B.Tech. (Biotechnology)

Revised 2018 Regulations, Curriculum & Syllabi

(Candidates admitted during Academic Year 2021-2022)

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University – Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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VISION OF THE DEPARTMENT

To offer world-class education by providing academic and professional competence in tune with technological and societal aspirations.

MISSION OF THE DEPARTMENT

- To provide a state-of-art infrastructure for a professional environment through standard academic practices, co-curricular and extra-curricular activities in-line with National and International paradigms.
- To facilitate a platform for student and faculty members towards qualitative interdisciplinary research for developing sustainable circular bioeconomy.
- To establish collaborations with biotech ventures and research institutes to inculcate professional and leadership qualities for students career advancements and faculty competency enhancement.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. To maintain high standards of teaching through innovative pedagogy for enabling students to be lifelong learners and globally competent professionals.

II. To foster creativity through innovation based research activities for upliftment of self and society promoting socio-economic growth.

III. To inculcate professional ethics and skills amongst the graduates and empowering them to have career advancement through placements, higher studies, and entrepreneurship.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give

and receive clear instructions.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOME (PSOs)

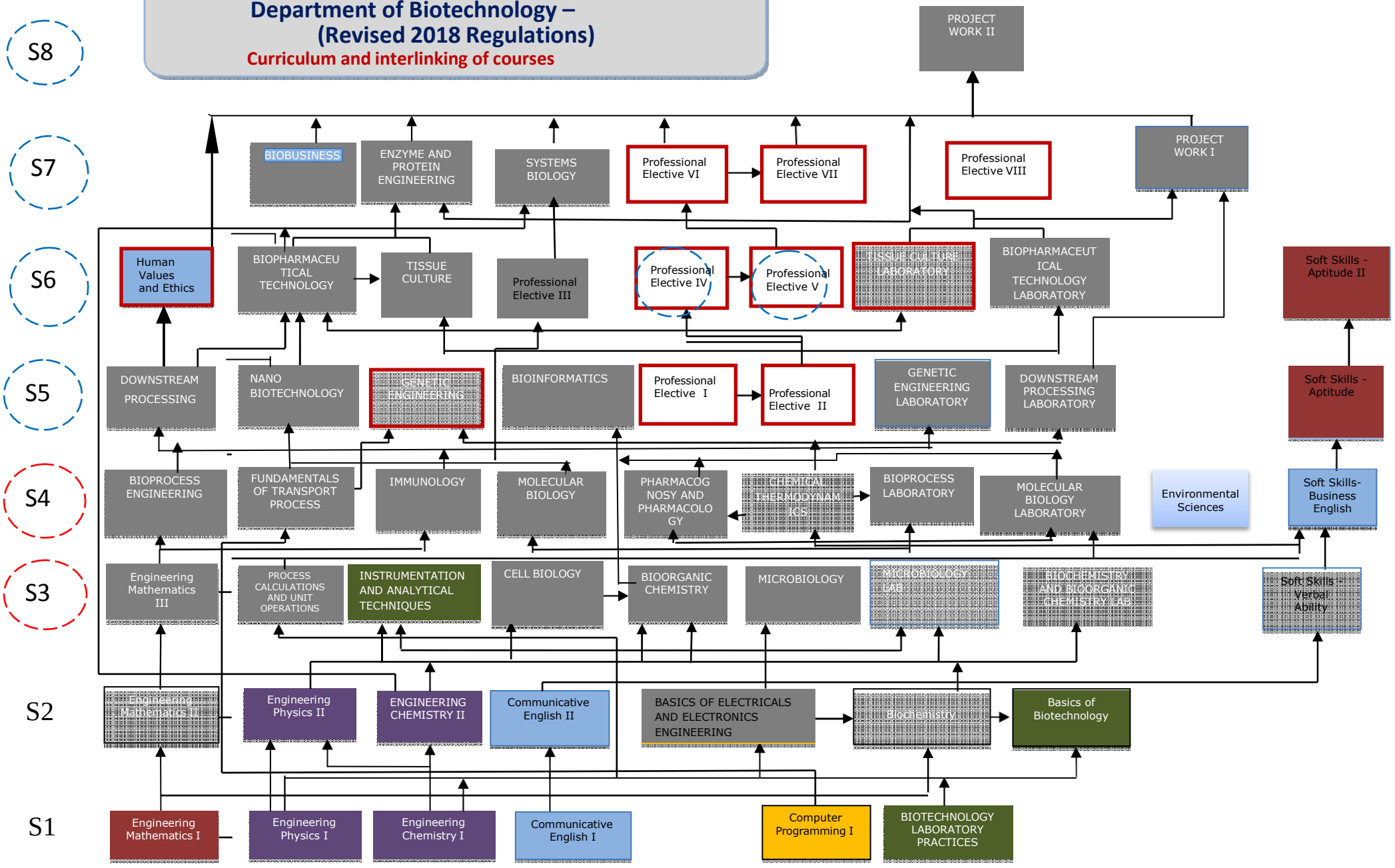
1. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
2. Design and synthesis of the novel biomolecule for the agriculture and healthcare sectors
3. Conceive, Plan and Deploy societal projects for environmental protection using Bioresources.

MAPPING OF PEOs & POs

POs	1	2	3	4	5	6	7	8	9	10	11	12
PEO I	X	X	X		X	X				X	X	
PEO II		X	X	X		X		X		X	X	X
PEO III						X	X		X		X	X

Department of Biotechnology – (Revised 2018 Regulations)

Curriculum and interlinking of courses



General Electives (I to IX) are the courses offered by the department.

DEPARTMENT OF BIOTECHNOLOGY
Minimum Credits to be Earned : 163

I SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18BT101	ENGINEERING MATHEMATICS I	3	1	0	**4**	4	50	50	100	BS
18BT102	ENGINEERING PHYSICS I	2	0	2	**3**	4	50	50	100	BS
18BT103	ENGINEERING CHEMISTRY I	2	0	2	**3**	4	50	50	100	BS
18BT104	COMPUTER PROGRAMMING	2	0	2	**3**	4	50	50	100	ES
18HS101	COMMUNICATIVE ENGLISH I	1	0	2	**2**	3	100	0	100	HSS
18BT106	BIOTECHNOLOGY LABORATORY PRACTICES	0	0	4	**2**	4	100	0	100	BS
Total		**10**	**1**	**12**	**17**	**23**				**-**

II SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18BT201	ENGINEERING MATHEMATICS II	3	1	0	**4**	4	50	50	100	BS
18BT202	ENGINEERING PHYSICS II	2	0	2	**3**	4	50	50	100	BS
18BT203	ENGINEERING CHEMISTRY II	2	0	2	**3**	4	50	50	100	BS
18BT204	BASICS OF ELECTRICALS AND ELECTRONICS ENGINEERING	2	0	2	**3**	4	50	50	100	ES
	LANGUAGE ELECTIVE	1	0	2	**2**	3	100	0	100	HSS
18BT206	BIOCHEMISTRY	3	0	0	**3**	3	50	50	100	ES
18BT207	BASICS OF BIOTECHNOLOGY	3	0	0	**3**	3	50	50	100	ES
Total		**15**	**1**	**6**	**21**	**25**				**-**

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18BT301	ENGINEERING MATHEMATICS III	3	1	0	**4**	4	50	50	100	BS
18BT302	PROCESS CALCULATIONS AND UNIT OPERATIONS	3	0	2	**4**	5	50	50	100	ES
18BT303	INSTRUMENTATION AND ANALYTICAL TECHNIQUES	3	0	0	**3**	3	50	50	100	ES
18BT304	CELL BIOLOGY	3	0	0	**3**	3	50	50	100	PC
18BT305	BIOORGANIC CHEMISTRY	3	0	0	**3**	3	50	50	100	PC
18BT306	MICROBIOLOGY	3	0	0	**3**	3	50	50	100	PC
18BT307	MICROBIOLOGY LAB	0	0	4	**2**	4	100	0	100	PC
18BT308	BIOCHEMISTRY AND BIOORGANIC CHEMISTRY LAB	0	0	4	**2**	4	100	0	100	ES
18GE301	SOFT SKILLS - VERBAL ABILITY	0	0	2	-	2	100	0	100	EEC
Total		**18**	**1**	**12**	**24**	**31**				-

IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18BT401	BIOPROCESS ENGINEERING	3	1	0	**4**	4	50	50	100	PC
18BT402	FUNDAMENTALS OF TRANSPORT PROCESS	3	1	0	**4**	4	50	50	100	ES
18BT403	IMMUNOLOGY	3	0	2	**4**	5	50	50	100	PC
18BT404	MOLECULAR BIOLOGY	3	0	0	**3**	3	50	50	100	PC
18BT405	PHARMACOGNOSY AND PHARMACOLOGY	3	0	0	**3**	3	50	50	100	PC
18BT406	CHEMICAL THERMODYNAMICS	3	1	0	**4**	4	50	50	100	ES
18BT407	BIOPROCESS LABORATORY	0	0	4	**2**	4	100	0	100	PC
18BT408	MOLECULAR BIOLOGY LABORATORY	0	0	4	**2**	4	100	0	100	PC
18HS001	ENVIRONMENTAL SCIENCE	2	0	0	-	2	100	0	100	HSS
18GE401	SOFT SKILLS– BUSINESS ENGLISH	0	0	2	-	2	100	0	100	EEC
Total		**20**	**3**	**12**	**26**	**35**				-

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21BT501	DOWNSTREAM PROCESSING	3	1	0	**4**	4	40	60	100	PC
21BT502	NANO BIOTECHNOLOGY	3	0	2	**4**	5	50	50	100	PC
21BT503	GENETIC ENGINEERING	3	0	0	**3**	3	40	60	100	PC
21BT504	BIOINFORMATICS	3	0	0	**3**	3	40	60	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	**3**	3	40	60	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	**3**	3	40	60	100	PE
21BT507	GENETIC ENGINEERING LABORATORY	0	0	4	**2**	4	100	0	100	PC
21BT508	DOWNSTREAM PROCESSING LABORATORY	0	0	4	**2**	4	100	0	100	PC
18GE501	SOFT SKILLS - APTITUDE I	0	0	2	-	2	100	0	100	EEC
Total		**18**	**1**	**12**	**24**	**31**				**-**
VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21HS002	HUMAN VALUES AND ETHICS	2	0	0	**2**	2	40	60	100	HSS
21BT602	BIOPHARMACEUTICAL TECHNOLOGY	3	0	0	**3**	3	40	60	100	EEC
21BT603	TISSUE CULTURE	3	0	0	**3**	3	40	60	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	**3**	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	**3**	3	40	60	100	PE
	PROFESSIONAL ELECTIVE V	3	0	0	**3**	3	40	60	100	PE
21BT607	TISSUE CULTURE LABORATORY	0	0	4	**2**	4	100	0	100	PC
21BT608	BIOPHARMACEUTICAL TECHNOLOGY LABORATORY	0	0	4	**2**	4	100	0	100	PC
18GE601	SOFT SKILLS - APTITUDE II	0	0	2	-	2	100	0	100	EEC
Total		**17**	**0**	**10**	**21**	**27**				**-**

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21BT701	BIOBUSINESS	3	0	0	**3**	3	40	60	100	PC
21BT702	ENZYME AND PROTEIN ENGINEERING	3	0	0	**3**	3	40	60	100	PC
	PROFESSIONAL ELECTIVE VI	3	0	0	**3**	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VII	3	0	0	**3**	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	**3**	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	**3**	3	40	60	100	PE
21BT707	PROJECT WORK I	0	0	6	**3**	6	100	0	100	EEC
Total		**18**	**0**	**6**	**21**	**24**				**-**
VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21BT801	PROJECT WORK II	0	0	18	**9**	18	100	0	100	EEC
Total		**0**	**0**	**18**	**9**	**18**				**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18HSH01	HINDI	1	0	2	**2**	3	100	0	100	HSS
18HSG01	GERMAN	1	0	2	**2**	3	100	0	100	HSS
18HSJ01	JAPANESE	1	0	2	**2**	3	100	0	100	HSS
18HSC01	CHINESE	1	0	2	**2**	3	100	0	100	HSS
18HSF01	FRENCH	1	0	2	**2**	3	100	0	100	HSS
PHYSICS ELECTIVES										
18GE0P1	NANOMATERIALS SCIENCE	3	0	0	**3**	3	50	50	100	BS
18GE0P2	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	**3**	3	50	50	100	BS
18GE0P3	APPLIED LASER SCIENCE	3	0	0	**3**	3	50	50	100	BS
CHEMISTRY ELECTIVES										
18GE0C1	CORROSION SCIENCE AND ENGINEERING	3	0	0	**3**	3	50	50	100	BS
18GE0C2	ENERGY STORING DEVICES	3	0	0	**3**	3	50	50	100	BS
18GE0C3	POLYMER SCIENCE	3	0	0	**3**	3	50	50	100	BS
MATHEMATICS ELECTIVES										
18GE0M1	GRAPH THEORY AND COMBINATORICS	3	0	0	**3**	3	50	50	100	BS
18GE0M2	ALGEBRA AND NUMBER THEORY	3	0	0	**3**	3	50	50	100	BS
18GE0M3	MATHEMATICAL FINANCE AND QUEUEING THEORY	3	0	0	**3**	3	50	50	100	BS
ENTREPRENEURSHIP ELECTIVES										
18GE0E1	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	**3**	3	50	50	100	PE
18GE0E2	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	**3**	3	50	50	100	PE

PROFESSIONAL ELECTIVES

VERTICAL I - BIOPROCESS ENGINEERING

Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
21BT001	FERMENTATION TECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT002	INDUSTRIAL MICROBIOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT003	ENVIRONMENTAL BIOTECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT004	BIOENERGY AND BIOFUELS	3	0	0	**3**	3	40	60	100	PE
21BT005	BIOREACTOR DESIGN MODELING AND SIMULATION	3	0	0	**3**	3	40	60	100	PE
21BT006	BIOPROCESS CONTROL AND INSTRUMENTATION	3	0	0	**3**	3	40	60	100	PE
21BT007	TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS	3	0	0	**3**	3	40	60	100	PE

VERTICAL II – APPLIED BIOTECHNOLOGY

Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
21BT008	ASTROBIOLOGY AND ASTROCHEMISTRY	3	0	0	**3**	3	40	60	100	PE
21BT009	BIOPROSPECTING AND QUALITY ANALYSIS	3	0	0	**3**	3	40	60	100	PE
21BT010	FOOD PROCESS AND TECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT011	MARINE BIOTECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT012	BIODIVERSITY	3	0	0	**3**	3	40	60	100	PE
21BT013	BIOSENSORS	3	0	0	**3**	3	40	60	100	PE
21BT014	BIOMATERIALS	3	0	0	**3**	3	40	60	100	PE

VERTICAL III - COMPUTATIONAL BIOTECHNOLOGY

Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
21BT015	PROGRAMS FOR BIOINFORMATICS	3	0	0	**3**	3	40	60	100	PE
21BT016	FUNDAMENTALS OF ALGORITHMS FOR BIOINFORMATICS	3	0	0	**3**	3	40	60	100	PE
21BT017	MOLECULAR MODELING	3	0	0	**3**	3	40	60	100	PE
21BT018	COMPUTER AIDED DRUG DESIGN	3	0	0	**3**	3	40	60	100	PE
21BT019	METABOLOMICS AND GENOMICS- A BIG DATA ANALYTICS	3	0	0	**3**	3	40	60	100	PE
21BT020	DATA MINING AND MACHINE LEARNING TECHNIQUES FOR INFORMATICS	3	0	0	**3**	3	40	60	100	PE

21BT021	SYSTEMS AND SYNTHETIC BIOLOGY	3	0	0	**3**	3	40	60	100	PE

VERTICAL IV - AGRO BIOTECHNOLOGY

Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
21BT022	PLANT TISSUE CULTURE AND TRANSFORMATION TECHNIQUE	3	0	0	**3**	3	40	60	100	PE
21BT023	TRANSGENIC TECHNOLOGY IN AGRICULTURE	3	0	0	**3**	3	40	60	100	PE
21BT024	BIOFERTILIZERS AND BIOPESTICIDES PRODUCTION	3	0	0	**3**	3	40	60	100	PE
21BT025	MUSHROOM CULTIVATION AND VERMICOMPOSTING	3	0	0	**3**	3	40	60	100	PE
21BT026	FUNGAL AND ALGAL TECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT027	PHYTOTHERAPEAUTICS	3	0	0	**3**	3	40	60	100	PE

VERTICAL V - ANIMAL BIOTECHNOLOGY

Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
21BT028	ANIMAL PHYSIOLOGY AND METABOLISM	3	0	0	**3**	3	40	60	100	PE
21BT029	ANIMAL HEALTH AND NUTRITION	3	0	0	**3**	3	40	60	100	PE
21BT030	ANIMAL CELL CULTURE TECHNIQUE	3	0	0	**3**	3	40	60	100	PE
21BT031	BIOTECHNIQUES IN ANIMAL BREEDING	3	0	0	**3**	3	40	60	100	PE
21BT032	FUNDAMENTALS OF ANIMAL TRANSGENICS	3	0	0	**3**	3	40	60	100	PE
21BT033	STEM CELL TECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT034	TISSUE ENGINEERING	3	0	0	**3**	3	40	60	100	PE

VERTICAL VI - MEDICAL BIOTECHNOLOGY

Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
21BT035	BASIC PRODUCTION ON MEDICAL BIOTECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT036	MOLECULAR THERAPEUTICS AND DIAGNOSTIC	3	0	0	**3**	3	40	60	100	PE
21BT037	BIONANO TECHNIQUES	3	0	0	**3**	3	40	60	100	PE
21BT038	CANCER AND NEUROBIOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT039	HUMAN GENETICS	3	0	0	**3**	3	40	60	100	PE
21BT040	VACCINE TECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT041	BIOPHARMACEUTICS AND	3	0	0	**3**	3	40	60	100	PE

	ITS BIOSIMILARS									

VERTICAL VII - QUALITY AND REGULATORY AFFAIRS

Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
21BT042	CLINICAL TRIALS AND HEALTHCARE POLICIES IN BIOTECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT043	BIOTECH PRODUCTS AND ITS VALIDATION	3	0	0	**3**	3	40	60	100	PE
21BT044	QA AND QC IN BIOTECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BT045	PATENT DESIGN, IPR IN BIOTECHNOLOGY AND BIOENTREPRENEURSHIP	3	0	0	**3**	3	40	60	100	PE
21BT046	BIOSAFETY AND HAZARD MANAGEMENT	3	0	0	**3**	3	40	60	100	PE
21BT047	GOOD MANUFACTURING PRACTICES	3	0	0	**3**	3	40	60	100	PE

HONOURS DEGREE (With Specialization)

VERTICAL V - ANIMAL BIOTECHNOLOGY

Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
21BTH28	ANIMAL PHYSIOLOGY AND METABOLISM	3	0	0	**3**	3	40	60	100	PE
21BTH29	ANIMAL HEALTH AND NUTRITION	3	0	0	**3**	3	40	60	100	PE
21BTH30	ANIMAL CELL CULTURE TECHNIQUE	3	0	0	**3**	3	40	60	100	PE
21BTH31	BIOTECHNIQUES IN ANIMAL BREEDING	3	0	0	**3**	3	40	60	100	PE
21BTH32	FUNDAMENTALS OF ANIMAL TRANSGENICS	3	0	0	**3**	3	40	60	100	PE
21BTH33	STEM CELL TECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BTH34	TISSUE ENGINEERING	3	0	0	**3**	3	40	60	100	PE

MINOR DEGREE (Other than Biotechnology Students)										
VERTICAL IV – AGRO BIOTECHNOLOGY										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21BTM01	PLANT TISSUE CULTURE AND TRANSFORMATION TECHNIQUE	3	0	0	**3**	3	40	60	100	PE
21BTM02	TRANSGENIC TECHNOLOGY IN AGRICULTURE	3	0	0	**3**	3	40	60	100	PE
21BTM03	BIOFERTILIZERS AND BIOPESTICIDES PRODUCTION	3	0	0	**3**	3	40	60	100	PE
21BTM04	MUSHROOM CULTIVATION AND VERMICOMPOSTING	3	0	0	**3**	3	40	60	100	PE
21BTM05	FUNGAL AND ALGAL TECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
21BTM06	PHYTOTHERAPEAUTICS	3	0	0	**3**	3	40	60	100	PE
21BTM07	PLANT TISSUE CULTURE AND TRANSFORMATION TECHNIQUE	3	0	0	**3**	3	40	60	100	PE

