surveillance of MD and Unique Device Identification (UDI), Quality System requirements and clinical evaluation and investigation. IMDRF study groups and guidance documents, ISO 13485, Quality Risk Management of Medical Devices: ISO 1497-

UNIT V	QUALITY IN FOOD, NUTRACEUTICALS, BIOLOGICAL AND COSMETIC PRODUCTS	9

WHO guidelines on nutrition. NSF International: Its Role in the Dietary Supplements and Nutraceuticals Industries, NSF Certification, NSF Standards for Food and Dietary Supplements. Good Manufacturing Practices for Nutraceuticals, Quality, safety and legislation for herbal products in India, USA and European Union, Analysis of Cosmetics, Toxicity screening and test methods: Quality control and toxicity studies as per Drug and Cosmetics Act, Analysis of Food additives- milk constituents and milk products- Pesticide analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	This course deals with the various aspects of quality control and quality assurance aspects of various biotechnological industries.

CO2:	It covers the important aspects like cGMP, QC tests, documentation, quality certifications, GLP and regulatory affairs.
CO3:	Learning the quality assurance and control the pharmaceutical industries
CO4:	Understand the processes of food products, nutraceuticals and cosmetic products
CO5:	Understand the quality measurement of the pharmaceutical products
CO6:	Understand the basic knowledge of processes of bio products and their different quality measurement parameters

TEXTBOOKS	
1.	Willig, H., Tuckeman, M.M. and Hitchings, W.S., "Good Manufacturing Practices for Pharmaceuticals", 5th Edition, Marcel Dekker Drugs and the Pharmaceutical Sciences, by CRC Press, New York,2000.
2	Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, Medical Devices by John J.Tobin and Gary Walsh
REFERENCE BOOKS:	
1	Mindy J. Allport-Settle, Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference, Paralogical Inc., USA, 2009.
2	P.P. Sharma. Cosmetics - Formulation, Manufacturing & Quality Control, Vandana Publications, NewDelhi
3	Geigert, J. (2002). Quality Assurance and Quality Control for Biopharmaceutical Products. In: Nail, S.L., Akers, M.J. (eds) Development and Manufacture of Protein Pharmaceuticals. Pharmaceutical Biotechnology, vol 14. Springer, Boston, MA. https://doi.org/10.1007/978-1-4615-0549-5_7
4	Avis, K. E., Wagner, C. M., & Wu, V. L. (Eds.). (2020). Biotechnology: Quality Assurance and Validation. CRC Press.

U23BTV43	ENTREPRENEURSHIP AND PATENT OF DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Student will be able to develop entrepreneurial skills and writing of business plan market strategies.
2	They will gain knowledge on patent filing and design
3	To understand the developing the business plan and marketing plan
4	To understand the operation management of patent design
5	To understand the self-awareness and creativity of the marketing plan

UNIT I	ENTREPRENEUR	9

Entrepreneurial motivation – dynamics of motivation. Entrepreneurial competency –Concepts. Developing Entrepreneurial competencies - requirements and understanding the process of entrepreneurship development, self-awareness, interpersonal skills, creativity, assertiveness, achievement, factors affecting entrepreneur role.

UNIT II	BUSINESS PLAN, MARKETING PLAN	9

Develop a Business Plan

UNIT III	MARKETING PLAN	9

Choose Your Location and Set Up for Business, Market Your Business, Hire and Manage a Staff

UNIT IV	OPERATIONS MANAGEMENT	9

Finance, Protect and Ensure Your Business, Record Keeping and Accounting, Financial Management.

UNIT V	PATENTS	9

Patents – objectives and benefits of patent, Trademarks, copyright, Geographic indicators, Concept, features of patent, Inventive step, Specification, Types of patent application, process E- filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Learning the overall regulations and conditions of the patent apply
CO2:	Understanding the financial management and accounting of the business and marketing plan
CO3:	Learn the dynamics motivations and interpersonal skills for the business management
CO4:	Understand the process of entrepreneurship development
CO5:	Understand the types of patent application process and specification
CO6:	Obtained the basic knowledge of the licensing, copyright, trademark and Geographic indicators for registering patent

TEXTBOOKS:

1.	Hisrich, R. D. and Peters, M. P. (1995): Entrepreneurship–Starting, Developing and Managing a New Enterprise, Richard D., Inwin, INC, USA.
2	Entrepreneurship Ideas in Action—South-Western,2000.

REFERENCE BOOKS:

1	Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
2	David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.

3	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September2013.
4	Kuratko, D. F. (2016). Entrepreneurship: Theory, process, and practice. Cengage learning.

U23BTV44	INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To learn the nature of the intellectual property rights
2	To learn the registration of IPR and their categories
3	To understand the patent amendment act for the legislations
4	To learn the laws of digital content protections
5	To understand the how to apply patent in different categories

UNIT I	INTRODUCTION	9

Introduction to IPRs, Basic concepts and need for Intellectual Property - IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR

UNIT II	REGISTRATION OF IPRs	9

Meaning and practical aspects of registration of Copyrights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III	AGREEMENTS AND LEGISLATIONS	9

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV	DIGITAL PRODUCTS AND LAW	9

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V	ENFORCEMENT OF IPRs	9

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Ability to manage Intellectual Property portfolio to enhance the value of the firm.
CO2:	Their knowledge to enable about the India and foreign IPR systems
CO3:	Understanding about the agreements and patent acts
CO4:	Understanding the different kind of laws for the protections of digital product
CO5:	Awareness of basics of copyrights, trademarks, geographical indications and patent acts for the individual products
CO6:	Obtained their knowledge about intellectual property rights for biotechnological products such as methodology formula, digital content etc.