ONE CREDIT COURSES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18BT0XA	MOLECULAR MARKER TECHNOLOGIES	1	0	0	**1**	-	100	0	100	EEC
18BT0XB	TRANSLATIONAL RESEARCH AND TECHNOLOGY TRANSFER	1	0	0	**1**	-	100	0	100	EEC
18BT0XC	MARINE FOOD TECHNOLOGY	1	0	0	**1**	-	100	0	100	EEC
18BT0XD	BEVERAGE, BAKING AND CONFECTIONERY TECHNOLOGY	1	0	0	**1**	-	100	0	100	EEC
18BT0XE	APPLIED SYSTEMS BIOLOGY	1	0	0	**1**	-	100	0	100	EEC
18BT0XF	FUNDAMENTALS OF LIQUID CHROMATOGRAPHY	1	0	0	**1**	-	100	0	100	EEC
18BT0XG	PROCESS VALIDATION AND QUALITY ASSURANCE FOR BIOPRODUCTS	1	0	0	**1**	-	100	0	100	EEC
18BT0XH	DIAGNOSTICS AND HEALTH CARE	1	0	0	**1**	-	100	0	100	EEC
18BT0XI	CLINICAL RESEARCH	1	0	0	**1**	-	100	0	100	EEC

ADDITIONAL ONE CREDIT COURSE										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18GE0XA	ETYMOLOGY	1	0	0	**1**	-	100	0	100	EEC
18GE0XB	GENERAL PSYCHOLOGY	1	0	0	**1**	-	100	0	100	EEC
18GE0XC	NEURO BEHAVIORAL SCIENCE	1	0	0	**1**	-	100	0	100	EEC
18GE0XD	VISUAL MEDIA AND FILM MAKING	1	0	0	**1**	-	100	0	100	EEC
18GE0XE	YOGA FOR HUMAN EXCELLENCE	1	0	0	**1**	-	100	0	100	EEC
18GE0XF	VEDIC MATHEMATICS	1	0	0	**1**	-	100	0	100	EEC
18GE0XG	HEALTH AND FITNESS	1	0	0	**1**	-	100	0	100	EEC
18GE0XI	BLOG WRITING	1	0	0	**1**	-	100	0	100	EEC
18GE0XJ	INTERPERSONAL SKILLS	1	0	0	**1**	-	100	0	100	EEC
18GE0XK	NEW AGE INNOVATION AND ENTREPRENEURSHIP	1	0	0	**1**	-	100	0	100	EEC
18GE0XL	NATIONAL CADET CORPS	1	0	0	**1**	-	100	0	100	EEC
18GE0XM	COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT	1	0	0	**1**	-	100	0	100	EEC
18GE0XN	DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES	1	0	0	**1**	-	100	0	100	EEC
18GE0XO	SOCIAL PSYCHOLOGY	1	0	0	**1**	-	100	0	100	EEC

OPEN ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18BT0YA	BIOFUELS	3	0	0	**3**	3	50	50	100	PE
18BT0YB	MUSHROOM CULTIVATION AND VERMICOMPOSTING	3	0	0	**3**	3	50	50	100	PE
18BT0YC	FORENSIC TECHNOLOGY	3	0	0	**3**	3	50	50	100	PE

SUMMARY OF CREDIT DISTRIBUTION

S.No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	12	10	4						26	16	15%	20%
2	ES	3	9	9	8					29	18	15%	20%
3	HSS	2	2				2			6	4	5%	10%
4	PC			11	18	18	7	6		60	37	35%	45%
5	PE					6	9	12		27	16	15%	20%
6	EEC						3	3	9	15	9	5%	10%
Total		17	21	24	26	24	21	21	9	163	100	-	-

BS- Basic Science
ES - Engineering Sciences
HSS - Humanities and Social
SciencesPC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement
CourseCA - Continuous Assessment
ES - End Semester Examination

18BT101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- Understand the concepts of vectors and Eigenvectors for different matrices to describe the stability of the linear systems in engineering fields.
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems
- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering systems.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the different forms of coordinate system in complex plane and characteristics of linear systems by Eigen values and Eigenvectors.
2. Apply various types of functions and their differentiation techniques involved in engineering fields.
3. Analyze different methods of integration used in engineering problems.
4. Analyze the suitable integration technique to calculate the area and volume of different surfaces.
5. Evalaute the concept of analytic function to estimate the integral in complex plane.

Articulation Matrix

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

UNIT I **9 Hours**

COMPLEX NUMBERS, VECTORS AND MATRICES

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices: Eigen values and Eigen vectors, Properties of eigen values and eigen vectors.

UNIT II **9 Hours**

CALCULUS

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions. Derivatives: Derivatives, differentiability, rules and properties, differentiation of transcendental functions, higher order derivatives, implicit differentiation, and differentiation of hyperbolic functions. Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

UNIT III **9 Hours**

INTEGRATION METHODS

Basic integration formulae for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

UNIT IV **9 Hours**

APPLICATIONS OF DERIVATIVES AND INTEGRATIONS

Extreme values, points of inflection and curve sketching, Rolls Theorem, Mean Value Theorem, optimization, indeterminate forms, L Hopitals Rule. Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

UNIT V **9 Hours**

COMPLEX ANALYSIS

Analytic Functions- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method. Cauchys Integral Formula - Classification of Singularities - Cauchys Residue Theorem

FOR FURTHER READING

Mass spring system in ordinary differential equations of higher order.

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.
3. Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
4. Anton H, Calculus with Analytic Geometry, 5th edition, John Wiley & Sons, 1995.
5. Ayres F Jr and Mendelson E, Schaum's Outline of Theory and Problems of Calculus, 4th edition, McGraw Hill, 1999.

18BT102 ENGINEERING PHYSICS I 2 0 2 3

Course Objectives

- Illustrate the Newtons laws of motion and wave motion with applications
- Understand the basic properties of electricity, magnetism and optics
- Differentiate the special theory of relativity and quantum physics from classical physics

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Apply the Newtons three laws of motion and apply the same to solve the real world problems involving elevator, atwood machine and acceleration of objects.
2. Apply the physical characteristics of simple harmonic motion, wave motion and find the solutionsfor wave equations.
3. Analyze the fundamental laws, properties of electricity and magnetism and apply the same to electric andmagnetic elements.
4. Analyze the principles of physical and geometrical optics in the mirrors, lenses, microscopes and diffraction gratings.
5. Evaluate the importance of special theory of relativity, quantum physics and analyse the wave andparticle nature of matter.

Articulation Matrix

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

UNIT I **6 Hours**

MECHANICS

Newtons laws of motion: Concept of force and its nature - Newtons first law and inertial frames - definition of mass - Newtons second law-gravitational force and weight - Newtons third law. Applications of Newton’
s laws: particle in equilibrium, particle under net force - weighing a mass in an elevator, the atwood machine and acceleration of two objects connected by a cord.

UNIT II **6 Hours**

OSCILLATIONS AND WAVES

Fundamentals of simple harmonic motion - energy of simple harmonic oscillator - spring mass system - time period of simple pendulum, compound pendulum and torsional pendulum - Damped oscillations. Travelling wave motion - sinusoidal waves on strings - speed of a wave - reflection and transmission - rate of energy transfer in wave motion

UNIT III **6 Hours**

ELECTRICITY AND MAGNETISM

Point charges - electric fields - Gausss law and its applications - electric potential - capacitance - energy stored in a capacitor. Concept and source of magnetic fields - Amperes theorem - determination of magnetic field due to different current distributions - Faradays law - self-induction and mutual induction - energy stored in an inductor

UNIT IV **6 Hours**

LIGHT AND OPTICS

Nature of light - laws of reflection and refraction - refractive index and Snells law - dispersion of light - total internal reflection - image formation: concave mirrors - convex mirrors - thin lenses - compound microscope - human eye. Conditions of interference - Youngs double slit experiment - intensity distribution of interference - phase change due to reflection - diffraction-narrow slit diffraction - single slit and two slit - intensity distribution - diffraction grating – applications.

UNIT V **6 Hours**

MODERN PHYSICS

Special theory of relativity - simultaneity and time dilation - twin paradox - length contraction -relativistic mass variation - space time graph.Black body radiation and Planck hypothesis - allowed energy levels - thermal radiation from different objects - photoelectric and Compton Effect. Matter waves - de-Broglie hypothesis - wave nature of particles - Davission-Germer experiment

1 **5 Hours**

EXPERIMENT 1

Determination of resultant of system of concurrent coplanar forces-Parallelogram law of forces

2 **5 Hours**

EXPERIMENT 2

Determination of moment of inertia-Torsional pendulum

3 **5 Hours**

EXPERIMENT 3

Determination of wavelength of mercury spectral lines-spectrometer

4 **4 Hours**

EXPERIMENT 4

Determination of refractive index of solid and liquid-travelling microscope

5 **3 Hours**

EXPERIMENT 5

Determination of wavelength of laser-diffraction grating

6 **4 Hours**

EXPERIMENT 6

Determination of frequency of a tuning fork-Meldes apparatus

7 **4 Hours**

EXPERIMENT 7

Thickness of a thin wire using interference of light-Air wedge method

Total: 60 Hours

Reference(s)

1. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2011
2. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011
3. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017
4. H D Young and R A Freedman, Sears and Zemansky's University Physics with Modern Physics, Pearson education, 2016
5. R K Gaur and S L Gupta, Engineering Physics, Dhanpat Rai Publications, 2012

18BT103 ENGINEERING CHEMISTRY I 2 0 2 3

Course Objectives

- Outline the bonding and arrangements of atoms in biomolecules and their interactions.
- Interpret the molecules three dimensional orientation and its optical rotations.
- Identify the different organic reaction intermediates and reaction mechanisms

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the bonding interactions of biomolecules and its three dimensional orientations
2. Apply the drug molecular interactions and reactions in biological species
3. Analyze the basic biological reaction and its organic mechanisms
4. Analyze a polymer material for the different biological applications
5. Evaluate a suitable analytical method for the identification of functional groups in organic compoundsand estimation of metal/metal ions in solution

Articulation Matrix

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

UNIT I **6 Hours**

CHEMICAL BONDING

Bonding: Classification of bonds - primary bonds (covalent, electrovalent, dative and metallic bonds) - secondary bonds (dipole-dipole, ionic, H-bonding, Vander Waals and hydrophobic interactions) - theories of chemical bonding - valence bond and molecular orbital theory. Thermodynamics of chemical reactions - Reaction isotherm.

UNIT II **6 Hours**

STEREOCHEMISTRY

Isomerism - classification - tautomersim. Stereochemistry- chirality - prochirality- CIP sequence rules - optical isomers (R & S) - types. re and si faces. Geometrical isomerism (E & Z). Types of strains in molecules - Bayers strain theory. Conformational analysis of alkanes and cycloalkanes - reactivity of cycloalkanes.

UNIT III **6 Hours**

ORGANIC REACTIONS AND MECHANISMS

Functional groups - bond cleavage - reactive species. Types of organic reactions. Substitution - nucleophilic substitution SN1 and SN2 mechanism - stereochemistry. Reactivity of alkyl halides - nucleophilicity - elimination. Esterification & hydrolysis - condensation - cyclisation - Rearrangement - isomerisation.

UNIT IV **6 Hours**

POLYMERS

Polymers - classification - polymerization - polymer characterizations - molecular weight - thermal stability physico-mechanical property - applications. Biopolymers - classifications - biodegradability and compatibility - Uses.

UNIT V **6 Hours**

ANALYTICAL INSTRUMENTATION TECHNIQUES

Chromatograpy - adsorption isotherms - classification. Spectroscopy- Jablonski diagram - UV-Visible, IR, NMR (1H and 13C) and Raman spectroscopy - theory and applications. Mass spectrometry: Principle, instrumentation and applications.

FOR FURTHER READING

Paper battery, Carbon nanotubes with a conventional sheet of cellulose based paper Polymers used in biomedical devices

1 **6 Hours**

EXPERIMENT 1

Construction of adsorption isotherm for equilibrium dye adsorption on cotton fibers

2 **6 Hours**

EXPERIMENT 2

Determination of specific rotation and purity of sucrose using Polarimeter

3 **6 Hours**

EXPERIMENT 3

Preparation of ethyl acetate by esterification and ester hydrolysis via saponification reactions

4 **6 Hours**

EXPERIMENT 4

Preparation of polystyrene polymer from styrene monomer by thermal polymerization

5 **6 Hours**

EXPERIMENT 5

Estimation of iron (Fe II) present in the given solution by spectrophotometry using thiocyanate reagent

Total: 60 Hours

Reference(s)

1. J. D. Lee, Concise Inorganic Chemistry, 5th Edition, John Wiley & Sons, 2008.
2. P.S. Kalsi, Stereochemistry Conformation and Mechanism, New Age International, 2005.
3. Jain and Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2013.
4. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, 1st Edition, New age International Publishers, New Delhi, 2014.

5. Padma L Nayak, Polymer Science, 1st Edition, Kalyani Publishers, New Delhi, 2005.
6. P.H. Rieger, Electrochemistry, Springer, Netherland, Second Edition (Reprint) 2012;S. Vairam, Engineering Chemistry, John Wiley & sons, 2014; B. H. Mahan, University Chemistry, Addison-wesley, 2013.

18BT104 COMPUTER PROGRAMMING 2 0 2 3

Course Objectives

- To learn the basics of computer organisation.
- To study the basics of C primitives, operators and expressions.
- To understand the different primitive and user defined data types.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Apply the solutions using problem solving techniques and number system conversions
2. Apply the programs using operators, type conversion and input-output functions
3. Analyze the decision making and looping statements in writing C programs
4. Analyze the concepts of arrays and strings in developing C programs
5. Evaluate the applications using structures and functions in C

Articulation Matrix

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

UNIT I **6 Hours**

INTRODUCTION TO COMPUTERS

Introduction to computers - Characteristics of Computers - Evolution of Computers - Computer Generations - Basic Computer Organization - Number System - Problem Solving Techniques - Features of a Good Programming Language.

UNIT II **6 Hours**

INTRODUCTION TO C PROGRAMMING

Overview of C-Structure of C program-Keywords-Constants- Variables-Data types-Type conversion Operators and Expressions: Arithmetic-Relational-Logical-Assignment- Increment and Decrement-Conditional-Bitwise - Precedence of operators-Managing I/O operations-Formatted I/O-Unformatted I/O.

UNIT III **6 Hours**

CONTROL STATEMENTS

Decision Making and Branching: simple if statement-if else statement-nesting of if else Statement-Switch Statement.Decision Making and Looping: while statement-do while statement-for statement-Nested for statement Jump Statements: goto-break-continue-return statement

UNIT IV **6 Hours**

ARRAYS AND STRINGS

Arrays: Introduction, one dimensional array, declaration - Initialization of one dimensional array, two-dimensional arrays, initializing two dimensional arrays, multi dimensional arrays.Strings: Declaring and initializing string variables- Reading strings from terminal - writing string to screen - String handling functions.

UNIT V **6 Hours**

STRUCTURES AND FUNCTIONS

Structures and Unions: Introduction-defining a structure- declaring structure variables-accessing structure members- structure initialization-Unions-Enumerated data type User Defined Functions: Elements of user defined functions -Definition of functions-return values and their types- function calls-function declaration-categories of function -call by value and call by reference-recursion-Preprocessor directives and macros.

FOR FURTHER READING

Creating and manipulating document using word - Mail merge - Creating spread sheet with charts and formula using excel - developing power point presentation with Animations - C graphics using built in functions

1 **2 Hours**

EXPERIMENT 1

Write a C program to perform arithmetic operations on integers and floating point numbers.

2 **2 Hours**

EXPERIMENT 2

Write a C program to implement ternary operator and relational operators.

3 **2 Hours**

EXPERIMENT 3

Write a C program to find the greatest of three numbers using if-else statement.

4 **2 Hours**

EXPERIMENT 4

Write a C program to display the roots of a quadratic equation with their types using switch case.

5 **2 Hours**

EXPERIMENT 5

Write a C program to generate pyramid of numbers using for loop.

6 **2 Hours**

EXPERIMENT 6

Write a C program to perform Matrix Multiplication

7 **2 Hours**

EXPERIMENT 7
Write a C program to check whether the given string is Palindrome or not.

8 **2 Hours**

EXPERIMENT 8
Write a C program to find the factorial of given number.

9 **3 Hours**

EXPERIMENT 9
Design a structure to hold the following details of a student. Read the details of a student and display them in the following format Student
details: rollno, name, branch, year, section, cgpa.
****
NAME:
ROLL NO:
BRANCH:
YEAR:
SECTION:
CGPA:

10 **3 Hours**

EXPERIMENT 10
Design a structure to hold the following details of a student. Read the details of a student and display them in the following format Student
details: rollno, name, branch, year, section, cgpa.
****
NAME:
ROLL NO:
BRANCH:
YEAR:
SECTION:
CGPA:

11 **3 Hours**

EXPERIMENT 11
Design a union to hold the following details of a Employee. Read the details of an employee and display them in the following format
details: Name, Employee Id, Address, Salary, Designation
****
NAME:
EMPLOYEE ID:
ADDRESS:
SALARY:
DESIGNATION:

12 **3 Hours**

EXPERIMENT 12
Write a C program to print the Fibonacci series using recursive function

13 **2 Hours**

EXPERIMENT 13
Write a c program to swap two numbers using call by value and call by reference.

Total: 60 Hours

Reference(s)

1. 1. Pradeep K. Sinha, Priti Sinha, Computer Fundamentals, BPB publications, 2008
2. 2. Ashok. N. Kamthane, Computer Programming, Second Edition, Pearson Education, 2012
3. 3. E.Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 2012
4. 4. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2013
5. 5. Byron Gottfried, Programming with C, Schaum's Outlines, Tata Mcgraw-Hill, 2013

18HS101 COMMUNICATIVE ENGLISH I 1 0 2 2

Course Objectives

- Read and understand the main points on familiar matters regularly encountered in work, school, or leisure
- Listen and respond in most common situations where English is spoken
- Write simple connected texts on topics which are familiar or of personal interest

Programme Outcomes (POs)

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Use appropriate grammar & vocabulary that is expected at the BEC Preliminary exam level
2. Understand the general meaning of non-routine letters within own work area, and short reports of a predictable nature
3. Write straightforward, routine letters of a factual nature, and make notes on routine matters, such as taking/placing orders
4. Follow simple presentations/demonstrations
5. Deal with predictable requests from a visitor, state routine requirements, and offer advice within own job area on simple matters

Articulation Matrix

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

UNIT I **9 Hours**

GRAMMAR

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

UNIT II **9 Hours**

READING

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer.

UNIT III **9 Hours**

WRITING

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

UNIT IV **9 Hours**

LISTENING

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

UNIT V **9 Hours**

SPEAKING

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making.

1. Goodbye party for Miss Pushpa T S - Nissim Ezekiel
2. Our Casuarina Tree - Toru Dutt
3. Palanquin Bearers - Sarojini Naidu
4. The Tyger - William Blake
5. Ode on a Grecian Urn - John Keats

Total: 45 Hours

Reference(s)

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018.

18BT106 BIOTECHNOLOGY LABORATORY PRACTICES

0 0 4 2

Course Objectives

- To provide hands on training for the performance of sterilization and aseptic maintenance.
- To gain the skills for making buffers and reagents.
- To develop the skills for preparing the equipment through standard calibration protocol.

Programme Outcomes (POs)

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

n. Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors.

o. Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply and prepare solutions of varying concentrations and pH adjustment
2. Apply the environmental remediation techniques including soil treatment and microbial consortia preparation.
3. Analyze , calibrate and measure the biological samples using colorimeter and spectrophotometer
4. Analyze the aseptic media and maintain during the incubation period.
5. Evaluate and prepare laboratory documents, reports, observe results and interpret the results

Articulation Matrix

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

1 **7 Hours**

EXPERIMENT 1

Names of glasswares and their use and handling; Cleaning and Washing of laboratory wares (Sterilization and Aseptic maintenance)

2 **7 Hours**

EXPERIMENT 2

Current Good Manufacturing Practices (cGMP) (Laboratory maintenance, safety and security)

3 **7 Hours**

EXPERIMENT 3

Solution/ Reagent preparation: Concentration - Molarity, Normality, Molality, Mole fraction, weight percentage, volume percentage, pH - buffers and their preparation, Basic mathematical skills for laboratory/ calibration curve - linear-curve fitting, least square method

4 **7 Hours**

EXPERIMENT 4

Simple laboratory processes: Distillation, Extraction, Filtration and Oven drying.

5 **8 Hours**

EXPERIMENT 5

Calibration and Measurement: weighing balance, pH meter (with pH adjustment), Thermometer, Pipette and Micropipette

6 **8 Hours**

EXPERIMENT 6

Measurement and Usage of Colorimeter and Spectrophotometer [Beer-Lambertz law, DNS/ Lowry assay]

7 **8 Hours**

EXPERIMENT 7

Media preparation and Microbial inoculation techniques

8 **8 Hours**

EXPERIMENT 8

Preparation, Maintenance of Lab Notebook/ record and Interpretation of results/observations

Total: 60 Hours

18BT201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinary differential equation and solve it by appropriate method

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the various parameters in partial differentiation and characterize the maxima and minima functions for signals and systems.
2. Apply multiple integral concepts to calculate the area and volume by appropriate vector integral theorems.
3. Analyze the convergence and divergence of sequences and series by various tests.
4. Analyze first order differential equations from real time phenomena and solve it by suitable method.
5. Evaluate the appropriate method to solve the second order differential equations.

Articulation Matrix

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

UNIT I **9 Hours**

PARTIAL DIFFERENTIATION

Functions of several variables, plotting of 2-variable functions, introduction to cylindrical and spherical coordinates, chain rule, total differential, gradient, directional derivatives, normal lines and tangent planes, extreme of functions of two variables, applications.

UNIT II **9 Hours**

MULTIPLE INTEGRALS

Double integrals, regions of integrations, triple integrals, applications (Cartesian coordinates only- Greens theorem and Gauss Divergence theorem).

UNIT III **9 Hours**

SEQUENCES AND SERIES

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurinseries, Taylors Theorem with remainder.

UNIT IV **9 Hours**

FIRST ORDER DIFFERENTIAL EQUATIONS LEX FUNCTIONS

Separable differential equations, homogeneous differential equations, exact differential equations, integrating factor, Bernoullis equation, applications.

UNIT V **9 Hours**

SECOND ORDER DIFFERENTIAL EQUATIONS

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications.

FOR FURTHER READING

Applications to Electrostatic and Fluid Flow.

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, ThomasCalculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
3. Ray Wylie and C Louis Barrett, Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
4. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012.
5. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.

18BT202 ENGINEERING PHYSICS II 2 0 2 3

Course Objectives

- To probe impact of physics in biomolecular structure and dynamics
- To exemplify the thermal and magnetic properties of smart materials
- To familiarize emerging trends in laser technology and crystalline materials

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Apply the heat transfer mechanism in the thermodynamic system using thermodynamic laws and apply the same in heat pumps and refrigerators.
2. Apply the properties of magnetic materials for biomedical applications such as drug delivery and radionuclide delivery.
3. Analyze the principle, characteristics, different types of lasers and explain the types of optical fiber for endoscope application.
4. Analyze the seven crystal systems, crystal planes and the characteristics of metallic crystal structures
5. Evaluate the structure and dynamics of bio-molecules by different techniques for bio-instrumental applications of X-ray, MRI, CT and PET scans

Articulation Matrix

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

UNIT I **6 Hours**

THERMODYNAMICS

Temperature-thermodynamic system - zeroth law of thermodynamics - heat and internal energy - work and heat in thermodynamic processes - first law of thermodynamics - applications of the first law - heat engines and the second law of thermodynamics - heat pumps and refrigerators

UNIT II **7 Hours**

MAGNETIC MATERIALS

Magnetism - origin of magnetic moment - classification of magnetic materials - ferromagnetism: magnetic domains - hysteresis curve - soft and hard magnetic materials - antiferro and ferrimagnetic materials - ferrites - applications: drug delivery for cancer therapy - radionuclide delivery.

UNIT III **6 Hours**

LASER AND FIBER OPTICS

Laser: Principle of laser - characteristics of laser- types - construction and working of semiconductor laser - excimer laser - medical applications: LASIK - photocoagulation.
Fiber optics: principle of light transmission through fiber- structure of optical fiber - types of optical fibers (refractive index profile and mode) - medical application: endoscope.

UNIT IV **5 Hours**

CRYSTAL PHYSICS

Crystalline and amorphous solids - unit cell - bravais lattice - miller indices - crystal structure: simple cubic, body centered cubic, face-centered cubic, hexagonal close-packed structure - diamond structure - crystal defects: point defects and line defects

UNIT V **6 Hours**

BIO PHYSICS

Introduction - structure: configuration versus conformation of biomolecules -protein and nucleic acid -internal rotation and rotational isomerism - biomolecular free energy, biomolecular structures and dynamics - luminescence methods - radio spectroscopy methods - nuclear magnetic resonance methods -applications: X-ray imaging, MRI, CT scans, and PET scans

1 **5 Hours**

EXPERIMENT 1

Using Lees disc apparatus,
(i) find the thickness of bad conductor and lees disc.
(ii) determine the coefficient of thermal conductivity of a bad conductor.

2 **5 Hours**

EXPERIMENT 2

Determine the Hall coefficient and the carrier concentration of semiconducting material.

3 **5 Hours**

EXPERIMENT 3

(i) Calculate the wavelength of laser using diffraction.
(ii) Determine the average particle size of lycopodium powder using laser source.

4 **5 Hours**

EXPERIMENT 4

Determination of acceptance angle and numerical aperture of a given fiber

5 **5 Hours**

EXPERIMENT 5

To study different crystals structures using interfacial angles and intercepts values

6 **5 Hours**

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material

Total: 60 Hours

Reference(s)

1. Fundamental of Biophysics, Andrey B. Rubin, Scrivener publishing, 2014
2. Physics for scientists and engineers, Raymond A. Serway and John W. Jewett, Jr. Seventh edition, Thomson books, 2008
3. Introduction to Magnetic Materials B. D. Cullrty, C. D. Graham, second edition, 2009.
4. Optoelectronic properties of semiconductors and superlattices, M.O. Manasreh (editor), Vol. 10, Julian cheng and niloy K. Dutta, Gordon and Breach Science Publishers, 2012
5. Solid State Physics: Structure and Properties of Materials, Wahab, M.A., Alpha Science International Ltd., 2017

18BT203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

- Recall the terminologies of heterocyclic compounds and identify their role in biomolecules
- Interpret the role of catalyst and its mechanism in chemical reactions
- Summarize the structure, preparation and industrial applications of commonly used polymers

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Apply the structure and functions biomolecules DNA and RNA
2. Analyze the enzyme catalysed biological reactions
3. Analyze the commercially available polymers and list its applications
4. Evaluate electrodes used in the electrochemical cells and use the concept for corrosion protection
5. Evaluate the fuels, based on calorific values for selected applications

Articulation Matrix

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

UNIT I **6 Hours**

AMINO ACIDS AND HETEROCYCLICS

Heterocyclics - classification. Aromaticity- pyrrole, furan, thiophene, pyridine, indole, imidazole, triazole, piperidine - structure and properties. Purine and pyrimidines bases in DNA and RNA - structure and properties - alpha-amino acids - stereochemistry, classification, structure, chemical synthesis and properties. Asymmetric synthesis of amino acids.

UNIT II **6 Hours**

CATALYSIS AND MECHANISM

Classification and mechanism with examples - acid base concepts. Reaction rates - Arrhenius equation - collision theory - transition state (or absolute reaction rate) theory - progress of reaction - graphical representation - potential energy diagram - Hammond principle - Hammond effect - Bronsted beta value - transition state - analogue - Paulis concept - design of transition state analogues.

UNIT III **6 Hours**

POLYMER MATERIALS

Fibre, plastic, elastomer, hydrogels - examples and characterizations - thermoplastics and thermosets - paints, bio-adhesive and biosealants - surfactants and emulsifiers. Plastics - additives - fillers, stabilizers, plasticizers, pigments, flame retardants - compounding and molding. Polymer for tissue engineering, orthopedic, ophthalmic and drug delivery applications. Biocomposites.

UNIT IV **6 Hours**

ELECTROCHEMISTRY

Redox reaction - electrode potential and Nernst equation - electrodes and electrochemical cells - classifications - enzyme electrodes - electrochemical biosensor. Potentiometry and voltametry - principles and applications - electro-synthesis - electrolytic splitting of water. pH-meter and measurements. Butler-Volmer equation - rate of electrochemical reaction. Corrosion - types - electrochemical corrosion and biochemical corrosion.

UNIT V **6 Hours**

FUELS AND ENERGY

Fuel - classification - characterization - biomass carbonization - types. Petroleum - refining of crude oil - properties - liquefaction of coal. Gaseous fuels. Biofuel - biodiesel. Energy storage devices - fuel cells - classification - microbial fuel cell. Batteries - classification, applications and their electrochemistry.

FURTHER READINGS

Recent developments in polymer degradation (Bacteria, Enzymes etc.,) Industrial enzyme catalysis; Pharmaceutical molecules from biomass

1 **6 Hours**

EXPERIMENT 1

Identification of different amino acids by qualitative tests.

2 **6 Hours**

EXPERIMENT 2

Determination of the rate of a typical chemical reaction and its activation energy using Arrhenius equation.

3 **6 Hours**

EXPERIMENT 3

Preparation of super absorbent polymers (hydrogels) from acrylic monomers.

4 **6 Hours**

EXPERIMENT 4

Determination of strength of Fe2 ion and HCl by potentiometry and pH meter.

5 **6 Hours**

EXPERIMENT 5

Determination of voltage and current outputs in lab model microbial fuel cell.

Total: 60 Hours

Reference(s)

1. B S Bahl, Arun Bahl, Advanced Organic Chemistry, S.Chand, 5th Edition, 2012.
2. M.B. Smith, J. March, Advanced Organic Chemistry, Wiley, 6th edition, 2015.
3. P Atkins, J de Paula, and J. Keeler, Physical Chemistry, Oxford University Press, 11th Edition, 2017.
4. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, 1st Edition, New age International Publishers, New Delhi, 2014.

5. Padma L Nayak, Polymer Science, 1st Edition, Kalyani Publishers, New Delhi, 2005.
6. Jain and Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2013; 7. S. Vairam, Engineering Chemistry, John Wiley & sons, 2014; 8. Robert M. Silverstein, Francis X. Webster and David J. Kiemle, Spectrometric Identification of Organic Compounds (7th edition), Wiley, 2007.

18BT204 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING **2 0 2 3**

Course Objectives

- To understand the basic concepts of dc electrical circuits and machines
- To examine the speed control methods of DC motor
- To illustrate the construction and operation of various semiconductor devices

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Apply the concept of current and voltage law for DC circuits
2. Apply the constructional details and working of DC machines
3. Analyze the construction, working principle and applications of different AC machines
4. Analyze the different speed control methods of DC motors and special machines
5. Evaluate the performance characteristics and applications of semiconductor devices and transducers

Articulation Matrix

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

UNIT I **6 Hours**

DC CIRCUITS

Definition of Voltage, Current, Power, Energy - Ohm's law -statement, Illustration and limitation - Kirchoff's Laws statement and Illustration - Resistance in series and voltage division technique - Resistance in parallel and current division technique-Simple problems

UNIT II **6 Hours**

DC MACHINES

Constructional details of DC Machines - Principle of operation of D.C. generator - EMF equation - Methods of excitation - Principle of operation of D.C. motor - Back EMF and torque equation - Types and Applications of DC machines

UNIT III **6 Hours**

AC MACHINES

Single Phase Transformer - Single Phase Induction motor - Three Phase induction motor - Construction and Working Principle – Applications.

UNIT IV **6 Hours**

ELECTRICAL DRIVES

Speed control of dc shunt motor - Armature Control - Flux Control - Construction and operation of Variable Reluctance and Permanent Magnet stepper motor

UNIT V **6 Hours**

ELECTRON DEVICES AND TRANSDUCERS

Characteristics of PN Junction diode - Half wave and Full wave Rectifiers - Bipolar Junction Transistor - Operation of NPN and PNP transistors - Construction and working of FET, Operational amplifiers- Inverting & Non inverting amplifiers and Introduction to transducers, Classification and its applications

FOR FURTHER READING

Voltage Regulator - BLDC Motor -SMPS - Autotransformer - Alternator

1 **6 Hours**

EXPERIMENT 1

Verification of Ohms law, KCL and KVL

2 **6 Hours**

EXPERIMENT 2

Load test on DC Shunt motor

3 **6 Hours**

EXPERIMENT 3

Load test on single phase transformer

4 **6 Hours**

EXPERIMENT 4

Speed control of dc shunt motor

5 **6 Hours**

EXPERIMENT 5

Diode as a switch

Total: 60 Hours

Reference(s)

1. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010
2. R. Muthusubramanian, S. Salivahanan, - Basic Electrical and Electronics Engineering, Tata McGraw-Hill Education, Reprint 2012
3. R. S. Sedha, A Textbook of Applied Electronics, S.Chand & Company Ltd, 2013
4. Jacob. Millman, Christos C.Halkias, Electronic Devices and Circuits, 3rd Edition ,Tata McGraw Hill Publishing Limited, New Delhi, 2010
5. A.Anand kumar, Fundamentals of digital circuits, 3rd Edition, PHI Learning Pvt Ltd, 2014

LANGUAGE ELECTIVE **1 0 2 2**

Course Objectives

- Read and understand ideas of complex text on both concrete and abstract topics
- Listen and understand technical discussions in his/her field of specialization
- Interact with a degree of fluency and spontaneity that makes regular interaction without strain

Programme Outcomes (POs)

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Use appropriate grammar & vocabulary that is expected at the BEC Vantage exam level.
2. Understand the general meaning of non-routine letters, and of a report of predictable / unpredictable topic
3. Write simple reports of factual nature and factual non-routine letters
4. Ask for factual information and understand the answer; and take/pass on workplace messages
5. Express opinions and present arguments to a limited extent; and give simple, prepared presentations on familiar topics

Articulation Matrix

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

UNIT I **9 Hours**

GRAMMAR

Tenses - Future continuous, Future perfect, Future perfect continuous, Past perfect, Past perfect continuous - Adjectives and adverbs - Mixed conditionals - Modals - can't have, needn't have - Modals of deduction and speculation - Narrative tenses - Passives - Phrasal verbs, extended - Relative clauses - Reported speech - Will and going to, for prediction - Wish - Would expressing habits, in the past.

UNIT II **9 Hours**

READING

Scanning and reading for gist - Understanding text structure - Reading for gist and specific information - Vocabulary and structure - Understanding sentence structure and error identification

UNIT III **9 Hours**

WRITING

A message, memo or email, Giving instructions, explaining a development, asking for comments, requesting information, agreeing to requests - Business correspondence: explaining, apologising, reassuring, complaining, short report: describing, summarising - proposal: describing, summarising, recommending, persuading.

UNIT IV **9 Hours**

LISTENING

Listening for and noting specific information - Listening to identify topic, context, Function - Following the main points and retrieving specific information from the text.

UNIT V **9 Hours**

SPEAKING

Giving personal information: Talking about present circumstances, past experiences and future plans, expressing opinions, speculating - Organising a larger unit of discourse: Giving information and expressing and justifying opinions - Turn-taking: negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing/disagreeing, suggesting, speculating, comparing and contrasting, and decision-making.

1. A Horse and Two Goats - R K Narayan
2. My Lord the Baby - Rabindranath Tagore
3. Twist in the Tale - Jeffery Archer
4. The Third and Final Continent - Jhumpa Lahiri
5. The Gift of the Magi - O Henry

Total: 45 Hours

Reference(s)

1. Guy Brook-Hart, "BEC Vantage: Business Benchmark Upper-Intermediate- Student's Books" 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Ian Wood, Paul Sanderson, Anne Williams with Marjorie Rosenberg, "Pass Cambridge BEC Vantage-Student's Book" 2nd Edition, Cengage Learning, New Delhi, 2014
3. Michael Handford, Martin Lisboa, Almut Koester, Angela Pitt, "Business Advantage - Student's Book Upper-Intermediate" Cambridge University Press, New Delhi, 2014.
4. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE - Self-study Edition", Cambridge University Press, UK, 2005.

18BT206 BIOCHEMISTRY 3 0 0 3

Course Objectives

- To learn the bio molecules in the biological system
- To study the mechanism and role of enzymes in metabolism
- To understand the metabolic pathways of biomolecules

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors

Course Outcomes (COs)

1. Apply the classification, structure, function and properties carbohydrates and lipids
2. Apply the structures , functions and classification of proteins and nucleic acids
3. Analyze the concepts of buffers, and principles and energetics of chemical reactions in metabolic pathways
4. Analyze the metabolism and energetic of carbohydrates and lipids in human system
5. Evaluate the metabolism of proteins, amino acids, nucleic acids, pyrimidines and purines in humanbody

Articulation Matrix

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

UNIT I **9 Hours**

CARBOHYDRATES AND LIPIDS

Biomolecules-Introduction. Classification, structure, nomenclature, properties, functions and qualitative analysis of carbohydrates and lipids

UNIT II **9 Hours**

PROTEINS AND NUCLEIC ACIDS

Amino acids- classification, structure and configuration. Pyrimidines , Purines, nucleosides, nucleotides- Structures. Classification, structure, properties and functions of proteins and nucleic acids . Lipoproteins-types and function. - Higher order structures of proteins and nucleic acids and their importance

UNIT III **9 Hours**

REACTIONS AND ENERGETICS OF METABOLISM

Buffering system , biological buffers. Metabolism - anabolism, catabolism and amphibolism; Chemistry of metabolism; coenzymes and their roles in metabolism- concepts of bioenergetics.

UNIT IV **9 Hours**

CARBOHYDRATES AND LIPID METABOLISM

Glycolysis and Krebs cycle, Pentose Phosphate Pathway (HMP Shunt), Cori cycle.Glycogen synthesis and breakdown, Electron transport chain and oxidative phosphorylation. Biosynthesis and degradation of lipids- fatty acids, phospholipids, cholesterol and lipoproteins.

UNIT V **9 Hours**

NITROGEN METABOLISM

Catabolism of Proteins , amino acids, nucleotides, pyrimidines and purines. Glucose-Alanine cycle. Biosynthesis of nucleotides-de novo and salvage pathways for purines and pyrimidines. Health disorders in nitrogen metabolism

FOR FURTHER READING

Electron transport chain and oxidative phosphorylation, concepts of bioenergetics

Total: 45 Hours

Reference(s)

1. D. L. Nelson and M. M. Cox, Lehninger's Principles of Biochemistry, 6 th edition WH Freeman &Co., 2012.
2. J. Tymoczko, J. Berg and L. Stryer, Biochemistry- A Short Course, Freeman and Company, 2009.
3. D. Voet and J. G. Voet, Biochemistry, John Wiley and Sons Inc., 2010.
4. C. K. Mathews, K. E. Van Holde and K. G. Ahern, Biochemistry, Pearson Education Private Ltd., 2000.
5. www.ocw.mit.edu

18BT207 BASICS OF BIOTECHNOLOGY 3 0 0 3

Course Objectives

- To introduce various streams of Biotechnology
- To expose students to industrial bioproducts/ process
- To create deeper understanding of Biotechnology application in the modern world

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
n. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors.
o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the importance of Biotechnology
2. Apply the knowledge of fermentation technology for product development
3. Analyze the nature of enzymes and its industrial applications
4. Analyze the role of transgenics in agriculture and environment
5. Evaluate the fermentation process in food industry and biofuel production

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO BIOTECHNOLOGY

Biotechnology - definition and historical development , Biotechnology - an Interdisciplinary and a three component core, product safety, main areas of applications of Biotechnology , substrates for Biotechnology - biomass, natural raw materials, by-products , chemical and petrochemical feedstocks

UNIT II **9 Hours**

BIOPROCESS / FERMENTATION TECHNOLOGY

Introduction of Bioprocess technology , principles of microbial growth , Bioreactor / fermenter and upstream, bioprocess and downstream and scale up , solid substrate fermentation

UNIT III **9 Hours**

ENZYME TECHNOLOGY

Nature of enzymes , industrial applications of enzymes , genetic engineering of enzymes , technology of enzyme production , immobilized enzymes

UNIT IV **9 Hours**

AGRICULTURAL AND ENVIRONMENTAL BIOTECHNOLOGY

Transgenic plants for pest and weed resistance , biocontrol agents , genetic engineering of transgenic animals, genetically engineered hormones and vaccines , microbes in wastewater treatment , composting , bioremediation.