TEXTBOOKS

1.	V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
2	S. V. Satakar, "Intellectual Property Rights and Copy Rights, EssEss Publications, New Delhi, 2002.

REFERENCE BOOKS:

1	Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition,2012.
2	Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.

3	Edited by Derek Bos worth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.
4	David, C., The Role of Intellectual Property Rights in Biotechnology Innovation, Edward Elgar Publishing Limited, Cheltenham, UK, 2009.

U23BTV45	BIOSAFETY AND HAZARD MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Familiarise with industrial safety procedures
2	Acquire knowledge on hazard identification
3	Impart on the promotion of industrial safety
4	Classify comprehensive risk analysis
5	Learn about implementation of safety procedures, risk analysis and assessment

UNIT I	INTRODUCTION	9

Need for safety in industries; Safety Programmes – components and realization; Potential hazards extreme operating conditions, toxic chemicals; safe handling

UNIT II	QUALITY CHECKS	9

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety.

UNIT III	RISK ANALYSIS	9

Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment – rapid and comprehensive risk analysis; Risk due to radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV	SAFETY AUDITS	9

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Flixborough-Mexico-Madras- Vizag Bopal analysis.

UNIT V	HAZARDOUS OPERATIONS	9

Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	To implement industrial safety procedures
CO2:	To identify potential hazards in a process plant
CO3:	To promote industrial safety awareness programmes
CO4:	To rectify comprehensive risk analysis in industrial process
CO5:	To create process plants with high safety procedures, risk analysis and assessment
CO6:	To develop risk free work environment for process plants

TEXTBOOKS

1.	Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", WileyInterscience, 1965.
2	Marcel, V.C., Major Chemical Hazard-Ellis Harwood Ltd., Chi Chester, UK, 1987.

REFERENCE BOOKS:

1	Handley, W., "Industrial Safety Handbook ", 2nd Edition., McGraw-HillBookCompany,1969.
2	Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention ", McGraw- HillBook Co., 1980.
3	Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prentice Hall, NJ,1990.

4	Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004.

OPEN ELECTIVES

U23BTO11	IMMUNO-TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Learn the concepts of immunology
2	Apply the concept for the development of relevant immunotechnology
3	Understand the mechanism involved in development of drugs
4	Classify the immunotherapeutic products
5	Modify the drugs to target diseases of interest

UNIT I	INTRODUCTION	9

Cells of the immune system and their development; primary and secondary lymphoid organs; humoral immune response; cell mediated immune responses; complement

UNIT II	ANTIBODIES	9

Monoclonal antibodies and their use in diagnostics; ELISA; Agglutination tests; Antigen detection assay; Plaque Forming Cell Assay.

UNIT III	CELLULAR IMMUNOLOGY	9

PBMC separation from the blood; identification of lymphocytes based on CD markers; FACS; Lymphoproliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays- IL2, gamma IFN, TNF alpha.; HLA typing

UNIT IV	VACCINE TECHNOLOGY	9

Basic principles of vaccine development; protein-based vaccines; DNA vaccines; Plant based vaccines; recombinant antigens as vaccines; reverse vaccinology

UNIT V	DEVELOPMENT OF IMMUNOTHERAPEUTICS	9

Engineered antibodies; catalytic antibodies; idiotypic antibodies; combinatorial libraries for antibody isolation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Apply the technology of immunology in designing drugs
CO2:	To develop immunotherapeutic products and vaccines
CO3:	Will be ready for the industry or become an entrepreneur.
CO4:	Gain knowledge on the mechanism involved in therapeutic assays
CO5:	Create libraries for immunotherapeutic products
CO6:	To engineer antibodies for vaccinology studies

TEXTBOOKS

1.	Constantin A. Bona, Francisco A. Bonilla, Textbook of Immunology, CRC Press, 2019
2	Kenneth M. Murphy, Casey Weaver, Janeway's Immunobiology 9th Edition, Garland Science, 2016

REFERENCE BOOKS:

1	Seamus J Martin, Dennis R. Burton, Ivan M. Roitt, and Peter J. Delves. Roitt's essential immunology. John Wiley & Sons, 2016.
2	A.K. Chakravarty, Immunology and Immunotechnology. 1st edition, Oxford university Press, 2006
3	Goldsby, R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Immunology, 5th ed., W.H. Freeman, 2003.
4	Murphy, Kenneth, and Casey Weaver. Janeway's immunobiology. Garland science, 2016.

U23BTO12	BASICS OF MICROBIAL TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Enable the non-biological students to understand about the basics of microbial technology and their pro and cons for living organisms.
2	Understand the concepts of microbial culture techniques
3	Gain knowledge on the importance of microbes in day-to-day life
4	Ensure the cultivation and control of microbes with physical and chemical approach
5	Familiarize with fundamental aspect of microbial cellular chemistry in bioproduct development

UNIT I	BASICS OF MICROBES AND ITS TYPES	9

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi

UNIT II	MICROBIAL TECHNIQUES	9

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

UNIT III	PATHOGENIC MICROBES	9

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengue, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV

UNIT IV	BENEFICIAL MICROBES	9

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

UNIT V	PRODUCTS FROM MICROBES	9

Fermented products – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, pharmaceutical products - Antibiotics, Vaccines.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able

CO1:	Microbes and their types.
CO2:	Cultivation of microbes.
CO3:	Pathogens and control measures for safety.
CO4:	Microbes in different industry for economy.
CO5:	understand microbial interactions in soil, nitrogen fixing organisms, bio fertilizer
CO6:	To produce industrial pharmaceutical products.

TEXTBOOKS

1	H. J. Peppler and D. Perlman, Microbial Technology Fermentation Technology, 2nd edition, Vol.2, Academic Press, 2014
2	I. Edward Alcamo, Fundamentals of microbiology, Benjamin Cummings, 1997

REFERENCE BOOKS:

1	Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2	Nina Parker, Mark Schneegurt, Anh-Hue Thi Tu, Brian M. Forster, Microbiology, OpenStax, 2016
3	Alexander N. Glazer, Hiroshi Nikaido, Microbial Biotechnology; Fundamentals of Applied Microbiology, 2nd edition, Cambridge University Press, 2007

4	Tortora, Fonke, Case, Microbiology: An introduction, 11th edition, Pearson Education, Inc, 2013

U23BTO13	INTRODUCTION TO CELL BIOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To study cell structure and functions of organelle function.
2	Exposure on transportations through cell membrane.
3	To focus on different receptors and model of signalling.
4	To introduce the concept of cell signalling.

UNIT I	AN OVERVIEW OF CELLS AND CELL RESEARCH	9

Origin and evolution of cells, cells as experimental models, tools of cell biology – chemistry of cells – molecular composition of cells, central role of enzymes, metabolic energy, biosynthesis of cell constituents, cell membrane.

UNIT II	CELL STRUCTURE AND FUNCTION – I	9

Nucleus, Endoplasmic reticulum, Golgi apparatus and Lysosomes, Bioenergetics and Metabolism – Mitochondria, chloroplasts, Peroxisomes.

UNIT III	CELL STRUCTURE AND FUNCTION - II	9

The cytoskeleton and cell movement, cell surface – transport of small molecules, Endocytosis, cell – cell interactions Adhesion Junctions-Tight junctions-Gap junctions- Plasmodesmata.

UNIT IV	CELL SIGNALING – CELL REGULATION	9

Signalling molecules and their receptors, functions, pathways of intracellular signal transduction – the Cell Cycle Mitosis and Meiosis –Cell death and cell renewal-Programmed cell death-Stem cells-Embryonic stem cells and therapeutic cloning.

UNIT V	CANCER	9

The Development and causes of cancer, tumour viruses, oncogenes, prevention and treatment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	Basic knowledge on cell structure and its functions.
CO2:	Understanding on nutrition transportation through cell membrane.
CO3:	Understand different types of receptors and model of signalling.
CO4:	Understanding of cell signalling and pathways
CO5:	Understanding of cell signalling and causes of cancer.
CO6:	Basic knowledge on cell structure,organization and signalling

TEXTBOOKS

1	The Cell: A molecular approach by Geoffrey M.Cooper.ASM Press, Pages:673

REFERENCE BOOKS:

1	Molecular Biology of the Cell Edition 4, Roberts, Keith Alberts, Bruce Johnson, Alexander Raff, Martin Walter, Peter Lewis, Julian, Garland
2	Molecular Cell Biology, Lodish, Harvey Krieger, Monty Kaiser, Chris A. Berk, Arnold, W H Freeman & Co

U23BTO14	LIFE STYLE DISEASE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students to:

1	Understand the basic concept of Lifestyle disease.
2	Learn different types of cancers and their causative disease.
3	Learn the diagnostic method for the specific treatment of cancer disease.
4	Understand types of Diabetes and Obesity.
5	Learn about the respiratory disease.

UNIT I	INTRODUCTION	9

Lifestyle diseases – Definition; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

UNIT II	CANCER	9

Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment.

UNIT III	CARDIOVASCULAR DISEASES	9

Coronary atherosclerosis – coronary artery disease; Causes -Fat and lipids, Alcohol abuse -– Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation.

UNIT IV	DIABETES AND OBESITY	9

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI.

UNIT V	RESPIRATORY DISEASES	9

Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	Identify and explain lifestyle diseases
CO2:	Differentiate between types of cancers
CO3:	Apply diagnostic methods for cancer treatment
CO4:	Analyze diabetes and obesity:
CO5:	Understand respiratory diseases

TEXTBOOKS

1	R. Kumar &Meenal Kumar, “Guide to Prevention of Lifestyle Diseases”, Deep & Deep Publications, 2003.
2	Gary Eggar et al, “Lifestyle Medicine”, 3rd Edition, Academic Press, 2017.

REFERENCE BOOKS:

1	James M.R, “Lifestyle Medicine”, 2nd Edition, CRC Press, 2013.
2	Akira Miyazaki et al, “New Frontiers in Lifestyle-Related Disease”, Springer, 2008.

U23BTO15	BIO-ECONOMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	Students will be able to understand basic concept of Bioeconomic, challenges, opportunities& regulations
2	Students will be able to understand development and innovation in terms of bioeconomy towards sustainable development
3	Students will be able to understand Inter- and trans-disciplinarity in bioeconomy &research approaches
4	Students will be able to explain biobased resources, value chain, innovative use of biomass
5	To understand biological knowledge to provide food, feed, industrial products

UNIT I	INTRODUCTION TO BIOECONOMICS	9

Bio-economics- Concept, Development of Economics and Bioscience (Concept of resource economics for scarcity of biological resources), Evolution and Development of Economics and Biology (Charles Darwin and the evolutionary paradigm).