UNIT V **9 Hours**

BIOTECHNOLOGY IN FOOD AND ENERGY

Food and beverage fermentations, alcoholic beverages, dairy fermented products , vegetable fermentation-sauerkraut , conversion of biomass to energy , production of ethanol and methane from biomass , safety aspectsin Biotechnology

FOR FURTHER READING

Wastewater treatment, composting, bioremediation

Total: 45 Hours

Reference(s)

1. John E Smith, Biotechnology, Cambridge University Press, 5th Edition, 2006
2. W.Crueger, and Anneliese Crueger, Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, 2003
3. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology, Cambridge University Press, 2001
4. L.E.Casida, Industrial Microbiology, New Age International (P) Ltd, 2005

18BT301 ENGINEERING MATHEMATICS III 3 1 0 4

Course Objectives

- Develop the knowledge of periodic and non periodic functions and their representations using Fourier analysis
- Understand the Laplace Transform to solve real world problems
- Predict the changes in the testing process using the concepts of statistics

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the properties of periodic and non-periodic vibrations with the help of Fourier analysis in biotechnology.
2. Apply the function in frequency domain for which the function defined in time domain through the techniques of Laplace transforms
3. Analyze the position of a particle that depends on more than one parameter, using partial differential equations
4. Analyze the outcome of bio technology problem using the concepts of probability and its distributions
5. Evaluate and validate the mathematical model for a bio technology problems with the help of hypothesistesting

Articulation Matrix

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

UNIT I **9 Hours**

FOURIER ANALYSIS

Fourier series for periodic functions. Orthogonal functions. The Euler coefficients. Fourier transforms. Properties of Fourier transform. Applications of Fourier series and transform analysis

UNIT II **9 Hours**

LAPLACE TRANSFORM

Properties and theorems of Laplace transform. Shifting theorems. Convolution. Applications to ordinary differential equations. Applications to linear system analysis.

UNIT III **9 Hours**

PARTIAL DIFFERENTIAL EQUATION

Introduction to partial differential equations. One-dimensional wave equation. Method of separation of variables. DAlemberts solution of the wave equation. Heat equation. Laplaces equation. Telegraph equations. Laplace transform method of solution.

UNIT IV **9 Hours**

PROBABILITY THEORY

Probability. Random variables, probability densities and distributions, mean and variance of a distribution. Conditional probability. Bayes theorem. Binomial, Poisson and normal distributions.

UNIT V **9 Hours**

MATHEMATICAL STATISTICS

Sample mean and variance. Sampling distributions. Statistical estimation of parameters, confidence intervals. Testing of hypotheses, one-sample and two-sample inferences. Applications to statistical quality control and reliability analysis.

Total: 60 Hours

Reference(s)

1. Kreyszig Erwin, Advanced Engineering Mathematics, 7th Edition, John Wiley, 1993.
2. Johnson Richard A. and Bhaltacharyya Gouri K., Statistics, Principles and Methods, 3rd Edition, John Wiley, 1996.
3. O Neil Peter V., Advanced Engineering Mathematics, 4th Edition, PWS-Kent, 1995.
4. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 1993.
5. Milton J. S. and Arnold Jesse C., Introduction to Probability and Statistics: Principles and Applications for Engineering and The Computing Sciences, McGraw Hill Inc, 3rd Edition, 1995.

18BT302 PROCESS CALCULATIONS AND UNIT OPERATIONS

3 0 2 4

Course Objectives

- To provide students the basic knowledge on chemical calculations and its application for material balance
- To impart the basic concepts of unit operation
- To understand the different unit operations and processes carried out in the chemical and biochemical industries

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
o. Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the various basic chemical calculations and its application
2. Apply the quantification of the process using material and energy balance
3. Analyze various size reduction equipment and measurement of the particle size
4. Analyze various types of mixers, flow patterns and scale up criteria for mixing and agitation
5. Evaluate the various types of equipments for filtration and sedimentation operation

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF CHEMICAL CALCULATION

Stoichiometry &chemical equations; Units,dimensions & conversions; Basic chemical calculations - mole, weight &volume%, Henry's law,Raoult's law and their applications to different systems

UNIT II **9 Hours**

MATERIAL AND ENERGY BALANCE

Material Balance without Chemical reaction-distillation, evaporation, drying& fermenter, recycle, bypass and purging operations; Energy balance- Sensible heat, latent heat

UNIT III **9 Hours**

MECHANICAL OPERATIONS - SOLIDS HANDLING, SIZING AND SCREENING

Properties of particulate solids, Screening- Determination of particle size, Screen analysis, Surface area measurements, Size reduction of solids- laws, stages of reduction, operating variables, intermediate and fine size reduction, Sieve analysis, Power driven machines - Crushers, ball mills, conveyers

UNIT IV **9 Hours**

MIXING AND AGITATION

Introduction to agitation and mixing of liquids, Mixing - types of mixers- ribbon and muller mixer, Mixing and bioreaction interactions-flow regimes with and without baffles, Agitation equipment, flow patterns in agitator, Power required for agitated vessels- power number and power number calculation, Scale up criteria for mixing and agitation equipment

UNIT V **9 Hours**

FILTRATION AND SEDIMENTATION

Filtration- Principles of cake filtration, Filter medium and filter aids, Constant rate filtration and constant pressure filtration. Batch and continuous filtration, Filtration equipments- plate and frame, leaf filter, rotary drum, Sedimentation and Settling theory, Equipment for sedimentation- thickeners, clarifiers centrifugation,

1 **8 Hours**

EXPERIMENT 1

Flow Measurement using Oriffice and Venturi

2 **6 Hours**

EXPERIMENT 2

Calculation of overall Heat Transfer Coefficient in Double Pipe Heat Excanger

3 **8 Hours**

EXPERIMENT 3

Calculation of Cake and Medium Resistance in Plate and Frame filter

4 **8 Hours**

EXPERIMENT 4

Liquid Liquid Extraction - Single and Multi stage

Total: 75 Hours

Reference(s)

1. N. Anantharaman and V. Venkataramani, Process Calculation, Prentice Hall of India, 2005
2. C. J. Geankoplis, Transport Processes and Unit Operations, Prentice Hall of India, 2007
3. W. L. McCabe, J.C. Smith and P. Harriott, Unit Operations in Chemical Engineering, Tata McGraw-Hill Professional, 2005

4. M. Coulson and J. F. Richardson, Coulson and Richardson's Chemical Engineering, Vol. 2, Butterworth Heineman, 2004
5. G. K. Roy, Fundamentals of Heat and Mass Transfer, Kanna Publications, 2004

18BT303 INSTRUMENTATION AND ANALYTICAL TECHNIQUES

3 0 0 3

Course Objectives

- To expose students with electrical and electronic components used in the analytical instruments
- To learn and understand the principles and operation of different instrumentation techniques
- To know the different molecular spectroscopic techniques and their analytical applications

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Use the analytical instruments and techniques to separate, purify and characterizebiological compounds.

Course Outcomes (COs)

1. Apply the function of electrical and optical component in analytical instruments and their calibration
2. Apply the spectroscopic techniques to identify, estimate and characterize analytes
3. Analyze the thermal behavior of materials using thermal analysis
4. Analyze chromatographic and electrophoretic techniques to separate, purify and quantify molecules
5. Analyze different types of electrodes and electroanalytical techniques for sensing and quantifying analytes

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF MEASUREMENT AND OPTICAL METHODS

Classification of instrumental methods - calibration methods for instruments - electrical components in circuits and their function - signal to noise ratio - signal - noise enhancement-sofware and hardware techniques.

General design of optical instruments - sources of radiation - wavelength selectors - materials for optical components and sample holders. Radiation transducers.

UNIT II **9 Hours**

MOLECULAR SPECTROSCOPY

Types of optical instruments- Fourier transform measurements-Theory and advantages. Measurement of transmittance and absorbance- Beer's law - Derivation and types of Deviation. Spectrophotometer analysis - qualitative and quantitative absorption measurements - types of spectrometers - UV - visible, IR , Raman and NMR-theory, instrumentation and applications

UNIT III **9 Hours**

THERMAL METHODS

Thermo-gravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC) theory, instrumentation and applications

UNIT IV **9 Hours**

SEPARATION METHODS

Introduction to chromatography - models - ideal separation - retention parameters - van - deemter equation - GC-MS - stationary phases - detectors - kovats indices- HPLC - pumps - columns- Detectors and instrumentation. Size exclusion, hydrophobic interaction, supercritical chromatographic techniques. Ion exchange, affinity - theory,instrumentation and applications. Capillary electrophoresis.

UNIT V **9 Hours**

ELECTRO -ANALYTICAL TECHNIQUES

Electrodes, reference electrodes, ion selective electrodes and pH meter. Potentiometry, Voltametry, coulometry and amperometry- theory, instrumentation and applications in life sciences.

FOR FURTHER READING

Advanced chromatographic techniques

Total: 45 Hours

Reference(s)

1. H. H. Willard, and L. L. Merrit, Instrumental Methods of Analysis, Prentice Hall of India, 2005.
2. D. A. Skoog, J. F. Holler and T. A. Nieman, Principles ofInstrumental Analysis, Thomson, 2006.
3. G. W. Ewing, Instrumental Methods of Chemical Analysis, Mc Graw Hill, 1985.
4. R. D. Braun, Introduction to Instrumental Analysis, Pharma Book Syndicate, Adithiya Art Printers, 1987.

18BT304 CELL BIOLOGY 3 0 0 3

Course Objectives

- To understand the basic structure and function of an organelle
- To understand the transportations through cell membrane
- To understand the concept of the cell division and signalling pathways

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
g. Environment and Sustainability:Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Design and synthesis of the novel biomolecule for the agriculture and healthcare sectors.

Course Outcomes (COs)

1. Understand the structure of cells, its division, and multiplication and explain how it leads to formation of cancer cells in our body.
2. Understand the knowledge of cell structure to demonstrate the mechanism of transportacross cell membrane
3. Apply the cell transport mechanism to assess the role of cell bound receptors and signaling process
4. Analyze the role of ion channels and justify the mechanism of neurotransmitters.
5. Evaluate the different models of signal amplification and secondary messengers involved in cell-to-cell Interaction

Articulation Matrix

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

UNIT I **9 Hours**

CELL STRUCTURE AND FUNCTIONS AND CELL CYCLE

History of cell biology; Comparison of eukaryotic and prokaryotic cells; biological membrane organization-membrane proteins; cytoskeletal proteins; Types of cell division - mitosis and meiosis; cell cycle and molecules that control cell cycle; cell cycle and cancer, oncogenes; growth hormones and their roles.

UNIT II **9 Hours**

TRANSPORT ACROSS CELL MEMBRANES AND RECEPTORS

Passive and Active transport, permeases, sodium potassium pump, Ca2+ ATPase pumps, lysosomal and vacuolar membrane ATP dependent proton pumps, co-transport (symport, antiport), endocytosis and exocytosis; receptor-mediated endocytosis.

UNIT III **9 Hours**

RECEPTORS AND CELL SIGNALING

Cytosolic; Nuclear and membrane bound receptors; Examples of receptors; Autocrine, paracrine and endocrine models of action.

UNIT IV **9 Hours**

ION CHANNELS

Types of Ion-channels; Ligand-gated and Voltage-gated ion channels; Neurotransmitters- mechanism of action, nerve conduction.Ion-channel agonists and antagonists.

UNIT V **9 Hours**

SIGNAL TRANSDUCTION

Signal amplifications; different models of signal amplification; Second messengers - cAMP, Inositol phosphates, DAG, cGMP, G proteins, Ca; Protein kinases, serine threonine kinases.

FOR FURTHER READING

Apoptosis and programmed cell death;Entry of virus and toxins into cells;Quantification and characterization of receptors;Ion channel defects;TNF receptor families

Total: 45 Hours

Reference(s)

1. H. Lodish, A. Berk, S. L. Zipurursky, P. Matsudaria, D. Baltimore and J. Darnell, Molecular Cell Biology, W. H. Free Man and Company, 2000.
2. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, and P. Walter, Molecular Biology of the Cell, Garland Science, 2002.
3. S. C. Rastogi, Cell Biology, India: New Age International Pub. Ltd., 2001.
4. E. D. P. Robertis De and E. M. F. Robertis De, Cell and Molecular Biology, B.I. Publications, Pvt. Ltd., 2005.
5. Gerald Karp and Nancy L. Puritt, Cell and Molecular Biology, Concepts and experiments, John Wiley and Sons Inc., 2004

18BT305 BIOORGANIC CHEMISTRY 3 0 0 3

Course Objectives

- To provide students with a basic understanding of weak interaction, stereo chemistry and structures of simple biomolecules, proteins and nucleic acids
- To introduce and understand the mechanism of enzyme action ,protein folding and unfolding and their biological significances
- To acquire/ demonstrate their basic knowledge and skill on the kinetics, mechanism and function of proteins/ enzyme action and improve their self learning and understanding skills on biochemical engineering and promote employability in biotech research areas

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability:Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

Course Outcomes (COs)

1. Apply the weak interactions in biomolecules with mathematical models, stereochemistry of nucleophilic substitution reactions and types of catalysis to understand the structure, properties and function of biomolecules.
2. Apply the enzyme structure and their stereo specificity of action
3. Analyze the kinetics and mechanism for enzymatic reaction and understand allosteric regulation.
4. Analyze higher order structural level, stability and sequencing in protein and nucleic acids and their chemical method of synthesis
5. Evaluate the protein folding-unfolding kinetics and know the importance of molecular chaperons.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO BIOORGANIC CHEMISTRY

Historical connection between organic and biological chemistry , nonbonding interactions and simplified equations representing these energies- stereochemistry of nucleophilic substitution reactions- ester formation and hydrolysis, analogy between chemical and biochemical reactions, chemistry of living cells, Types of Catalysis - mechanisms for elctrophilic, nucleophilic and covalent catalysis with typical examples. Potential energy diagram-Hammonds postulate

UNIT II **9 Hours**

ENZYMES: STRUCTURE, STEREOCHEMISTRY AND MECHANISM

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

UNIT III **9 Hours**

ENZYME KINETICS

Transition state analogues - reaction rates . Michaelis-Menton Kinetics. Derivation of rate equation for equilibrium and non-equilibrium models. Mechanism of enzyme action. Energetics of enzyme catalysed reaction . Significances of change in enthapy, free energy, entropy in enzyme kinetics. Kinetics of multisite co-operative enzymes-sequential (Koshland-Nemethy-Filmer (KNF) and Concerted (Monod - Changeux -Wyman model) models.

UNIT IV **9 Hours**

PROTEINS AND NUCLEIC ACIDS

Chemical synthesis of proteins , different types of secondary structural elements in proteins, stability of proteins - stability - activity trade off. Chemical synthesis of nucleotides and poly nucleotides . Chemical and enzymatic methods for sequencing of proteins and nucleic acids.

UNIT V **9 Hours**

PROTEIN FOLDING

Protein folding pathways, folding kinetics-basic methods - two state kinetics - multistate kinetics, transition states in protein folding-1H-2H exchange studies in protein-Linderstrom-Lang model- folding of peptides- CI2 folding. Molecular chaperons-heat shock proteins-GroEL -GroES- mechanism of action.

FOR FURTHER READING

Structures of aromatic heterocyclic and polycyclic aromatic compounds, structural levels in proteins and nucleic acids, functions of proteins and nucleic acids, types of DNA and RNA, ribozyme- classification, mechanism of catalysis and uses

Total: 45 Hours

Reference(s)

1. A. Fersht, Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding, New York: W. H. Freeman and company, 1999.
2. H. Dugas, Bioorganic Chemistry, Springer Verlag, 1999.
3. D. L. Nelson and C. M. M. Lehninger, Principles of Biochemistry, W.H. Freeman & Co., 2005.
4. C. K. Mathews, K. E. Van Holde, and K. G. Ahern, Biochemistry, Pearson Education, Indian Reprint, 2003.
5. F. Campbell, Biochemistry, Thomson Books, Indian Reprint, 2007

18BT306 MICROBIOLOGY 3 0 0 3

Course Objectives

- This course aims to develop skills of the Students in the identification of microbes, structure, metabolism and their industrial applications
- To understand the interaction of host and pathogen
- To acquire prerequisite knowledge for all Bioprocess Technology processes

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
m. Use the analytical instruments and techniques to isolate, purify and characterize biologicalcompounds.
o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Understand how the microbes are classified and usage of microscopic techniques to study the microbial staining procedures
2. Understand and apply the structure of Microbes and assess its way of multiplication
3. Analyze the level of nutrient requirement to study the microbial growth and its metabolism.
4. Analyze the role of antimicrobial drugs in microbial control and outline the mechanism of pathogenicity and host defense.
5. Evaluate the microbial involvement in synthesis of economically important products.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Classification and nomenclature of microbes; Principle and applications of Microscopy - Light, dark field, phase contrast and fluorescence microscope; Staining techniques: Principles and application- Gram, Acid fast, Capsule, Flagella, Endospore and Lacto phenol cotton blue.

UNIT II **9 Hours**

STRUCTURE AND MULTIPLICATION OF MICROBES

Colony morphology and arrangement of bacterial cells; Structure and multiplication of bacteria, fungi (Rhizopus) and viruses (TMV); life history of mycoplasma, actinomycetes (Streptomyces), yeast, and bacteriophages.

UNIT III **9 Hours**

MICROBIAL NUTRITION, GROWTH AND METABOLISM

Nutritional requirements and media for bacterial growth; Bacterial growth curve, nutritional classification of organisms; methods to quantitate bacterial growth, preservation techniques; Bacterial metabolism - respiration and fermentation (lactic acid and ethanol).

UNIT IV **9 Hours**

MICROBIAL CONTROL AND HOST INTERACTION

Physical and chemical methods of microbial control; Antimicrobial drugs - mode of action and drug resistance, Antibacterial, Antifungal and Antiviral agents; mechanisms of pathogenicity - mode of entry, penetration of host defences and damage.

UNIT V **9 Hours**

INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY

Biofertilizers, Biopesticides, Production of alcohol, amoxicillin; bioremediation; leaching of ores by microbes; microbial treatment of wastewater - aerobic and anaerobic methods.

FOR FURTHER READING

Microbial diseases - source, mode of infection and treatment of Candidiasis, Rabies, Chikungunya, Dengue, Malaria and Typhoid

Total: 45 Hours

Reference(s)

1. L. M. Prescott, J. P. Harley and D. A. Klein, Microbiology, Wm. C. Brown Publishers, 2004.
2. M. J. Pelczar, E. C. S. Chan and N. R. Krein, Microbiology, Tata McGraw-Hill, 2002.
3. G. J. Tortora, B. R. Funke and C. L. Case, Microbiology, Addison Wesley Longman, Inc. 2001.
4. R. M. Atlas and Renk, Principles of Microbiology, McGraw-Hill Higher Education, 1995.