UNIT II	BIOECONOMICS AND THERMODYNAMICS	9

Thermodynamic analysis and thermo economics, Exergy cost, Exergetic efficiency, 1st and 2nd Laws of Thermodynamics applied to economics, economic processes and elasticity, entropy and utility, Concept of exergy in waste – Waste to value

UNIT III	BIOECONOMICS AND SUSTAINABILITY	9

Development of resource efficient bioeconomy, Social and economic challenges for bioeconomy, Concept of Market and Market failures, Reasons for market failures, Externalities Concept and understanding of ecological and carbon footprint

UNIT IV	TOTAL ECONOMIC VALUE OF BIORESOURCES	9

Understanding of total economic value (TEV) of a resource, Application of the concept of TEV to renewable and non-renewable resources, Understanding of the principles behind use and non-use value Introduction to Option and Quasi-option value

UNIT V	MARKET AND NON-MARKET VALUATION METHODS	9

Understanding of different Market and Non-market valuation methods, revealed preference and stated preference methods for estimating use and non-use value, Market cost method. Application of different methods to different conditions.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	Understanding the basics and development of bio economics
CO2:	Learn the law of thermodynamics for the bioeconomic
CO3:	Understand the social and market challenges of the bio economics
CO4:	Understand the economic values and principles of quasi option values
CO5:	Learn the validation of the market, non-market methods and their applications
CO6:	Obtained their basic knowledge towards the bioproducts and marketing

TEXTBOOKS

1	Clark, C.W. Mathematical bio economics, John Wiley & Sons, USA, 2010
2	Asafu-Adjaye, J. Environmental Economics for Non-Economists, World Scientific Publishing Co. Pvt. Ltd., London, 2000.

REFERENCE BOOKS:	
1	Viaggi, D. The bioeconomy: delivering sustainable green growth, CAB International publishers, U.K, 2018.
2	Glasson, J., Therivel R., Chadwick, A. Introduction to Environmental Impact Assessment, 3rd edition, Routledge, Taylor & Francis Group, 2013.
3	Satpute,M.S., Lamdande, A.G., Kadam, V.D. and Garud, S.R. Life cycle assessment of food. Internat. J. Agric. Engg., 6(2), (2013), 558-563.
4	Muthu, S.S. The Handbook of Carbon Footprint, CRC Press, Taylor & Francis Group, 2016.

U23BTO16	MOLECULAR PATHOGENESIS OF INFECTIOUS DISEASES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To enable the students, know that infectious disease
2	To understand about the microbial toxins and modern molecular pathogenesis
3	To know about the host pathogen interaction and identifying virulence factors
4	To control pathogens by modern approaches.
5	To understand the interactions of pathogen and control

UNIT I	OVERVIEW	9

Historical perspective - discovery of microscope, Louis Pasteur's contributions, Robert Koch's postulates, early discoveries of microbial toxins, toxic assays, vaccines, antibiotics and birth of molecular genetics and modern molecular pathogenesis studies, Various pathogen types and modes of entry.

UNIT II	HOST-DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES	9

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

UNIT III	MOLECULAR PATHOGENESIS (WITH SPECIFIC EXAMPLES)	9

Virulence, virulence factors, virulence- associated factors and virulence lifestyle factors, molecular genetics and gene regulation in virulence of pathogens, Vibrio Cholerae: Cholera toxin, co- regulated pili, filamentous phage, survival E.coli pathogens: Enterotoxigenic E.coli (ETEC), labile & stable toxins, Entero- pathogenic E.coli (EPEC), type III secretion, cytoskeletal changes, intimate attachment; Enterohaemorrhagic E.coli (EHEC), mechanism of bloody diarrhoea and Hemolytic Uremic Syndrome, Enteroaggregative E.coli (EAEC). Shigella: Entry, macrophage apoptosis, induction of macropinocytosis, uptake by epithelial cells, intracellular spread, inflammatory response, tissue damage Plasmodium: Life cycle, erythrocyte stages, transport mechanism and processes to support the rapidly growing schizont, parasitiparous vacuoles, and knob protein transport, Antimalarials based on transport processes. Influenza virus: Intracellular stages, Neuraminidase & Haemagglutinin in entry, M1 & M2 proteins in assembly and disassembly, action of amantadine.

UNIT IV	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 responses

UNIT V	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: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	Host pathogen interactions at the cellular and molecular networks level.
CO2:	Diagnosis the diseases by molecules that examinations.
CO3:	Modern therapeutic strategies on various pathogens.
CO4:	Learn the molecular characterization and cytotoxicity of the pathogen.
CO5:	Understand the history, assays and vaccines of the human pathogen.

CO6:	Obtained their basic knowledge of screening, isolation, culturing of the human pathogen and cytotoxicity and vaccination against the pathogen.
TEXTBOOKS	
1	Browning, G., & Citti, C. (2014). Mollicutes: molecular biology and pathogenesis. Caister Academic Press.
2	Groisman, E.A., Principles of Bacterial Pathogenesis, Academic Press, 2001.
REFERENCE BOOKS:	
1	Recent reviews in Infect. Immun., Mol. Microbiol., Biochem. J., EMBO etc
2	Nester, Anderson, Roberts, Pearsall, Nester, "Microbiology: A Human Perspective", McGraw Hill, 3rd Edition, 2001.
3	Eduardo A. Groisman, Principles of Bacterial Pathogenesis, Academic Press, 2001.
4	Salyers, A.A. and Whitt, D.D., Bacterial Pathogenesis , A molecular Approach, ASM Press, Washington, 2nd Edition, 2002

U23BTO17	PRINCIPLES OF VIROLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To learn the physiochemical properties of virus.
2	To learn the screening, culturing, maintenance and biosafety of virology laboratory.
3	To understand the receptors involved in the cellular interactions and nuclear signalling's.
4	To understand the signal transport for necrosis and apoptosis.
5	To learn the biomarkers involved in the mechanism of viral persistence.