18BT307 MICROBIOLOGY LAB 0 0 4 2

Course Objectives

- Imparts hands on training in the aseptic techniques and operation of equipment
- Develops skills in the isolation and identification of microbes
- To study the metabolites and its antagonistic effects on other organisms

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

j.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k.Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l.Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

m.Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the isolation technique and identification of microorganisms from various sources
2. Analyze the preservation of microorganisms
3. Analyze the microbes for production of bioproduct and biomass
4. Analyze the growth characteristics of bacteria
5. Evaluate the microbes present in environmental samples

Articulation Matrix

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

1 **10 Hours**

EXPERIMENT 1

Microscopic observation of microorganisms

2 **10 Hours**

EXPERIMENT 2

Culturing of microorganisms - in broth, plates (pour plate and streak plate)and slant

3 **10 Hours**

EXPERIMENT 3

Staining techniques - Gram staining - Endospore staining,

4 **10 Hours**

EXPERIMENT 4

Determination of Bacterial growth curve

5 **10 Hours**

EXPERIMENT 5

Antibiotic sensitivity assay by Kirby-Bauer Test

6 **10 Hours**

EXPERIMENT 6

Enumeration of microbial population from soil and water

Total: 60 Hours

Reference(s)

1. Microbiology Laboratory Manual

18BT308 BIOCHEMISTRY AND BIOORGANIC CHEMISTRY LAB

0 0 4 2

Course Objectives

- To provide hands on training for the analysis of biomolecules qualitatively
- To develop the skills for preparing the equipment through standard calibration protocol
- To provide hands on training for quantitative analysis of spectrophotometer

Programme Outcomes (POs)

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
m. Use the analytical instruments and techniques to separate, purify and characterizebiological compounds
n. Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

Course Outcomes (COs)

1. Apply the laboratory documents, reports, observe results and interpret the results
2. Analyze the biomolecules using different parameters Qualitatively
3. Analyze the biological samples using colorimeter and spectrophotometer
4. Analyze the synthesize of organic molecules , purify them and identify using their properties
5. Evaluate and prepare the organic molecules for medicine and pharma industry

Articulation Matrix

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

1 **6 Hours**

EXPERIMENT 1

Qualitative analysis of carbohydrates

2 **6 Hours**

EXPERIMENT 2

Qualitative analysis of aminoacids

3 **8 Hours**

EXPERIMENT 3
Estimation of amino acids by ninhydrin method

4 **8 Hours**

EXPERIMENT 4
Determination of saponification /acid number of lipids

5 **8 Hours**

EXPERIMENT 5
Quantitative analysis of DNA and RNA by UV spectrophotometer

6 **8 Hours**

EXPERIMENT 6
Synthesis, purification by crystallization and identification (melting point) of aspirin

7 **8 Hours**

EXPERIMENT 7
Preparation of 5, 10, 15, 20-tetrakisphenyl porphyrin

8 **8 Hours**

EXPERIMENT 8
Synthesis of ethyl acetate by Fischer esterification and its purification by distillation

Total: 60 Hours

Reference(s)

1. A. Manickam , S. Sadasivam, Biochemical Methods, 3 rd Edition, New Age International Pvt Ltd Publishers, 2009

18GE301 SOFT SKILLS - VERBAL ABILITY 0 0 2 0

Course Objectives

- To help students gain adequate proficiency in vocabulary
- To help students become proficient in basic writing skills related to workplace communication
- To read and understand unabridged text

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Take up verbal ability part of the placement tests with confidence
2. Write with confidence in professional and workplace communication
3. Distinguish fact from opinion by reading passages from a text

Articulation Matrix

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

UNIT I **15 Hours**

INTRODUCTION

Synonyms - Antonyms - Word Groups - Verbal Analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text & Paragraph Completion.

UNIT II **15 Hours**

BASICS OF VERBAL APTITUDE

Sentence Formation - Paragraph Formation - Change of Voice - Change of Speech - Reading Comprehension - Sentence Equivalence - Jumbled Sentences - Spotting Errors -Homophones Homonyms - Commonly Mispronounced/Misspelt Words.

Total: 30 Hours

Reference(s)

1. Murphy, Raymond. English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English. IV Edition. United Kingdom: Cambridge University Press. 2012.
2. Lewis, Norman. Word Power Made Easy. New York: Pocket Books. 1991.
3. Baron"s The Official Guide for New GMAT Review, New Jersey: John Wiley & Sons, Inc. 2015.

18BT401 BIOPROCESS ENGINEERING 3 1 0 4

Course Objectives

- To understand the role of biotechnologists in bioprocess industry.
- To apply the engineering concepts for biological conversion of raw materials
- To perform simulations of reactors and model the kinetics of product formation

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. 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.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effectivereports and design documentation, make effective presentations, and give and receive clear instruction
k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l.**Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
n. Process designing and production of novel biomolecule for the agricultural, environmental and healthcare sectors
o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources.

Course Outcomes (COs)

1. Understand the fermentation process and sterilization kinetics.
2. Apply the cellular stoichiometry and energy balance to study the fermentation process.
3. Analyze the mass transfer coefficient parameters and medium optimization techniques.
4. Analyze the bioreactor types, selection and scale-up for industrial application.
5. Evaluate the structured models and metabolic pathways in product formation.

Articulation Matrix

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

UNIT I **9 Hours**

STERILIZATION TECHNIQUES AND FERMENTATION PROCESS

Overview of fermentation process and industry; Basic configuration of fermentor and its ancillaries; Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization; Design of sterilization equipment.

UNIT II **9 Hours**

CELLULAR STOICHIOMETRY IN BIOPROCESS

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

UNIT III **9 Hours**

MEDIUM REQUIREMENTS AND MASS TRANSFER IN BIOREACTORS

Medium requirements for fermentation process; Medium formulation; Medium optimization methods; Mass transfer by diffusion and convection, Methods for the measurement of kLa, oxygen mass transfer methodology in bioreactors - microbial oxygen demands; Factors affecting oxygen transfer rate.

UNIT IV **9 Hours**

BIOREACTOR TYPES, ANAYSIS AND SCALE-UP

Bioreactor classification: Stirred Tank reactor, Packed bed reactor, Airlift reactor, Fluidized Bed Reactor and Bubble column reactor; Various accessories of bioreactors. Cultivation mode of organisms: batch, continuous and fed-batch systems; Online and Offline Monitoring and control of Bioreactor; Scale up and selection of bioreactors.

UNIT V **9 Hours**

MODELLING, SIMULATION AND BIOENERGETICS OF BIOPROCESSES

Study of structured models for analysis of various bioprocesses: compartmental models, single cell models and plasmid replication/ stability model, Dynamic simulation of batch, fed batch, steady and transient culture metabolism. Bioenergetics, Control sites of major metabolic pathway.

Total: 60 Hours

Reference(s)

1. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering - Basic Concepts, Prentice Hall, 2002.
2. M. Pauline Doran, Bioprocess Engineering Principles, Academic Press Limited, 1995.
3. Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Principles of Fermentation Technology, Butterworth Heinemann publications, 1995.
4. Harvey W. Blanch, S. Douglas and Clark, Biochemical Engineering, New York: Marcel Dekker Inc., 1997.

18BT402 FUNDAMENTALS OF TRANSPORT PROCESS

3 1 0 4

Course Objectives

- To impart the significance of mass transfer principles used in bioprocess.
- To develop knowledge for application of mass transfer equipments
- To assess the principles of measuring the fluid flow

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m.Use the analytical instruments and techniques to separate, purify and characterizebiological compounds

Course Outcomes (COs)

1. Apply the principle of liquid liquid diffusion and methods of distillation.
2. Apply the principles of extraction, drying and adsorption with industrial applications
3. Analyze the principles of conductive and convective modes of heat transfer
4. Evaluate the principle and working method of heat exchangers and evaporators
5. Evaluate the types of fluids and demonstrate the method to estimate fluid flowrate

Articulation Matrix

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

UNIT I **9 Hours**

DIFFUSION AND DISTILLATION

Introduction to mass transfer operations; Ficks Law of Diffusion, one component transferring to non diffusing component and equimolar diffusivity estimation; Basic concepts of distillation , VLE, Relative volatility; Methods of distillation - Simple, steam, flash distillation, azeotropic, extractive and molecular distillation, Continuous fractionation- McCabe-Thiele method.

UNIT II **9 Hours**

EXTRACTION AND DRYING

Liquid liquid extraction applications, Solvent selection,Design calculations for stage wise extraction, single stage and multi stage operation, crosscurrent and countercurrent operations; liquid extraction equipments. Solid liquid extraction, Drying of wet solids; Classification of drying equipments.

UNIT III **9 Hours**

CONDUCTIVE AND CONVECTIVE HEAT TRANSFER

Modes of heat transfer- Principles of Conduction, convection and radiation; Fourier law of heat conduction, Conduction - Steady state heat conduction through unilayer and multilayer walls, Convective heat transferprinciple. Adsorption -adsorption Isotherm, freudlich, langmuir and BET equation.

UNIT IV **9 Hours**

HEAT EXCHANGERS AND EVAPORATORS

Heat exchangers-, Parallel and counter flow heat exchangers, Principle and Working of double pipe, shell and tube heat exchanger, Overall & Individual heat transfer co-efficient, LMTD, Evaporators-single effect and multiple effect evaporators

UNIT V **9 Hours**

FLUID MECHANICS

Nature of fluids, properties of fluids, classification of fluids, hydrostatic equilibrium;Manometers;Measurement of fluid flow-orifice meter, venturimeter, pilot tube and Rota meter. Flow controls-gate valve, globe valve, butterfly valve, globe and ball valve Pumps- Classification, Principle, Characteristics and working of centrifugal pump and reciprocating pump, Peristaltic pump. Continuity equation,Bernoulli equation;

FOR FURTHER READING

HETP calculations - Vapour liquid equilibrium

Total: 60 Hours

Reference(s)

1. R. E. Treybal,Mass Transfer Operations, New York: McGraw-Hill, 2002.
2. J. M. Coulson and J. F. Richardson, Chemical Engineering,Vol.I&II, Pergamon Press, 1998
3. W. L. Mc-Cabe, J. C. Smith and P. Harriot, Unit Operations in Chemical Engineering, New York: McGraw-Hill Inc., 2005
4. G. K. Roy, Fundamentals of Heat and Mass Transfer, Kanna Publishers, 2006.
5. C. J. Geankoplis, Transport Processes and Unit Operations, Prentice Hall of India, 2007.

18BT403 IMMUNOLOGY 3 0 2 4

Course Objectives

- To understand the concepts of immune system and the structure, functions and properties of different cell types and organs that comprise the immune system
- To comprehend the range of immunological agents and the strategies that may be used to prevent and combat infectious diseases
- To understand transplantation and autoimmunity

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
n. Process designing and production of the novel biomolecules for agricultural, environmental and healthcare sectors

Course Outcomes (COs)

1. Apply the basics of immune system and its components
2. Apply the various antigen antibody reactions
3. Analyze the mechanism of cell mediated immunity
4. Analyze the immune response related to microbial infection, allergy and hypersensitivity
5. Analyze about organ transplantation and immunological anomalies related to autoimmune disorders and tumor

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO IMMUNE SYSTEM

Cells of immune system - B-Lymphocytes, T-Lymphocytes, Macrophages, Dendrite cells, Natural Killer, Eosinophils, Neutrophils, Mast cells; innate and acquired immunity; Organization and structure of lymphoid

organs, Types of immunity and immune responses. Antigens epitopes, antigenicity, factors influencing antigenicity.

UNIT II **9 Hours**

HUMORAL RESPONSE

Development, maturation, activation and differentiation of B-cells, Theory of clonal selection, Antibodies: structure, function and classification; Monoclonal and polyclonal antibodies - principles and production.

UNIT III **9 Hours**

CELLULAR RESPONSE

Development, maturation, activation and differentiation of T-cells. T Cell Receptor, APC, Processing and presentation of antigen for immune response, Major histocompatibility complex.

UNIT IV **9 Hours**

INFECTION AND IMMUNITY

Injury and inflammation, Immune responses to infections - immunity to viruses, bacteria, fungi and parasites, Cytokines, Complement, Immunosuppression, Immunotolerance, resistance and immunization; Allergy and hypersensitivity. Basics of vaccine, types of vaccine and vaccinations chart.

UNIT V **9 Hours**

TRANSPLANTATION, AUTOIMMUNITY AND TUMOR IMMUNOLOGY

Transplantation of organ and tissue transplantation, laws of transplantation, genetics of transplantation - HLA system, mechanism and prevention of graft rejection, immunosuppressive drugs, autoimmune disorders, treatment of autoimmune disorders, tumor immunology: tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy.

FOR FURTHER READING

Types of antigen antibody reactions - agglutination, precipitation, Immunodiffusion - single, double, radial, immunoelectrophoresis.

1 **3 Hours**

EXPERIMENT 1

Blood grouping and Blood Typing (ABO)

2 **3 Hours**

EXPERIMENT 2

Detection of Salmonella antibody in serum (Widal test)

3 **3 Hours**

EXPERIMENT 3

Ouchterlony double immunodiffusion (ODD)

4 **3 Hours**

EXPERIMENT 4

Radial immunodiffusion (RID)

5 **3 Hours**

EXPERIMENT 5

Rocket immunoelectrophoresis (RIE)

6 **5 Hours**

EXPERIMENT 6

Enzyme-linked Immunosorbent assay (ELISA)

7 **10 Hours**

EXPERIMENT 7

SDS PAGE and Western Blotting

Total: 75 Hours

Text Book(s)

1. Judith A Owen, Jenni Punt, Sharon A Stranford, Patricia P Jones, Janis Kuby, Kuby Immunology 7th Edition,New York : W.H. Freeman, 2013.

Reference(s)

1. A David Male, Jonathan Brostoff, David Roth and Ivan Roitt, Immunology, Mosby Publication, 2006.
2. Ashim K. Chakravarty, Immunology and Immunotechnology, Oxford University Press India Publication, 2006.
3. Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby, Kuby Immunology, W.H. Freeman & Company, 2006.
4. P. M. Lydyard, A. Whelan and M. W. Fanger, BIOS Instant Notes in Immunology, Taylor & Francis Publication, 2011
5. P. M. Lydyard, A. Whelan and M. W. Fanger, BIOS Instant Notes in Immunology, Taylor & Francis Publication, 2011

18BT404 MOLECULAR BIOLOGY 3 0 0 3

Course Objectives

- To familiarize students on macromolecule's properties, structures and functions
- To expose students to various molecular events in prokaryotes
- To create deeper understanding on regulation of genes activities

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
k.Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects andin multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Process designing and production of novel biomolecules for theagricultural,environmental and healthcare sectors
n. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the three major macromolecules and their properties in living organisms.
2. Analyze the mechanism of DNA replication in prokaryotes.
3. Analyze the mechanism of transcription and universal genetic code in prokaryotes.
4. Analyze the process of translation and DNA repair system in prokaryotes.
5. Evaluate the concept of gene regulation and its significance in prokaryotes

Articulation Matrix

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

UNIT I **9 Hours**

MACROMOLECULES

Macromolecules major classes - chemical structures and properties; Physical and chemical structure of DNA; Alternative structure of DNA; RNA molecules- classes, structure and functions.

UNIT II **9 Hours**

DNA REPLICATION

Properties of genetic material; DNA replication in prokaryotes- untwisting of highly coiled DNA, de novo and covalent extension initiations, elongation and termination; Prokaryotic and eukaryotic DNA polymerases; Plasmids- characteristics, types and applications.

UNIT III **9 Hours**

TRANSCRIPTION AND GENETIC CODE

Bacterial and eukaryotic RNA polymerases; Transcription in prokaryotes - initiation, elongation and termination; The genetic code- salient features, RNA and DNA codon tables; Wobble base pair; Aminoacyl-tRNA synthetases; Posttranscriptional modification - mRNA processing.

UNIT IV **9 Hours**

TRANSLATION AND DNA REPAIR

Translation in prokaryotes- initiation, elongation and termination; DNA damage - sources and types; DNA repair mechanisms - direct reversal, excision repair, recombinational repair and SOS response; Inhibitors of translation - antimicrobial agents that bind with 30S and 50S ribosomal subunits.

UNIT V **9 Hours**

REGULATION OF GENE ACTIVITY

Principles of gene regulation and operon concept; Transcriptional regulation - lac operon, galactose operon, arabinose operon, tryptophan operon, attenuation, autoregulation; Feedback inhibition and allosteric control.

FOR FURTHER READING

Hydrolysis of nucleic acids; Conformations of plasmid DNA; DNA replication in eukaryotes- initiation, elongation and termination; DNA transcription and translation in eukaryotes.

Total: 45 Hours

Reference(s)

1. G. M. Malacinski, Freifelder's Essentials of Molecular Biology,Narosa Publishing House, 2005
2. J. K. Pal and S. S. Ghaskadbi, Fundamentals of Molecular Biology, Oxford University Press, New Delhi, 2011
3. J. Watson, T. Baker, S. Bell, A. Gann, M. Levine and R. Losick, Molecular Biology of the Gene, Pearson Education, Inc., 2008
4. J. E. Krebs, E. S. Goldstein and S. T. Kilpatrick, LewinÃƒÂ¢??s Genes X, Sudbury, MA: Jones & Bartlett Publishers, 2009
5. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter, Molecular Biology of the Cell, Garland Science, 2008
6. H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, M. P. Scott, A. Bretscher, H. Ploegh, and P. Matsudaira, Molecular Cell Biology, W. H. Freeman & Co., 2007

18BT405 PHARMACOGNOSY AND PHARMACOLOGY **3 0 0 3**

Course Objectives

- To introduce concepts of essential medicines
- To expose students to foresee, prevent and manage adverse drug events and drug interactions
- To build deeper understanding of basic concepts of drug screening and testing from natural sources

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
g.Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h..Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
m. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors
n. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Understand the mechanism of drug action and its relevance in the treatment of different diseases.
2. Apply the fundamental knowledge on various aspects of drugs acting on different systems of the body.
3. Analyze the principles and method of testing of various drugs.
4. Analyze the techniques in production and evaluation of crude drugs.
5. Evaluate the rate and mechanism of drug action.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Pharmacognosy and Pharmacology - definition and historical perspective, sources of drugs, adulteration and evaluation of crude drugs, nomenclature and classification of drugs, routes of drug administration, types of dosage forms, significance of pharmacopoeial standards

UNIT II **9 Hours**

PHYTOPHARMACEUTICALS

Occurrence, chemical nature, medicinal uses and health benefits of Saponins - Diosgenins and Shatavarins, Flavonoids - Hesperidin and Quercetin, Carotenoids - Carotene (Alpha & Beta)) and Xanthophyll (Lutein), Limonoids - Limonene and alpha Terpineol, Vitamins - Cholecalciferol and Tocopherols.

UNIT III **9 Hours**

SCREENING, TESTING AND PHARMACOVIGILANCE OF NATURAL DRUGS

Phytopharmacological screening of anti-inflammatory, antiulcer and anti-diabetic drugs, stability testing of natural products, toxicity studies as per OECD guidelines, WHO and AYUSH guidelines for safety monitoring of natural drugs, spontaneous reporting schemes for bio-drug adverse reactions, bio drug-drug and bio drug-food interactions

UNIT IV **9 Hours**

SYSTEMIC PHARMACOLOGY

Drugs Affecting Autonomic Nervous System - Cholinergic and Anticholingergic, Peripheral Nervous System - Local anaesthetics and Skeletal muscle relaxants, Central Nervous system - Antianxiety, Cardiovascular System - Anti-anginal and Antihypertensive, Respiratory System - Expectorants, Kidney Function - Diuretics and Antidiuretics

UNIT V **9 Hours**

PHARMACOKINETICS AND PHARMACODYNAMICS

Basics of clinical and population pharmacokinetics, toxicokinetics, pharmacokinetic and pharmacodynamics parameters, order of a reaction - Zero order, first order and mixed order kinetics, principles of drug action (stimulation, depression, irritation , replacement and cytotoxic action)

FOR FURTHER READING

Peripheral Nervous System - toxicity studies as per OECD guidelines

Total: 45 Hours

Reference(s)

1. W. C. Evans, Trease and Evans Pharmacognosy, W.B. Sounders & Co., London, 16th Edition, 2009
2. C. K. Kokate, Purohit and Gokhlae, Text book of Pharmacognosy, Nirali Prakashan, 37th Edition, 2007
3. S. H. Ansari, Essentials of Pharmacognosy, Birla publications, 2nd edition, 2007
4. R. A. Harvey, M. A. Clark, and R. Finkle, Pharmacology, LWW Publishers, 5th Edition, 2011
5. B. Katzung, S. Masters, and A. Trevor, Basic and Clinical Pharmacology, McGraw-Hill Medical, 11th Edition, 2009
6. Richard D. Howland, Lippincott's illustrated reviews: Pharmacology, Lippincott Williams & Wilkins, 7th Edition, 2007

18BT406 CHEMICAL THERMODYNAMICS 3 1 0 4

Course Objectives

- To get familiar with the process, system and free energy which are essential for Biochemical engineering
- To understand the physiological conditions such as pressure and temperature which are essential for any process or product development
- To perform calculations and estimate the necessary conditions for an industrial process

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
g.Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l.Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m.Use the analytical instruments and techniques to separate, purify and characterizebiological compounds

Course Outcomes (COs)

1. Apply the law of thermodynamics and non-ideality to assess the thermodynamic properties of fluids
2. Analyze the thermodynamic property of mixtures
3. Analyze the phase equilibrium behavior using VLE calculations
4. Evaluate the equilibrium constant and equilibrium conversion using chemical reaction equilibria
5. Evaluate the thermodynamic concepts and principles for various industrial processes

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION AND BASIC CONCEPTS

Definitions and fundamental concepts, Laws of thermodynamics; First law of thermodynamics for Flow and non flow Process; Internal energy, Enthalpy, Heat capacity, P-V-T behavior of Pure fluids; Processes involving ideal gases, calculation of Heat effects accompanying chemical reactions, Hess law. second law of thermodynamics, Entropy concepts and calculation of entropy changes

UNIT II **9 Hours**

THERMODYNAMIC PROPERTIES OF MIXTURES

Classification of thermodynamic properties, work function , Gibbs free energy , Maxwell relations and

applications, Relationship among thermodynamic properties , Partial molar properties; concepts of chemical potential and fugacity; activity and activity coefficient; Gibbs Duhem equations.

UNIT III **9 Hours**

PHASE EQUILIBRIA

Criteria for phase equilibria and stability; phase equilibria for binary and multi component systems; Phase rule and Duhem theorem.VLE Equilibrium, VLE for ideal solutions, Phase diagrams for binary solutions and ternary mixtures.

UNIT IV **9 Hours**

CHEMICAL REACTION EQUILIBRIA

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

UNIT V **9 Hours**

APPLICATION OF THERMODYNAMICS

Refrigeration, coefficient of performance, Carnot cycle for ideal refrigeration, Choice of refrigerant, Liquefaction Processes, Ideal Steam power cycles

FOR FURTHER READING

Basic statistical mechanical concept, ensemble and partition function,

Total: 60 Hours

Reference(s)

1. S.I.Sandler, Chemical, Biochemical, and Engineering Thermodynamics, John Wiley publications, 2006
2. K. V. Narayanan, A Text Book of Chemical Engineering Thermodynamics, Prentice Hall of India, 2001.
3. J. M. Smith, H. C. Van Ness and M. M. Abbot, Chemical Engineering Thermodynamics, McGraw-Hill Inc., 2001.
4. P. Atkins, J. D. Paula, Physical chemistry, Oxford University Press, 2002.
5. Terrell L. Hill.. An Introduction to Statistical Thermodynamics, Dover Publications

18BT407 BIOPROCESS LABORATORY 0 0 4 2

Course Objectives

- To provide hands on training for the performance of sterilization and aseptic maintenance.
- To gain the skills on analyzing substrate and product kinetics of bioreactor.
- To develop the skills in line with industry oriented biochemical experiments.
- To provide hands on training for studying different modes of bioreactor
- To develop the skills in the mass transfer analysis for the production of metabolites.

Programme Outcomes (POs)

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

m. Use the analytical instruments and techniques to isolate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the aseptic media and calculate del factor of reactors
2. Apply and determine commercially important bioproducts
3. Analyze the physical and environmental parameters involved in optimization process of reactors
4. Analyze the fermentation process through modern software/tools
5. Evaluate the mass transfer coefficients and rheological properties of bioreactor

Articulation Matrix

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

1 **10 Hours**

EXPERIMENT 1

Batch Sterilization techniques in bioreactor

2 **10 Hours**

EXPERIMENT 2
Growth and Product kinetics from microorganisms in BATCH and FED-BATCH mode

3 **10 Hours**

EXPERIMENT 3
Medium Optimization techniques for Bioprocess systems (Plackett Burman Design)

4 **10 Hours**

EXPERIMENT 4
Effects of pH, Temperature and Substrate on free/ immobilzed Enzyme activity. Use of MATLAB for determnation of Enzyme kinetic parameters

5 **10 Hours**

EXPERIMENT 5
Estimation of qO2 and kLa by dynamic gassing out method

6 **10 Hours**

EXPERIMENT 6
Rheological studies of Fermentation Broth

Total: 60 Hours

Reference(s)

1. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering - Basic Concepts, Prentice Hall, 2002.
2. M. Pauline Doran, Bioprocess Engineering Principles, Academic Press Limited, 1995.
3. Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Principles of Fermentation Technology, Butterworth Heinemann publications, 1995.
4. Harvey W. Blanch, S. Douglas and Clark, Biochemical Engineering, New York: Marcel Dekker Inc., 1997.

18BT408 MOLECULAR BIOLOGY LABORATORY 0 0 4 2

Course Objectives

- To make wider practical dexterity in the area of molecular biology tools and techniques
- To acquire practical skill in isolating and analyzing nucleic acid from living cells

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h.Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i.Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j.Communicate effectively on complex engineering activities with the engineering communityand with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
n.Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

Course Outcomes (COs)

1. Apply the isolation of genomic DNA from bacteria, plant and animal tissues
2. Apply the quantification of DNA using analytical techniques
3. Analyze the restriction digestion and molecular weight determination of DNA
4. Analyze three major macromolecules and their properties in living organisms.
5. Evaluate the concept of gene regulation and its significance in prokaryotes

Articulation Matrix

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

1 **10 Hours**

EXPERIMENT 1

To isolate genomic DNA from Bacteria

2 **10 Hours**

EXPERIMENT 2
To isolate genomic DNA from plant tissue

3 **10 Hours**

EXPERIMENT 3
To isolate genomic DNA from animal tissue

4 **10 Hours**

EXPERIMENT 4
To quantify DNA using UV spectrophotometer / DNA nano drop

5 **10 Hours**

EXPERIMENT 5
To digest DNA using restriction enzymes

6 **10 Hours**

EXPERIMENT 6
To identify DNA molecule using agarose gel electrophoresis

Total: 60 Hours

Reference(s)

1. J. Sambrook, D. Russell, and D. W. Russell, Molecular cloning-A laboratory Manual (A set of Volume 1, 2 and 3), USA: Cold Spring Harbor Laboratory Press, 2000

18HS001 ENVIRONMENTAL SCIENCE 2 0 0 0

Course Objectives

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Analyze the existing environmental challenges related to pollution and its management
4. Analyze the suitable strategies for sustainable management of components of environmental science
5. Evaluate the impacts of population and human activities on environment

Articulation Matrix

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

UNIT I **6 Hours**

NATURAL RESOURCES

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification) - water logging - salinity - case studies. Energy resources: renewable(solar, wind, tidal, geothermal and hydroelectric power) - non renewable energy sources

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: forest ecosystem - desert ecosystem - ecological succession. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity - field study

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - marine pollution - thermal pollution - noise pollution. Disaster management: causes - effects - control measures of floods - earthquake - cyclone - landslides

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development : Definition - Unsustainable to sustainable development - urban problems related to energy. Environmental ethics - issues and possible solutions - solid waste management - causes - effects - 3R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. Environment protection act: Air (Prevention and control of pollution) act - wildlife protection act.

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

Human population: Population growth - characteristics - variation among nations - population explosion - women and child welfare programmes - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

FOR FURTHER READING

Human rights: E - waste and biomedical waste -Identification of adulterants in food materials

Total: 30 Hours

Reference(s)

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

18GE401 SOFT SKILLS-REASONING 0 0 2 0

Course Objectives

- To acquire command of both the receptive skills (Listening, Reading) and the productive skills (Writing and Speaking) of English language
- To understand and make effective use of English language in business contexts

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Listen, Read, Speak, and Write Business English at the level of independent users
2. Appear for the Business English Certificate (BEC) Vantage level examination conducted by the Cambridge Assessment English

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1									2			2			
2									2			2			

UNIT I **15 Hours**

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information

Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

UNIT II **15 Hours**

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

1 **15 Hours**

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information - Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

2 **15 Hours**

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

Total: 60 Hours

Reference(s)

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self - study Practice Tests with Key, Heinle - a part of Cengage Learning, Delhi, 2003.

21BT501 DOWNSTREAM PROCESSING 3 1 0 4

Course Objectives

- To introduce the methods of separation technology
- To expose students to techniques of product fractionation
- To create deeper understanding of final product purification

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g.Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
j.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k.Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

Course Outcomes (COs)

1. Apply the separation techniques used in downstream processes for the purification of biomolecules.
2. Apply the techniques of insoluble removal and predict the parameters for large scale operations.
3. Apply various downstream techniques for bulk product isolation.
4. Analyze the high-resolution product purification based on product characteristics and cost effectiveness.
5. Evaluate the application of equipment utilizing downstream techniques in final product formulation.

Articulation Matrix

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

5	2		2		3	3					3	2		1	

UNIT I **9 Hours**

DOWNSTREAM PROCESSING IN BIOTECHNOLOGY

Scope and importance of Downstream Processing in Biotechnology; need for bioproduct purification; characteristics of biomolecules and bioprocesses; criteria for selection of bio-separation techniques; Role of DSP methods in bioprocess economics; Pretreatment of cells; Cell disruption methods.

UNIT II **9 Hours**

PHYSICAL METHODS OF SEPARATION

Pretreatment and removal of insolubles; Unit operations for solid - liquid separation; Flocculation and sedimentation; Centrifugation - basket, tubular bowl, disk and ultra centrifugation; Filtration - conventional and cross flow filtration, Pervaporation, Kinetics, design and economic consideration

UNIT III **9 Hours**

ISOLATION OF PRODUCTS

Adsorption - Types and applications; liquid-liquid extraction - Reversed micellar and aqueous two-phase extraction; Membrane separation - micro, ultra filtration, reverse osmosis, dialysis; criteria for selection of membranes; Precipitation - Types and scale up

UNIT IV **9 Hours**

PRODUCT RESOLUTION AND FRACTIONATION

Chromatography - principles, instrumedisntation and types - adsorption, reverse phase, ion-exchange, size exclusion, hydrophobic interaction, Bioaffinity chromatography and Pseudo affinity chromatography; Electrophoresis and the methodologies.

UNIT V **9 Hours**

FINISHING OPERATIONS FOR FINAL PRODUCT

Crystallization - principles, practices and equipments; Drying - principles, practices, and equipments; Lyophilization - principles, practices and equipments

FOR FURTHER READING

Criteria for scale up; Vacuum extraction; Recrystallization

Total: 60 Hours

Reference(s)

1. P. A. Belter, E. L. Cussler and Wei-Shou Hu, Bioseparations - Downstream Processing for Biotechnology, Wiley Interscience, 1988
2. B. Sivasankar, Bioseparations - Principles and Techniques, Prentice Hall of India Pvt. Ltd., 2007
3. R. G. Harrison, P. Todd, S. R. Rudger and D. P. Petrides, Bioseparation Science and Engineering, Oxford University Press, 2003
4. Product Recovery in Bioprocess technology, BIOTOL series, Butterworth Heinemann, 2006

21BT502 NANO BIOTECHNOLOGY 3 0 2 4

Course Objectives

- To develop the skills of the student in the area of nano biotechnology and its application
- To familiarize student with different techniques for synthesizing and characterizing of various nanoparticles
- To motivate and facilitate student to undertake the project and research work in nanobiotechnology

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
l.Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Use the analytical instruments and techniques to isolate, purify and characterize biologicalcompounds.
n. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sector

Course Outcomes (COs)

1. Apply the synthesis and characterization of nanoparticles
2. Apply the suitable methods in the preparation of DNA and peptide nanostructures
3. Analyze the usage of analytical tools in nanobiotechnology
4. Analyze the applications of nanoparticles in drug delivery
5. Evaluate the strategies in the preparation of biomaterials in nanomedicine

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO NANOBIOTECHNOLOGY

Synthesis and Characteristics of nanoparticles; Characterization of Nanoscale materials, Strategies for Nano

architecture- bottom up, top down and functional approaches; Quantum dots, Carbon nanotubes- properties, synthesis and application.

UNIT II **9 Hours**

DNA AND PROTEIN BASED NANOSTRUCTURES

DNA-gold particle conjugates; DNA nanostructrures for mechanics and computing; Polymer nanocontainers; Peptide nanotubes and their applications electronics, antibacterial agents, DNA microarrays; Nanobiosensors.

UNIT III **9 Hours**

NANOANALYTICS AND NANO-STRUCTURED MATERIALS

UV-visible spectrophotometer; Particle size analyzer; Zeta sizer; X-Ray Diffractometer, Transmission electron microscopy, Scanning electron microscopy; Energy-dispersive X-ray spectroscopy; Atomic force microscopy; Mass spectroscopy; Fourier transform infrared spectroscopy; X-ray photoelectron spectroscopy.

UNIT IV **9 Hours**

NANOPARTICLES IN DRUG DELIVERY

Applications of Nanobiotechnology in drug delivery; Polymeric nanoparticles for drug and gene delivery; Liposomes; Micelles for drug delivery; Nanotoxicology- Cyto-toxicity, Geno-toxicity In vivo tests/assays etc.

UNIT V **9 Hours**

NANOMATERIALS AND NANOMEDICINE

Cardiavascular implants,Biomaterials for optamology,Structure, property of Biological Materials: tissues, bones and teeth, collagen rich,tissues, elastic tissues, nanostructured collagen mimics in tissue Engineering. Biopolymers: Preparation of nanobiomaterials Polymeric scaffolds collagen, Elastins:Mucopolysaccharides, proteoglycans, cellulose and derivates; Dextrans; Alginates;Pectins; Chitin, nanosurgery.

FOR FURTHER READING

Synthesis of nanoparticles bacteria, fungi, yeast and plants, chemical Transformation of Biomaterials. protein self-assembly,nanochips, nanopolymers.instruments

EXPERIMENT 1 **4 Hours**

Synthesis of metal nanoparticles by chemical reduction method (Ag, Cu, Au and Fe NPs).

EXPERIMENT 2 **4 Hours**

Synthesis of metal nanoparticles by biological method

EXPERIMENT 3 **4 Hours**

Synthesis of metal oxide nanoparticles (ZnO, Fe_3O_4, CuO, CdO and Al_2O_3 NPs)

EXPERIMENT 4 **5 Hours**

Characterization of NPs by UV-visible spectrophotometer, fluorescent spectrophotometer and FTIR analysis

EXPERIMENT 5 **4 Hours**

Evaluation of antimicrobial property of NPs.

EXPERIMENT 6 **4 Hours**

Preparation of drug carrier by nanoemulsion technique.

EXPERIMENT 7 **5 Hours**

Preparation of polymer containers for controlled drug release application

Total: 75 Hours

Reference(s)

1. C. M. Niemeyer and C. A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, Weiheim: Wiley-VCH Verlag GmbH and Co. KGaA, 2004
2. T. Pradeep, Nano: The Essentials Understanding Nanoscience and Nanotechnology, New Delhi: Tata McGraw- Hill, 2008.
3. H. S. Nalwa, Encyclopedia of Nanoscience & Nanotechnology, California: American Scientific Publishers, 2004
4. Bhusan, Handbook of Nanotechnology,Berlin, Heidelberg, Germany: Springer-Verlag, 2004
5. P. M. Ajayan, L. S. Schadler, and P. V. Braun, Nanocomposite Science and Technology, Weiheim: Wiley-VCH Verlag, GmbH & Co. KGaA, 2003

21BT503 GENETIC ENGINEERING 3 0 0 3

Course Objectives

- To familiarize students on various enzymes and vectors used in genetic engineering
- To give exposure on cloning techniques and their applications
- To create deeper understanding on various techniques of gene manipulation

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
m.Use the analytical instruments and techniques to separate, purify and characterize biological compounds.
n.Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

Course Outcomes (COs)

1. Apply the microbial enzymes for constructing recombinant DNA
2. Apply the vectors for cloning and expression of gene of interest
3. Analyze the mechanism of construction of DNA libraries
4. Analyze the molecular techniques used in genetic engineering
5. Evaluate the applications of genetic engineering in biotechnology

Articulation Matrix

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

UNIT I **9 Hours**

ENZYMES USED IN GENETIC ENGINEERING

Nuclease- exonucleases and endonucleases; Restriction enzymes- nomenclature, types, applications; Restriction endonuclease- blunt and sticky ends; RNases, DNA Ligase, Polymerases; DNA Modifying enzymes- alkaline phosphatase, polynucleotide kinase and terminal deoxynucleotidyl transferase.

UNIT II **9 Hours**

VECTORS FOR GENE CLONING AND EXPRESSION

Characteristics of cloning and expression vectors; Plasmids-pSC101, pBR322, pSF2124, colE1, pUC, pGEM,

pMUTIN, pGEX-3X, pET and pTrcHis, Ti plasmid; Bacteriophage vector- lambda; Yeast vectors- plasmids and YAC; Shuttle vectors; Cosmid and phagemid vectors.

UNIT III **9 Hours**

CONSTRUCTION OF LIBRARIES

Linkers, adaptors and homopolymer tailing; Construction of genomic library; cDNA construction- hairpin loop strategies; Directional and non directional cDNA synthesis; Construction of full length cDNA library- Oligo capping; Okayama and Berg method of cDNA cloning; Screening of libraries.

UNIT IV **9 Hours**

TECHNIQUES FOR GENETIC ENGINEERING

Polymerase chain reactions; RAPD; RFLP; Molecular beacons and Taqman assay; Nucleic acid sequencing; Southern and northern blotting; Gene transfer technologies

UNIT V **9 Hours**

APPLICATIONS OF GENETIC ENGINEERING

Gene therapy- ex vivo and in vivo; Genetic engineering in medicine- recombinant therapeutics and biopharmaceuticals, antibiotics, vaccines; Genetic engineering in agriculture- bio pesticides, herbicides; Applications in environment-bioremediation or environment clean-up

FOR FURTHER READING

Mammalian and plant expression vectors; In-situ hybridization; Site-directed mutagenesis; Primer designing; DNA fingerprinting; National regulatory mechanism for implementation of Biosafety guidelines for handling GMOs; Regulation for GM plants, Hybridization and labeling.

Total: 45 Hours

Reference(s)

1. Smita Rastogi and Neelam Pathak, Genetic Engineering, Oxford University Press, 2009
2. T.A.Brown, Gene Cloning an Introduction, U.K: Blackwell Publishers, 2001
3. R.W.Old and S.B.Primrose, Principles of Gene Manipulation: An Introduction to Genetic Engineering, Blackwell Science Publications, 2001
4. B.D.Singh, Biotechnology, Kalyani Publishers, 2010

21BT504 BIOINFORMATICS 3 0 0 3

Course Objectives

- To understand the theory and background of commonly available bioinformatics tools
- To navigate through internet-based biological databases and genomic browsers
- To use online resources for biological applications

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g.Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
k.Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
m.Use the analytical instruments and techniques to separate, purify and characterizebiological compounds

Course Outcomes (COs)

1. Apply the importance of biological databases and their usage
2. Apply the knowledge of bioinformatics in analysis of biological information
3. Analyze the evolutionary concepts to build phylogenetic tree
4. Analyze the concepts of systems biology for its application in metabolic engineering and synthetic biology
5. Evaluate the importance of advanced bioinformatic techniques for drug designing and high throughput analysis

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO BIOINFORMATICS

Introduction to bioinformatics, Basics of database, Biological databases, Protein and Nucleic Acid Databases, PDB, NCBI, Swissprot, KEGG, Uniprot

UNIT II **9 Hours**

SEQUENCE ALIGNMENT

Pairwise sequence alignments - basic concepts of sequence alignment, local and global alignments, Dot Plot, scoring matrices, Multiple Sequence Alignment - CLUSTALW, Genetic Algorithm, HMM

UNIT III **9 Hours**

PHYLOGENETIC ANALYSIS

Basic concepts in systematics, taxonomy and phylogeny; molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees.