UNIT I	HISTORY OF VIROLOGY	9

History and principles of virology, virus taxonomy, introduction to replication strategies. Virus structure and morphology. Viruses of veterinary importance

UNIT II	PRINCIPLES AND BIOSAFETY OF VIROLOGY LABORATORY	9

Principles of bio-safety, containment facilities, maintenance and handling of laboratory animals and requirements of virological laboratory. Plant viruses, plant virus propagation. Bacteriophages, bacteriophage propagation and viroids.

UNIT III	VIRAL RECEPTORS	9

Definition, structure and methods of discovery of viral receptors (polio, herpes, VSV, HIV). Kinetics of receptor binding. Cellular interactions—clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms. Nuclear localization signals and nuclear pore transit, virus –cytoskeletal interactions, chaperons.

UNIT IV	SIGNAL TRANSPORT OF VIRAL PROTEINS	9

Replication sites and their characterization, IRES, replicons, transport of viral proteins. Host cell 'shut off', apoptosis, necrosis, stress response, alteration of signalling pathways, cellular basis of transformation, types of cenotaphic effects, ultrastructural cytopathology.

UNIT V	BIOMARKERS OF THE VIRUS	9

Cellular injury associated markers, mechanism of viral persistence and latency—in vivo and in vitro models (JE, measles, LCM and HIV).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	Understand the origin, structure of virus and taxonomy of virus
CO2:	Understand the handling and biosafety measurements of virus research
CO3:	Understand the morphology and types of viral receptors
CO4:	Learn the signal transduction of the cellular basis for apoptosis
CO5:	Learn the biomarkers involved in the cellular injury
CO6:	Obtained their knowledge of *invitro* and *in vivo* modelling for the diagnosis and treatment for disease caused by virus and veterinary importance of the virus.

TEXTBOOKS

1	Culture of Animal Cells: A Manual of Basic Technique. R. Ian Freshney. Latest edition / Pub. Date: September 2005. Wiley.
2	Culture of Cells for Tissue Engineering. R. Ian Freshney. Pub. Date: March 2006. Wiley.

REFERENCE BOOKS:

1	Invertebrate Tissue Culture Methods. Jun Mitsuhashi. Latest edition /Pub. Date: February 2002. Publisher: Springer-Verlag New York, LLC.
2	Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka

	Latest edition / Pub. Date: December 2003 Publisher: American Society Microbiology. Narosa Publ. House
3	Virus Dynamics: Mathematical Principles of Immunology and Virology. Martin A. Nowak, Robert May. Latest edition / Pub. Date: January 2000. Publisher: Oxford University Press
4	Gonzalez-Vilchis, R. A., Piedra-Ramirez, A., Patino-Morales, C. C., Sanchez-Gomez, C., & Beltran-Vargas, N. E. (2022). Sources, characteristics, and therapeutic applications of mesenchymal cells in tissue engineering. Tissue Engineering and Regenerative Medicine, 19(2), 325-361.

U23BTO18	FUNDAMENTALS AND APPLICATIONS OF NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	The student will be able to understand introduction, classification of nanostructured materials.
2	To learn about the synthesis of nano materials
3	To understand the nano materials and it purposes.
4	To study about the characterization techniques for nano materials.
5	To know about the applications of nano materials

UNIT I	CLASSIFICATION AND PROPERTIES	9

Introduction and Classification of Nanostructured materials: Zero-, One-, Two- and Three-dimensional structure, Size control of metal Nanoparticles and their properties: Optical, Electric, Magnetic properties.

UNIT II	SYNTHESIS OF NANOMATERIALS	9

Synthesis of Nano Materials: Introduction to synthesis of nanostructure materials, Bottom-up approach and Top-down approach. Physical Methods – ball milling, sputtering, and evaporation. Chemical methods – Photochemical synthesis, electrochemical synthesis, and co-precipitation method. Thermolysis route – spray pyrolysis. Biological methods – bacteria, fungi and actinomycetes.

UNIT III	NANOMATERIALS	9

Nanoforms of Carbon – Buckminster fullerene –graphene and carbon nanotube, Single wall Carbon Nanotubes (SWCNT) and Multi wall Carbon nanotubes (MWCNT). Nanometal oxides – ZnO, MgO, TiO_2 and $AgTiO_2$. Nano clays – functionalization and applications – Quantum wire, Quantum dots preparation, properties and application.

UNIT IV	CHARACTERIZATION TECHNIQUES	9

Characterization Techniques: X-ray diffraction technique, Electron Microscope – SEM, and TEM. Surface Analysis Techniques – AFM, SPM, and STM, UV spectrophotometry and FTIR.

UNIT V	APPLICATION	9

Nano InfoTech: Information storage – Nano computer and Nanobiotechnology, Bioimaging – Micro Electro Mechanical System and Nano Electro Mechanical System. Nanofillers, Nanocoating, and Nano barriers, Nanoparticles for sun barrier products – In Photostat, solar cell and battery.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	Classify nanomaterials and identify its properties.
CO2:	Develop nanoparticles using different methods.
CO3:	Expand nanomaterials and its purpose.
CO4:	Develop knowledge in characteristics nanomaterials.
CO5:	Adapt nanotechnology in Electrical applications.