UNIT IV **9 Hours**

INTRODUCTION TO SYSTEMS BIOLOGY

Introduction to systems biology, Systems theory, Advantages over reductionist approach, Biological networks - metabolic, signaling & regulatory network, Flux analysis MFA & FBA, Bottom-up approach, Top-down approach, Applications - Metabolic engineering, Synthetic biology.

UNIT V **9 Hours**

ADVANCED BIOINFORMATICS

Data mining, Clustering & Classification, Next Generation Sequence Analysis, High Throughput databases, Computer aided drug design, Quantitative structure activity relationship (QSAR) for drug designing.

Total: 45 Hours

FOR FURTHER READING

Online Tools, open source databases

Reference(s)

1. David B. Mount: Bioinformatics. Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York, 2001
2. Andreas D. Baxevanis, B. F. Francis Ouellette: Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Volume 39, John Wiley, 1998
3. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall, 2006

   James Tisdall, Beginning Perl for Bioinformatics. O'Reilly & Associates, 2000

21BT507 GENETIC ENGINEERING LABORATORY 0 0 4 2

Course Objectives

- To build sound practical knowledge in gene amplification using genetic engineering tools
- To acquire practical skills in gene cloning techniques
- To create deeper understanding on various techniques of gene manipulation

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h.Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i.Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k.Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l.Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n.Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

Course Outcomes (COs)

1. Apply the bacterial gene amplification & perform the using PCR
2. Apply the gene cloning using genetic engineering tools and techniques
3. Analyze the Plasmid profiling using chemical lysis method
4. Analyze and construct recombinant DNA for microbial enzymes
5. Evaluate the preparation of vectors for cloning and expression of gene of interest

Articulation Matrix

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

1 **10 Hours**

EXPERIMENT 1
Isolation of iapA gene of Listeria monocytogenes by PCR and its confirmation by agarose gel electrophoresis.

2 **10 Hours**

EXPERIMENT 2
Purification of amplified iapA DNA and ligation in pGMT easy vector system

3 **10 Hours**

EXPERIMENT 3
Preparation of E. coli DH5a competent cells by glycerol methods

4 **10 Hours**

EXPERIMENT 4
Transformation of recombinant pGMT easy vector into E. coli DH5a by electroporation method

5 **10 Hours**

EXPERIMENT 5
Confirmation of recombinant transformed clones using Blue White screening

6 **10 Hours**

EXPERIMENT 6
Isolation of recombinant plasmid DNA using alkaline lysis method

Total: 60 Hours

Reference(s)

1. J. Sambrook, D. Russell, and D. W. Russell, Molecular cloning-A laboratory Manual (A set of Volume 1, 2 and 3), USA: Cold Spring Harbor Laboratory Press, 2000

21BT508 DOWNSTREAM PROCESSING LABORATORY **0 0 4 2**

Course Objectives

- To implement the techniques of bioseparation.
- To expose students to the techniques of final product purification
- To create deeper understanding of final product purification

Programme Outcomes (POs)

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

h.Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i.Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k.Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l.Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

n.Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

Course Outcomes (COs)

1. Apply the separation techniques for the recovery of biomolecules from fermentation broth.
2. Apply the techniques used for final purification and product formulation
3. Analyze the chromatography techniques in bio molecules separation
4. Analyze techniques of insoluble removal and predict the parameters for large scale operations
5. Evaluate the techniques of high-resolution product purification based on product characteristics and cost effectiveness

Articulation Matrix

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

1 **10 Hours**

EXPERIMENT 1
Cell disruption techniques - Physical, Chemical and Mechanical

2 **10 Hours**

EXPERIMENT 2
Aqueous two phase extraction of biological molecules.

3 **10 Hours**

EXPERIMENT 3
Microfiltration using tangential flow separation

4 **10 Hours**

EXPERIMENT 4
Precipitation and Electrophoresis of proteins

5 **10 Hours**

EXPERIMENT 5
Purification of biomolecules using chromatographic techniques

6 **10 Hours**

EXPERIMENT 6
Crystallization of metabolites

Total: 60 Hours

Reference(s)

1. P. A. Belter, E. L. Cussler and Wei-Shou Hu, Bioseparations - Downstream Processing for Biotechnology, Wiley Interscience, 1988
2. B. Sivasankar, Bioseparations - Principles and Techniques, Prentice Hall of India Pvt. Ltd., 2007

18GE501 SOFT SKILLS - APTITUDE I 0 0 2 0

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Recongnize the need for, and have the preaparation and ability to engage in independent and life long learning in the broadest context of technological change

Course Outcomes (COs)

1. Explain various concepts of number systems and their techniques in solving the percentage, average and age problems.
2. Analyse the profit and loss of real time situations and the relation between ratio, proportion and variation.
3. Apply different techniques to find the distance, speed and time of various moving objects.
4. Understand the concepts of coding, sequences and series, data interpretation and critical reasoning to solve real time logical reasoning problems.

Articulation Matrix

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

1 **2 Hours**

NUMBER SYSTEMS

Introduction - Definition - Classification on Numbers- Power cycles and remainders - Short cut process- Concept of Highest Common Factor-Concept of Least Common Multiple- Divisibility- Number of zeros in an expression.

2 **2 Hours**

PERCENTAGE

Introduction - Definition and Utility of Percentage - Importance of base/denominator for percentage calculations-Concept of percentage values through additions-Fraction to percentage conversion table.

3 **3 Hours**

AVERAGES AND AGES

Introduction-Average of different groups-Addition or removal of items and change in average- Replacement of some of the items.

4 **3 Hours**

RATIO, PROPORTIONS AND VARIATION

Introduction- Ratio- Properties-Dividing a given number in the given ratio-Comparison of ratios-Proportions-

Useful results on proportion- Continued proportion-Relation among the quantities more than two-Variation.

5 **2 Hours**

PROFIT AND LOSS

Gain/Loss and percentage gain or percentage loss-Multiplying equivalents to find sale price-Relation among cost price, sale price, gain/loss and percentage gain or percentage loss-An article sold at two different selling price-Two different articles sold at same selling price-Percentage gain or percentage loss on selling price-Percentage gain or percentage loss on whole property.

6 **2 Hours**

TIME AND WORK

Introduction-Basic concepts-Concepts on working with different efficiencies-Pipes and Cisterns-Work Equivalence (Man Days) -Alternative approach.

7 **2 Hours**

TIME, SPEED AND DISTANCE

Definition-Basics of Time, Speed and Distance - Relative speed-Problems based on Trains-Problems based on Boats and Streams-Problems based on Races-Time taken with two difference modes of transport-Time and distance between two moving bodies.

8 **3 Hours**

CODING AND DECODING

Introduction-Description of Coding method-Coding patterns - Concepts of Coding and Decoding-Problems involving Coding and Decoding methods.

9 **2 Hours**

SEQUENCE AND SERIES

Introduction-Sequences of real numbers - Number and Alphabet series-Description of Number and Alphabet series-Analogy-Odd man out-Power series.

10 **3 Hours**

DATA SUFFICIENCY

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid.

11 **3 Hours**

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems-Direction-Plotting diagrams.

12 **3 Hours**

CRITICAL REASONING

Introduction-Basic concept of critical reasoning- Weaken the argument-Strengthen the argument-Flaw in the argument-Evaluate the conclusion.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

21HS002 HUMAN VALUES IN ETHICS 2 0 0 2

Course Objectives

- Understand the concept of good values and comprehend the importance of value-based living.
- Recognize the culture of peace through education.
- Identify and apply the practices for value development and clarification.

Programme Outcomes (POs)

h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Apply the importance of human values and ethics in life.
2. Apply the importance of harmonious living in a diverse society.
3. Analyze the sensitivity to the crying needs of society such as ungodliness, corruption, poverty, and suffering, and play a vital role in eradicating them.
4. Analyze the intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Evaluate the correct balance between professional excellence and social commitment.

Articulation Matrix

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

UNIT I **6 Hours**

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

1.Importance of Human Values & Ethics in 21st Century
2.Understanding the theory of basic human values and ethics
Openness to change
Self-enhancement
Conservation
Self-transcendence
3. Schwartz Value Survey: Self-Assessment

UNIT II **6 Hours**

EMBRACING THE COMMON ETIQUETTE

Altruism – Integrity -Freedom -Justice -Honesty -Truthfulness -Responsibility -Compassion

UNIT III **6 Hours**

CONTINUOUS HAPPINESS AND PROSPERITY

An overview on basic Human Aspirations - Understanding and living in harmony at various levels of life - Embracing self-love and wellness -Understanding harmony in the family and society

UNIT IV **6 Hours**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

Reflection on growing global multifold problems: poverty, pollution, hunger, disease, unemployment, caste system, child labour, gender equality, politics and violence.
Understanding the challenges in cultural, personal, social, political, and economic environment

UNIT V **6 Hours**

UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS CO-EXISTENCE

Understanding the harmony in the Nature - Holistic perception of harmony at all levels of existence - Practice Exercises and Case Studies will be taken up in Practice Sessions

Total: 30 Hours

Reference(s)

1. Martin, G. (2011). The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin.
2. Gupta, N. L. (2002). Human Values For The 21St Century. India: Anmol Publications Pvt. Limited.
3. Mishra, A. (2017). Happiness Is All We Want. India: Bloomsbury Publishing.
4. Universal Human Values. (2023). (n.p.): Booksclinic Publishing.
5. A Textbook On Professional Ethics And Human Values. (2007). India: New Age International (P) Limited

21BT602 BIOPHARMACEUTICAL TECHNOLOGY 3 0 0 3

Course Objectives

- Introduce diverse sources and classes of biopharmaceuticals
- Expose students to various modes of drug delivery
- Build deeper understanding of application of biotechnology tools in the world of medicine

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g.Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
m. Use the analytical instruments and techniques to isolate, purify and characterize biological compounds
n. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors

Course Outcomes (COs)

1. Apply the difference between chemical and bio-based pharmaceuticals
2. Apply the knowledge of biological effects of bioactive substances for their use as therapeutics
3. Analyze the need for formulation of biopharmaceuticals
4. Analyze various criteria for selection of drug carriers that result in effective drug delivery
5. Evaluate drug action based on the difference in physiological functions of a host

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Biopharmaceuticals - definition, classification, current status and future prospects. traditional pharmaceuticals of biological origin, generic and branded biopharmaceuticals, biosimilars - global and Indian scenario, advantages and issues concern with the use of biosimilars

UNIT II **9 Hours**

PRODUCTION AND THERAPEUTIC APPLICATIONS OF BIOPHARMACEUTICALS

Cytokines - IFN-, IL-2; Hormones - Insulin, Human growth hormone; Antibodies - Monoclonal and Polyclonal, Vaccines - hepatitis B, Porcilis pesti; Anticoagulant - Hirudin

UNIT III **9 Hours**

FORMULATION OF BIOPHARMACEUTICALS

Rational for formulation of biotherapeutics, formulation excipients - solubility enhancers, anti aggregating agents, buffers, cryoprotectants, antioxidants, methods to enhance shelf- life of protein based therapeutics, preservatives and packaging techniques

UNIT IV **9 Hours**

CONVENTIONAL DOSAGE FORMS AND NOVEL DRUG DELIVERY SYSTEMS (NDDS)

Liquid dosage forms - Suspensions, emulsions; Semisolid dosage forms - Ointments, creams; Soild dosage forms - Tablets, Capsules; modes of NDDS - targeted, controlled and modulated, advantages and factors affecting NDDS

UNIT V **9 Hours**

MECHANISM OF ACTION OF BIOPHARMACEUTICALS

Mechanisms of drug absorption, distribution and metabolism, factors governing absorption, distribution and metabolism of a drug, Pharmacokinetics and Pharmacodynamics of therapeutic peptides, Bioavailability and Bioequivalence

Total: 45 Hours

Reference(s)

1. Daan J A Crommelin, Pharmaceutical Biotechnology, Taylor &Francis Group, 2nd Edition, 2010
2. Gary Walsh, Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley & Sons, Inc., 2nd Edition, 2003
3. Rodney J. Y. Ho, Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, John Wiley & Sons, Inc., 2ndEdition, 2013
4. Gary Walsh, Pharmaceutical Biotechnology: Concepts and Applications, John Wiley & Sons, Inc., 2007
5. Oliver Kayser and Heribert Warzecha, Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, John Wiley & Sons, Inc., 2nd Edition, 2012

21BT607 TISSUE CULTURE LABORATORY 0 0 4 2

Course Objectives

- To impart hands on training in the aseptic techniques and operation of equipment
- To study the different culturing techniques involved in plant and animal tissue culture.
- To learn about different origins and types of contamination in a cell culture environment

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the basic principles in plant and animal tissue culture experiments.
2. Apply the knowledge to optimize media for the in vitro culturing of plant and animal cells
3. Analyze the different methods that are suitable for plant and animal cells culturing
4. Analyze the different nutritional and environmental requirements for growing cells
5. Evaluate different factors that affects cell growth in culture

Articulation Matrix

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

1 **8 Hours**

EXPERIMENT 1

Organizing plant tissue culture laboratory

2 **8 Hours**

EXPERIMENT 2

Preparation of plant tissue culture medium

3 **8 Hours**

EXPERIMENT 3

Preparation of explants (Callus and shoot induction)

4 **8 Hours**

EXPERIMENT 4
Organizing animal tissue culture laboratory

5 **14 Hours**

EXPERIMENT 5
Culturing of chick embryo and primary cell isolation

6 **14 Hours**

EXPERIMENT 6
Media preparation, cell counting, staining and preservation techniques

Total: 60 Hours

Reference(s)

1. M. K. Razdon, Introduction to Plant Tissue Culture, Oxford & IBH Publishing Company, 2006
2. U. Satyanarayana, Biotechnology, Book & Allied Pvt. Ltd., 2007.
3. Readings in Mammalian cell culture. R. Pollack., Cold Spring Harbour Laboratory (198)
4. Culture of Animal Cells. R. Ian Freshney and R. Alan., Liss. Inc. (1987).

21BT608 BIOPHARMACEUTICAL TECHNOLOGY LABORATORY

0 0 4 2

Course Objectives

- To provide hands on training good laboratory practices
- To impart the skills for ensuring sterility of biopharmaceuticals
- To acquire skills in preparing various pharmaceutical dosage forms

Programme Outcomes (POs)

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

n. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors

Course Outcomes (COs)

1. Apply good laboratory practices in biopharmaceutical manufacturing facilities
2. Analyze biopharmaceuticals for their sterility
3. Evaluate the efficiency of different carrier molecules used for drug delivery
4. Evaluate the pharmacological functions of bioactive compounds isolated from natural source
5. Create novel dosage forms for effective drug delivery

Articulation Matrix

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

1 **7 Hours**

EXPERIMENT 1

Good Laboratory Practice (GLP) protocols for cleaning, decontamination and sanitization

2 **7 Hours**

EXPERIMENT 2

Sterility testing of injectables by membrane filtration

3 **7 Hours**

EXPERIMENT 3

Sterility testing of freeze dried formulation by direct inoculation

4 **7 Hours**

EXPERIMENT 4

Preparation of blank and loaded liposome for drug delivery

5 **8 Hours**

EXPERIMENT 5

Preparation of controlled release formulation

6 **8 Hours**

EXPERIMENT 6

Isolation, screening and quantification of bioactive compounds from natural source

7 **8 Hours**

EXPERIMENT 7

Determination of bacterial endo-toxins by Limulus Amebocyte Lysate (LAL) Test

8 **8 Hours**

EXPERIMENT 8

Anti Lipid Peroxidation (Thiobarbituric Acid Reactive Substances) assay

Total: 60 Hours

Reference(s)

1. S. B. Bhise, R. J. Dias, S. C. Dhawale and K. K. Mali, Laboratory Manual of Biopharmaceutics and Pharmacokinetics, Trinity Publishing House, 2010
2. H. C. Ansel, Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams & Wilkins, 7th Edition, 2000

18GE601 SOFT SKILLS-APTITUDE II **0 0 2 0**

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and multidisciplinary settings.

j. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Course Outcomes (COs)

1. Apply the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
2. Understand the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
3. Analyse objects involving cubes and cuboids in determining the number of sides colored.
4. Interpret various data from graphs and tables to determine ratio, percentage and averages.
5. Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

Articulation Matrix

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

1 **2 Hours**

PERMUTATION AND COMBINATION

Definition-Fundamental rules-Theorems on Permutation-Theorems on Combination.

2 **2 Hours**

PROBABILITY

Concept and Importance of Probability-Underlying factors for real Life estimation of probability-Basic facts about probability-Some important consideration while defining event.

3 **2 Hours**

SYLLOGISM AND VENN DIAGRAM

Concepts on Syllogisms-Venn diagram-Interpretation-Venn diagram-solving.

4 **4 Hours**

SIMPLE INTEREST AND COMPOUND INTEREST

Introduction-Definition - Effect of change of P, R, T on simple interest-Amount-Amount becomes N times the principle-Repayment of debt in equal installments-Rate and time are numerically equal-Compound Interest-Conversion period-Basic formula-Special cases-To find the principle / Time /Rate-Difference between

Compound Interest and Simple Interest-Equal annual installment to pay the borrowed amount.

5 **2 Hours**

MIXTURES AND ALLIGATION

Definition-Alligation rule-Mean value (cost price) of the mixture-Some typical situations where allegation can be used.

6 **4 Hours**

CUBE AND LOGARITHM

Introduction-Basic Concepts of Cube and Cuboid-Problems involving cubes and cuboids of various dimensions-Problems involving coloured cubes and cuboids - Basic concepts of Logarithm-Laws of Logarithms including change of base-Common logarithm (base 10) - Properties of Logarithms to solve equations involving logarithmic expressions.

7 **2 Hours**

DATA INTERPRETATION

Introduction-Ratio-Percentage-Average-Tables - Graphs and Charts.

8 **2 Hours**

PROGRESSION AND LOGICAL REASONING

Arithmetic progression-Geometric progression-Harmonic progression-Theorems related with progressions.

9 **2 Hours**

PROBLEM ON AGES

Introduction-Basic concept-Usage of Percentage and Averages -Applications.

10 **2 Hours**

ANALYTICAL REASONING

Introduction-Basic concept-Non verbal Analytical Reasoning -Arrangements.

11 **2 Hours**

BLOOD RELATION

Introduction-Basic concept-Kinds of relation-Tree diagram -Relations.

12 **2 Hours**

VISUAL REASONING

Introduction-Basic concepts-Odd man out-Next series-Mirror image and water image

13 **2 Hours**

SIMPLIFICATIONS

Introduction-Basic concepts-Arithmetic operations-Equation solving methods-Puzzles.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S

Chand Publications.

5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

21BT701 BIOBUSINESS 3 0 0 3

Course Objectives

- To inculcate the spark of creating bio business
- To explore the entrepreneurial skills for Bio startups
- To create the entrepreneurship ecosystem

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors.
o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the basics of bio business and correlate it with development of biotech industries.
2. Apply specific business strategies for successful initiation of business startups.
3. Analyze the significance of legal protection of Bio inventions and commercialization.
4. Analyze the recent business schemes and funding opportunities for starting bio ventures.
5. Evaluate the scope of export business and legal procedures for exporting value added commercially significant bio products.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO BIO BUSINESS

Need and scope of Bio business, Bio Business boom and Indian economy, Industry - academia collaboration,

Role of entrepreneurs in economic development,Growth of biotechnology and biopharmaceutical industries, Market share of biotechnology industry at global level.

UNIT II **9 Hours**

BIO BUSINESS STRATEGIES

Self-Discovery,Customer Discovery, Design Thinking for Customer Delight, Market survey, Value chain and value proposition, business model canvas, Business plan, break-even point, bootstrapping, Iterating the Minimum viable product, Capstone Project Presentation, Mentoring and Venture Support, Blue Ocean Strategy, Return on Investment (ROI) and Return on Equity (ROE), Digital presence of entrepreneurs and online marketing.