TEXTBOOKS

1	A.S Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publication, Bristol & Philadelphia, 1996.

U23BTO19	BIOLOGY FOR ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To familiarize the students with the basic biological concepts and their engineering applications.
2	To enable the students with an understanding of bio design principles to create novel devices and structures.
3	To provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems.
4	To motivate the students, develop the interdisciplinary vision of biological engineering.

UNIT I	BIOMOLECULES AND THEIR APPLICATIONS	9

Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).

UNIT II	HUMAN ORGAN SYSTEMS AND BIO DESIGNS - 1	9

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease).Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye).Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators)

UNIT III	HUMAN ORGAN SYSTEMS AND BIO-DESIGNS - 2	9

Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems). Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis).

UNIT IV	NATURE-BIOINSPIRED MATERIALS AND MECHANISMS	9

Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes - haemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).

UNIT V	TRENDS IN BIOENGINEERING	9

Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Self-healing Bio concrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	Elucidate the basic biological concepts via relevant industrial applications and case studies.
CO2:	Evaluate the principles of design and development, for exploring novel bioengineering projects.
CO3:	Corroborate the concepts of biomimetics for specific requirements.

CO4:	Think critically towards exploring innovative biobased solutions for socially relevant problems.
CO5:	understanding of bio design principles to create novel devices and structures.
TEXTBOOKS	
1	Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022.
2	Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
REFERENCE BOOKS:	
1	Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011.
2	Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
3	Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
4	Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.

U23BTO20	HYDROPONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Understand the concept of hydroponics
2.	Acquire the knowledge on soilless cultivation system
3.	Prepare media for hydroponics cultivation
4.	Learn the hydroponic cultivation technique
5.	Learn the applications of hydroponic cultivation.

UNIT I	INTRODUCTION TO SOILLESS CULTURE	9

Definition, History and origin of soilless culture, Present status of hydroponics contrasts with soil-based culture, Applications & future developments.

UNIT II	MACRONUTRIENTS, MICRONUTRIENTS	9

Functions and effect on plants, deficiency symptoms of the following essential minerals N, P, Mg, Ca, K, S, Fe, Mn, Cu, Zn, B, Mo, Physical factors, light Quantity, energy, photoperiodism *etc*), Temperature (Heating and cooling), Humidity, CO2, ppm, pH and TDS

UNIT III	CULTURAL CONDITIONS	9

Plant nutrition. Inorganic salts (fertilizers) major and minor nutrients formulating, monitoring and analysing. Selection of fertilizers, media used for hydroponics-expanded clay, rock wool, coir, perlite, pumice, vermiculite, sand gravel *etc*. Weed management, diseases and pest control.

UNIT IV	TECHNIQUES IN HYDROPONICS	9

Static solution culture, continuous-flow solution culture and aeroponics.

UNIT V	CULTIVATION OF CROP PLANTS BY HYDROPONICS	9

Passive sub-irrigation, Ebb and flow or flood and chain irrigation. Deep water culture protocols for Tomato cultivation through Dutch bucket method, chilly cultivation through NFT system, Spinach through raft System and measurements of yield

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Learn the concept of hydroponics.
CO2:	Understand the concepts on soilless cultivation system.
CO3:	Learn to prepare media for hydroponics cultivation.
CO4:	Understand the hydroponic cultivation technique.
CO5:	Learn the concept of hydroponics.
CO6:	Understand the functions and applications of hydroponic cultivation.

TEXTBOOKS

1.	Keith Roberto, How to Hydroponics. The future Garden Press NewYork.4thEdition
2.	Howard M. Resh. Hobby Hydroponics. CRC Press, USA.

REFERENCE BOOKS:

1.	Prasad S and Kumar U. Green House management for Horticultural crops. Agro-Bios India.
2.	Dahama A.K. Organic Farming for Sustainable Agriculture. Agrobios, India
3.	Sangeeta Singh, Tanmaya Kumar Bhoi, and Vipula Vyas. "Interceding Microbial Biofertilizers in Agroforestry System for Enhancing Productivity." In Plant Growth Promoting Microorganisms of Arid Region, Singapore: Springer Nature Singapore, 2023.

4.	Gde Gunarsa, I. Ketut Arnawa Ni Putu Pandawani, and I. Ketut Sumantara. "Urban Farming Planning Development of Household Scale Hydroponic Systems in Urban Area." International Journal of Sustainability, Education, And Global Creative Economic (IJSEGCE),2021.

U23BTO21	BIO MICROFLUIDICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To aware the students about the fundamental principles of microsystems.
2.	To provide the concepts essential for the designing of lab-on -a chip and Point -of- care devices for biomedical application.
3.	Hands on experience of fabricating simple microfluidic device
4.	Hands on experience of in-house microfabrication (Photolithography).
5.	To learn the performance and merit of different and point-of-care devices' concepts, importance, design, and work mode.

UNIT I	MICROFABRICATION	9

Introduction to MEMS and BioMEMS, Silicon microfabrication: materials and methods Microfabrication using soft substrate: materials and methods, biomedical application of MEMS devices.

UNIT II	TECHNIQUES IN MICROFABRICATION	9

Introduction to microfabrication and types of Microfabrication techniques: Photolithography, E-Beam Lithography, X-ray Lithography, Soft lithography, etc.

UNIT III	PRINCIPLES OF MICROFLUIDIC DEVICES	9

Basic principles in microfluidics, design principles for microfluidic devices, device fabrication procedures, (such as optical lithography and soft lithography), components of microfluidic devices utility of microfluidic devices in various biological, chemical, and optical sensing applications, optofluidic, Inertial-microfluidics, droplet-microfluidics, microfluidics based-flow cytometry.

UNIT IV	CHARACTERIZATION OF MICROFLUIDICS	9

Characteristics of microflow, Flow actuation: electrokinetic flow, pressure driven flow, surface energy driven flow, centrifugal microflow. Concept of bio-microfluidics, Design and function of H-filter and T-sensor, Peclet number.

UNIT V	APPLICATIONS OF MICROFLUIDIC DEVICES	9

Concept of ‘Lab on a chip’, Components of lab-on-a chip: micropump, microvalve, micromixer, microsensor, lenses, heaters, sensors, etc. Field flow fractionation (FFF), Microfluidic PCR, Microfluidic cell sorter, Lab-on-chip array for biomolecules, minimally invasive biomedical microdevices, and Microfluidics Future prospects.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	To understand the design of MEMS, BioMEMS, and microfluidics-based analytical platforms per the requirement.
CO2:	Ability to identify basic requirements for a design application related to microfabrication and its techniques for biomedical systems.
CO3:	To develop the skill to realize, build, and get hands-on experience fabricating simple microfluidic devices.
CO4:	To analyse, compare, and appreciate the performance and merit of different lab-on -a chip concepts, designs, and modes of work.
CO5:	To analyse, compare and appreciate the performance and merit of different and point-of-care devices' concepts, importance, design, and work mode.
CO6:	Develop knowledge on microfluidics.

TEXTBOOKS	
1.	E. Meng, Biomedical Microsystems, CRC Press, 2010, 1st Ed. ISBN-13: 978-1420051223,
2.	P. Tabeling, S. Chen, Introduction to microfluidics, Oxford University Press, 2010, 1st Ed. ISBN-13: 978-0199588169.
REFERENCE BOOKS:	
1.	Suman Chakraborty, Microfluidics and Microfabrication, Springer, 2014, ISBN-10:9781489984609
2.	Francesco Piraino and Šeila Selimovic, Diagnostic Devices with Microfluidics, CRC Press 1 edition, 2017, ISBN-10: 1498772935
3.	Hongliang Wang, Yunqiao Pu, Arthur Ragauskas, and Bin Yang. "From lignin to valuable products–strategies, challenges, and prospects." Bioresource technology 271 (2019): 449-461.
4.	Thao MinhHo, Aysan Razzaghi, Arun Ramachandran, and Kirsi S. Mikkonen. "Emulsion characterization via microfluidic devices: A review on interfacial tension and stability to coa-lescence." Advances in Colloid and Interface Science 2992022.

U23BTO22	BIORESOURCE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Identify various renewable energy sources.
2.	Describe large-scale fuel technologies and bioconversions.
3.	Demonstrate how biogas is produced from various bio-resources.
4.	Distinguish between the processes involved in bioethanol and butanol production.
5.	Evaluate the mechanism involved in biodiesel production.

UNIT I	RENEWABLE ENERY SOURCE	9

Hydropower, Geothermal power, solar power, wind power, Biofuel, Biomass, feed stocks (agricultural crops, bioenergy crops, agricultural waste residues, wood residues, waste stream).

UNIT II	FUEL TECHNOLOGY AND BIOCONVERSION	9

History- Definition of biofuel, applications of biofuel (transport, direct electricity generation, home use and energy content of biofuel) - Bioconversion of lignocellulosic, cellulose saccharification, pretreatment technologies (air separation process, mechanical size reduction, autohydrolysis) - Pulping and bleaching , Enzymatic deinking.

UNIT III	BIOGAS	9

Biogas plant, feed stock materials, biogas production, factors affecting methane formation -Role of methanogens , Biohydrogen production - Oxygen sensitivity problems in Hydrogenases

UNIT IV	BIO ETHANOL AND BUTANOL	9

Advantages of ethanol over fossil fuels, production of ethanol from cellulosic materials, ethanol recovery - Biobutanol production, energy content and effects on fuel economy - Octane rating, air fuel ratio, specific energy, viscosity, heat of vaporization -Butanol fuel Mixtures

UNIT V	BIODIESEL	9

Production of biodiesel, oil extraction from algae by chemical solvents, enzymatic, expeller press - Osmotic shock and ultrasonic assisted extraction - Applications of biodiesel, environmental benefits and concerns

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Understand the various renewable energy sources
CO2:	Learn the concept on large-scale fuel technologies and bioconversions
CO3:	Learn how biogas is produced from various bio-resources.
CO4:	Know the processes involved in bioethanol and butanol production.
CO5:	Understand the mechanism involved in biodiesel production
CO6:	Learn about the applications in bioresource technology

TEXTBOOKS

1.	Alain. A. V., Biomass to biofuels strategies for global industries, John Wilwy & sons ltd, 1th Edition, 2010.
2.	Twidell., J & Weir., T., Renewable energy resources, Taylor &Francis, 2nd Edition, 2006.

REFERENCE BOOKS:

1.	Luque, R., Camp. J., Hand book of biofuel production processes and technologies, Woodhead publishing ltd., 1st edition, 2011.
2.	Jose Antonio Garrido-Cardenas, Francisco Manzano-Agugliaro, Francisco Gabriel Acien-Fernandez, and Emilio Molina-Grima. "Microalgae research worldwide." Algal research2018).

3.	Bhawna Sharma, Christian Larroche, and Claude-Gilles Dussap. "Comprehensive assessment of 2G bioethanol production." Bioresource technology (2020): 123630.
4.	Sang-HyounKim, Gopalakrishnan Kumar, Wei-Hsin Chen, and Samir Kumar Khanal. "Renewable hydrogen production from biomass and wastes (ReBioH2-2020)." Bioresource technology 2021.

U23BTO23	FUNDAMENTALS OF BIOCHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	To enhance skills in the areas of biochemical processes, to provide the fundamental back-ground of biological systems, bio-chemical engineering.
2	To make better understanding of food processing and waste treatment.
3	To make better understanding of microbial world and their growth.
4	Maintain and improve fermentation technology knowledge.
5	To make better understanding and enhance skill for recovery of product.

UNIT I	INTRODUCTION	9

Introduction to biochemical process industries, industrial alcohols, antibiotics, acids, alcoholic beverages, enzymes, vitamins, single cell protein.

UNIT II	FOOD PROCESSING AND WASTE TREATMENT	9

Food processing and biological waste treatment. Interaction of chemical engineering principles with biological sciences.

UNIT III	BIOLOGICAL SYSTEMS AND BIOPROCESS ENGINEERING	9

Life processes, Unit of living system, microbiology, reaction in living systems, biocatalysts, model reactions. Fermentation mechanisms and kinetics: kinetic models of microbial growth and product formation.

UNIT IV	BIOREACTOR DESIGN AND FERMENTATION ENGINEERING	9

Fermenter types; Modeling of batch and continuous fermenter. Bioreactor design, mixing phenomena in bioreactors. Sterilization of media and air, sterilization equipment, batch and continuous sterilize design.

UNIT V	BIOCHEMICAL SEPARATION AND PURIFICATION TECHNIQUES	9

Biochemical product recovery and separation. Membrane separation process: reverse osmosis, dialysis, ultrafiltration; Chromatographic methods: adsorption chromatography, gel filtration, affinity chromatography etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	The students are expected to understand the basic importance and need for bio-chemical engineering and also the difference between bioprocesses and chemical processes.
CO2:	Have good knowledge and skill for food processing
CO3:	Ability to understood growth pattern and kinetics of microbe.
CO4:	Ability to run fermenter and bioreactor and knowledge for industrial applications.
CO5:	Well knowledge for biochemical product recovery and separation.

TEXTBOOKS

1.	JE Bailey and DF Ollis, 'Biochemical engineering fundamentals', 2nd edition, McGraw Hill, 1986.

REFERENCE BOOKS:

1.	M. L. Shuler, F. Kargi, 'Bioprocess Engineering', 2nd Ed., Prentice Hall, 2002

U23BTO24	BIOTECHNOLOGY FOR HUMAN WELFARE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1	This paper will enable the students to learn the basics and lay strong foundation in understanding the biotechnological techniques in human welfare.
2	To make better understanding of Agricultural biotech
3	To make better understanding of Food and dairy technology
4	Maintain and improve knowledge on disease diagnosis
5	To make better understanding and enhance skill for prevention of diseases

UNIT I	AGRICULTURAL BIOTECHNOLOGY	9

Organic farming. Integrated farming, Vermicompost, Crop Improvement.

UNIT II	FOOD & DAIRY BIOTECHNOLOGY	9

Microbes as food, feed. Prebiotics. Probiotics. Algae - SCP, Beta carotene, Fungi as food – Mushroom. Fermented food products.

UNIT III	BIOTECHNOLOGY FOR DISEASE DIAGNOSIS	9

Clinical diagnosis. Lab diagnosis – Microscopy, Macroscopy, Biochemical, serological & Molecular diagnosis of diseases – PCR, RT –PCR, RAPD, RFLP, Karyotping

UNIT IV	BIOTECHNOLOGY FOR TREATMENT & PREVENTION OF DISEASES	9

Treatment – Symptomatic therapy, specific therapy, antimocrobials Prevention – Active immunization, passive immunization, combined immunization, herd immunity.

UNIT V	ENVIRONMENTAL BIOTECHNOLOGY	9

Waste management – Solid, liquid, sewage, municipal waste Bioremediation. Bioleaching. Biodegradation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1:	to comprehend Applications and products of agri technology, Describe N2 fixation, pest resistance gene transfer, and livestock improvement
CO2:	Ability to emphasize on Products of Food and Biotechnology and its effect on human welfare
CO3:	Apply knowledge and skills of immunology, bioinformatics, computational modelling of proteins, drug design and simulations to test the models and aid in diagnosis
CO4:	Describe therapeutic agents, vaccines, gene therapy, diagnostics, and the human genome project.
CO5:	Acquire knowledge about biodegradable materials to protect environment pollution

TEXTBOOKS

1.	D. Balasubramanian, C. F. A. Bryce, K. Dharmalingham, J. Green and K.Jayaraman.1996. Concepts in Biotechnology. Universities Press.
2.	Ashok K. Chauhan. 2009. A Textbook of Molecular Biotechnology. I.K. International Publishing house Pvt. Ltd.
3.	Chandrakant Kokate, SS Jalalpure, Pramod H.J. 2011. Textbook of Pharmaceutical Biotechnology. A division of Reed Elsevier India Pvt. Ltd.

REFERENCE BOOKS:

1.	B.C. Bhattacharyya and Rintu Banerjee. 2007. Environmental Biotechnology. Oxford Higher Education Publication