UNIT III **9 Hours**

BIO BUSINESS AND PROTECTION

Technological Innovation and Entrepreneurship, Design-Driven Innovation, Intellectual property rights, technology licensing, financial assistance for Patent filing systems in India and other countries, benchmarking, IP protection & commercialization strategies, relevance of cost theories in business decision-making,

UNIT IV **9 Hours**

BIO BUSINESS SCHEMES AND FUNDING OPPORTUNITIES

Resource Mobilization-Angel Investor, funds from Government agencies - MSME, DBT, BIRAC, Startup & Make in India, private agencies like venture capitalists:/angel investors and bank for bio entrepreneurship.

UNIT V **9 Hours**

BIO STARTUPS ANDEXPORTS

scope of export business and Legal procedures and registration -Company, bank accounts,IE code and export promotion council, Supply Chain and Shipping Logistics, Statutory and legal requirements for starting a company/venture, Cash flow management, Estimation of income, expenditure, profit, income tax.

FOR FURTHER READING

Government funded start up schemes in india

Total: 45 Hours

Reference(s)

1. Dr. Craig Shimasaki ,Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Academic Press; 1 edition, 2014
2. Anas Rasheed , Ipr in Biotechnology, Createspace Independent Pub, 2017.
3. Team PrabhatPrakashan, Government Schemes, Missions, Campaigns and Programmes In India, PrabhatPrakashan; 1 edition, 2018
4. I C Dhingra, MAKE IN INDIA, Cosmos Book Hive; 1 edition, 2016
5. Allen McCarthy, Freight Broker Business Startup: How to Start, Run & Grow a Successful Freight Brokerage Business, CreateSpace Independent Publishing Platform; 1 edition, 2017
6. Yann Aubinand Arnaud Idiart, Export Control Law and Regulations Handbook (Global Trade Law), Wolters Kluwer; 3 edition3rd Edition

21BT702 ENZYME AND PROTEIN ENGINEERING 3 0 0 3

Course Objectives

- To provide students with a basic understanding of classification, nomenclature, mechanism and specificity of enzyme-coenzyme action, extraction, purification and characterization of enzymes
- To understand enzyme immobilization methods , kinetics of free, immobilized and allosteric enzymes
- To learn the stability, dynamics, structure/function relationships, folding of proteins and rational drug design

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
n. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors

Course Outcomes (COs)

1. Apply and gain knowledge on enzyme, coenzyme and their classification
2. Apply the basic downstream techniques for processing, Production and Purification of enzymes from various sources at an industrial scale
3. Apply the theoretical and practical aspects of enzyme kinetics for promoting research
4. Analyze the tertiary and quaternary structure of proteins
5. Evaluate the role of structure function relationship of proteins

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO ENZYMES AND PROTEIN

Nomenclature and Classification of enzymes. Mechanism and specificity of enzyme action - Units for enzyme activity - Coenzymes-Classification, Coenzymes in metabolic pathways, metal-activated enzyme and metalloenzyme; enzymes without cofactors, Abzymes, synzymes, non-protein enzymes and thermophilic enzymes. pH and temperature effect on enzyme activity.

UNIT II **9 Hours**

ENZYMES: EXTRACTION, PURIFICATION AND IMMOBILIZATION

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays, Physical and chemical techniques for enzyme immobilization adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding.

UNIT III **9 Hours**

KINETICS OF ENZYME

Single and multisubstrate enzyme catalysed reaction- MM kinetics-turnover number-catalytic efficiency- ping-pong bi-bi mechanism, random - order mechanism and compulsory order mechanisms; Types of inhibition & models for substrate and product inhibition. Immobilized enzyme kinetics - Analysis of Film and Pore Diffusion Effects on Kinetics of immobilized Enzyme Reactions,

UNIT IV **9 Hours**

PROTEIN ARCHITECTURE AND STRUCTURE

Primary structure: peptide mapping, peptide sequencing -automated Edman method. Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structures, topology diagrams, prediction of substrate binding sites. Tertiary structure: Domains, folding, denaturation and renaturation, Quaternary structure: Modular nature, formation of complexes.

UNIT V **9 Hours**

STRUCTURE-FUNCTION RELATIONSHIP

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp Repressor, Eukaryotic transcription factors - Membrane proteins: General characteristics, Transmembrane segments, prediction - Immunoglobulins: IgG Light chain and heavy chain architecture - Abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase,

FOR FURTHER READING

TIM barrel structures nucleotide binding folds, prediction of substrate binding sites

Total: 45 Hours

Reference(s)

1. Wiseman, Alan. Hand book of Enzyme Biotechnology, 3rd ed., Ellis Harwood 1995
2. Chaplin and Bucke, Enzyme Technology, Cambridge University Press, 1990
3. Price and Stevens, Fundamentals of Enzymology, Oxford University Press,
4. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997
5. Branden C. and Tooze J., Introduction to Protein Structured 2ndEdition, Garland Publishing, 1999.
6. Creighton T.E. Proteins, 2ndEdition. W.H. Freeman, 1993

21BT707 PROJECT WORK I 0 0 6 3

Course Objectives

- To extend knowledge to devise a real time problem and project goals
- To identify the various tasks of the project to determine standard procedures
- To recognize the various procedures for validation of the product and cost effectiveness

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m.Use the analytical instruments and techniques to isolate, purify and characterize biological compounds
n. Process designing and production of the novel biomolecules for the agricultural,environmental and healthcare sectors.
o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the real world problem, identify the requirement and develop the design solutions
2. Apply the technical presentation and communication skills
3. Analyze the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Evaluate and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Create the report and present oral demonstrations

Articulation Matrix

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

Total: 90 Hours

21BT801 PROJECT WORK II 0 0 18 9

Course Objectives

- To extend knowledge to devise a real time problem and project goals.
- To identify the various tasks of the project to determine standard procedures
- To recognize the various procedures for validation of the product and cost effectiveness

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m.Use the analytical instruments and techniques to isolate, purify and characterize biological compounds
n. Process designing and production of the novel biomolecules for the agricultural,environmental and healthcare sectors.
o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the real world problem, identify the requirement and develop the design solutions
2. Apply the technical presentation and communication skills
3. Analyze the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Evaluate and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Create the report and present oral demonstrations

Articulation Matrix

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

Total: 180 Hours

DISCIPLINE ELECTIVES

21BT001 FERMENTATION TECHNOLOGY 3 0 0 3

Course Objectives

- To recognize the fundamentals of fermentation technology.
- To comprehend growth and metabolism, genetics and metabolic engineering in the age of genomics, the biological basis for monitoring bioprocesses including process analytical technology, and applications of the modern biological concepts in bioprocess developments
- To distinguish bioreactor operations and assess power requirements in bioreactors.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Process designing and production of the novel biomolecules for the agricultural, environmental and healthcare sectors.
o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the growth and metabolism of microorganisms.
2. Apply the bioprocess concepts in mammalian cell culture technology
3. Analyze the biological basis for industrial fermentations and cell cultures
4. Analyze the bioreactor operations in bacterial and mammalian cell systems
5. Evaluate the students to use microorganisms to produce valuable pharmaceutically important bioproducts onan industrial scale.

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF INDUSTRIAL FERMENTATION

Major types of organisms used in fermentation, Mammalian cell culture system, Plant cell tissue and organ cultures, Metabolic pathways and metabolic control mechanisms, Batch culture, Continuous Culture, Fed – Batch – Types, applications, Fermentation kinetics.

UNIT II **9 Hours**

PRODUCTION OF PRIMARY AND SECONDARY METABOLITES

Organic acids fermentation, Solvents fermentation, Antibiotic production: Classification, Vitamins fermentation, Food flavouring agents and preservative production, Production of single cell protein,

Recombinant protein production, Biopolymers production, Bioinsecticide production, Biofuel production

UNIT III **9 Hours**

MICROBIAL AND MEDIA PREPARATION FOR FERMENTATION

Isolation, preservation and improvement of industrially important microorganisms, media for industrial fermentations – media formulation, Development of inoculum for industrial fermentations

UNIT IV **9 Hours**

FERMENTER FOR FERMENTATION

Large Fermenter design and types-basic functions of a Fermenter for microbial and animal cell culture – alternative vessel design, common measurements and control systems. Sensors – solutions to common problems in fermentation, anaerobic fermentation.

UNIT V **9 Hours**

PRODUCT DEVELOPMENT, FORMULATION, AND QUALITY ASSESSMENT

Product development: Unit operations involved in Powder and liquid products, Basics Formulation procedure – animal feed, cellulase for paper indstry, Quality control of fermented products – alcohol, Organic acid, and antibiotic testing.

FOR FURTHER READING

Wine and Cider production; Alcohol production; Biogas

Total: 45 Hours

Reference(s)

1. Emt.el-Mansi & CFA. Bryce Fermentation Microbiology & Biotechnology, Taylor & Francis Ltd. (2004).

2. Stanbury, P.F., A. Whitaker & S.J. Hall. Principles of fermentation technology Oxford Press. (1997).

3. Arnold L. Demain & Julian E. Davis. Industrial Microbiology & Biotechnology, ASM Press. (2004).

4. Vogel. H.C., Todaro. C.L., "Fermentation and Biochemical Engineering Handbook - Principles, Process design, and Equipment", Noyes Publications, 1997

21BT002 INDUSTRIAL MICROBIOLOGY 3 0 0 3

Course Objectives

- To provide student with firm understanding of the techniques involved in fermentation process and reactor systems
- To understand the significance of bioresources and its role in microbial biotechnology
- To discuss the treatment techniques pertaining to environmental biotechnology

Programme Outcomes (POs)

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

c. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

d. Graduates will demonstrate knowledge of professional and ethical responsibilities

n. Process designing and production of the novel biomolecules for the agricultural,environmental and healthcare sectors.

Course Outcomes (COs)

1. Apply the microbes and media and optimize culture conditions
2. Apply the fermenters for maximum production of biomass and bioproducts
3. Analyze the various biomolecules of microbial origin
4. Evaluate the industrially important bioproducts
5. Create bio active compounds of pharmaceutical importance

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Isolation, identification and methods of purification of microbial strains; Quantification of microorganisms - direct and indirect methods; preservation of microbial cultures, genetic improvement ofmicrobial strains.

UNIT II **9 Hours**

FERMENTATION TECHNOLOGY

Types of bioreactors; operation of bioreactors; media for industrial fermentation, solid substratefermentation, primary and secondary metabolites; principles of microbial growth, culture system.

UNIT III **9 Hours**

BIOTRANSFORMATION

Biotransformation -reactions, techniques, product recovery; biotransformation of steroids, antibiotics,

arachidonic acid , glycerol; biotransformation for the production of ascorbic acid, indigo.

UNIT IV **9 Hours**

MICROBIAL PRODUCTION

Alcohols (Ethanol & Butanol), acetone, Production of citric acid, Acetic acid, Succinic acid, vinegar,Lactic acid & Industrial production of Vitamins (B2, B12, Ascorbic acid)

UNIT V **9 Hours**

PHARMACEUTICAL MICROBIOLOGY

Industrial production of Insulin, human growth hormone, monoclonal antibodies, Interferons & antibiotics (Penicillin ,streptomycin)

FOR FURTHER READING

Enzymes -sources, types, applications of cellulase, pectinase, xylanase, laccase, amylase, glucose isomerase, SCP, Aminoacids -sources and applications of Methionine, Lysine; commercially important fermentation processes.

Total: 45 Hours

Reference(s)

1. U. Sathyanarayana, Biotechnology,Kolkata: Books and Allied (P) Ltd., 2005
2. W. Crueger and A. Crueger, Biotechnology: A Textbook: of Industrial Microbiology, Panima Publishing Corporation, 2003
3. P. F. Stanbury, A. Whitaker and S. J. Hall, Principles of Fermentation Technology, Butterworth-Heinemann (Elsevier Science), 2005
4. C. Ratledge and B. Kristiansen, Basic Biotechnology, Cambridge University Press, 2001

21BT003 ENVIRONMENTAL BIOTECHNOLOGY 3 0 0 3

Course Objectives

- Develop a basic knowledge on the global issues pertaining to environment
- Analyze the various techniques involved in treating the wastes
- Understanding the process of biodegradation and bioremediation

Programme Outcomes (POs)

a. An ability to independently carry out research /investigation and development work to solve practical problems
b. An ability to write and present a substantial technical report/document
d. Graduates will demonstrate knowledge of professional and ethical responsibilities
m.Use the analytical instruments and techniques to isolate, purify and characterize biologicalcompounds
n. Process designing and production of the novel biomolecules for the agricultural,environmental and healthcare sectors.

Course Outcomes (COs)

1. Apply the challenges and problems associated with the climatic issues with the current environmental scenario
2. Analyze the various biological treatment methods to treat the wastewater
3. Analyze the various waste minimization techniques and control measures that help to reduce wastes
4. Analyze the various hazardous waste minimization techniques and control measures that help to reduce hazardous wastes
5. Evaluate various biodegradation and bioremediation methods and their performance in eliminating wastes

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Climate change, Greenhouse gases and their sources, ozone depletion. Effects of industrial activity- acid rain, smog, global warming and eutrophication, Radiation hazards. Introduction to treatment of liquid and solid wastes; Contributions of Biotechnology to waste treatment and environmental managements

UNIT II **9 Hours**

BIOLOGICAL WASTEWATER TREATMENT

Characteristics of wastewaters, Preliminary and primary wastewater treatments, Secondary treatment- Aerobic lagoons or ponds, trickling filters, activated sludge process, fluidized bed, Anaerobic treatment-Anaerobic ponds, anaerobic reactors, UASB, Tertiary treatment- removal of suspended solids, oil and grease, nitrogen

removal, phosphorus removal.

UNIT III **9 Hours**

SOLID WASTE MANAGEMENT

Solid wastes - types of solid wastes, characteristics of solid wastes, segregation, collection, transportation. Disposal methods - Sanitary land filling, Recycling, composting, Incineration, Waste minimization techniques. Recovery of energy from solid wastes

UNIT IV **9 Hours**

HAZARDOUS WASTE MANAGEMENT

Hazardous Wastes- Sources & Classification, physicochemical properties, Hazardous Waste Control &Treatment. Hospital Waste Management, Disaster Management.

UNIT V **9 Hours**

BIODEGRADATION

Biodegradation of macromolecules; xenobiotics; Bioremediation of metal contaminated soils, spilled oil land grease deposits, synthetic pesticides. Phytotechnology-terrestrial phytosystems, metal phytoremediation, Phytotechnology-aquatic photosystems, algal treatment system

FOR FURTHER READING

Water conservation in industry - A case study from Sterlite industries limited, Tamil Nadu. Case study analysis of oil spill cleanup methods for more effective handling of future accidents. The Kudankulam controversy- A case study

Total: 45 Hours

Reference(s)

1. Alan Scragg, Environmental Biotechnology, Oxford University Press Inc., 2007.
2. Bimal C. Bhattacharyya and B. Rintu, Environmental Biotechnology, Oxford University Press Inc., 2007
3. P. R. Yadav, and Rajiv Tyagi, (2006) .Environmental Biotechnology, Discovery Publishing house
4. InduShekhar Thakur, (2006) Environmental Biotechnology- Basic concepts and application, I.K International, Pvt. Ltd., 2006

21BT004 BIOENERGY AND BIOFUELS 3 0 0 3

Course Objectives

- To introduce the basic concepts, principles, potentials and limitations of biological energy sources
- To introduce various form of energy derivation such as liquid, gas from biological sources
- To know and understand contemporary issues pertaining to the energy and environment

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

n.Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

o. Conceive, Plan and Deploy societal projects for environmental protection using Bio-resources

Course Outcomes (COs)

1. Apply the concepts in biomass conversion to derive energy from them
2. Apply the biogas production technology with environmental sustainability
3. Analyze the technology involved in liquid bio-fuels production and analyze the properties
4. Analyze the various technologies involved in biomass processing
5. Evaluate the major unit processes/operations of an integrated bio-refinery

Articulation Matrix

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

UNIT I **9 Hours**

BIOMASS TYPES, PROPERTIES AND CONVERSION

Biomass Sources, Characteristics & Preparation: Biomass Sources and Classification. Chemical composition and

properties of different biomass materials. Biomass conversion: Thermochemical (pyrolysis, reforming, gasification, hydrothermal conversion, biochemical conversion, combustion), biochemical (anaerobic digestion, fermentation etc) and mechano-chemical conversion. Preparation of woody biomass: Size reduction, Briquetting of loose biomass, Drying, Storage and Handling of Biomass, hydrogen production and biological fuel cell.

UNIT II **9 Hours**

BIOGAS TECHNOLOGY

Feedstock for biogas production, Aqueous wastes containing biodegradable organic matter, animal residues-.Microbial and biochemical aspects- Operating parameters for biogas production Kinetics and mechanism - Dry and wet fermentation. Digesters for rural application-High rate digesters for industrial waste water treatment

UNIT III **9 Hours**

BIO-ETHANOL

Bio- fuels -Production of Fuel Ethanol by Fermentation Of Sugars. Sugar cane molasses and other sources for fermentation ethanol-Sources and processing of oils and fats for liquid fuels. Gasohol as a Substitute for Leaded Petrol.

UNIT IV **9 Hours**

BIODIESEL

Biodiesel − Microorganisms and raw materials used for microbial Oil production − Treatment of the feedstocks prior to production of the Biodiesel − Current technologies of biodiesel production − Purification of biodiesel; Industrial production of biodiesel − Biodiesel production from single cell oil

UNIT V **9 Hours**

BIOREFINERIES

Bio refinery: concept and types - Definition and types of bio refineries - co-products of oil bio refineries: oil cake and glycerol - purification of glycerol obtained in biodiesel plant - anaerobic and thermal gasification of biomass – optimization of bio refinery process - economics of bio refineries.

FOR FURTHER READING

Solar Energy, wind energy and hydro energy; Alcohol production - cellulose degradation; Biogas and producer gas engines. Second and third generation Biofuels.

Total: 45 Hours

Reference(s)

1. Sunggyu Lee and Y T Shah, Biofuels and Bioenergy- Process and Technology, CRC Press, 2014.
2. VV N Kishore, Renewable energy engineering and technology - principles and practice TERI Press, New Delhi, 2010.
3. Caye M. Drapcho, N.P. Nhuan and T. H. Walker, Biofuels Engineering Process Technology , Mc Graw Hill Publishers,New York, 2008
4. Jonathan R.M, Biofuels - Methods and Protocols (Methods in Molecular Biology Series), Humana Press Humana Press, New York, 2009
5. Lisbeth Olsson (Ed.), Biofuels (Advances in Biochemical Engineering/Biotechnology Series, Springer-Verlag Publishers, Berlin, 2007.

21BT005 **BIOREACTOR DESIGNMODELLING AND SIMULATION** **3 0 0 3**

Course Objectives

- To introduce the importance of modelling and simulation in bioprocess
- To expose students to mathematical model for modelling a bioprocess
- To create models and simulate bioprocess for improving the quality of process

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

m.Use the analytical instruments and techniques to separate, purify and characterizebiological compounds.

n.Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

o.Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the principles of bioprocess modeling and simulation
2. Apply the knowledge of mathematical models in biochemical engineering systems
3. Analyze the modelling for reactors
4. Analyze the modelling for fermenters
5. Evaluate the application of Superpro Designer, MATLAB and SIMULINK in the bioprocess systems

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MODELING AND SIMULATION

Basic principles of Modeling, definition of Modeling and simulation, Fundamental lawsContinuity equation, energy equation, equation of motion, transport equation, equation of state, Phaseand chemical equilibrium, chemical kinetics, Model building, application of mathematical modeling

UNIT II **9 Hours**

MODELS FOR BIOCHEMICALENGINEERING SYSTEMS

Models based on Mass, component, energy and force balance: Batch reactors, PFR, CSTR, Gravity flow systems, Reactors in series, Concept of Heated tanks

UNIT III **9 Hours**

MODELING OF REACTORS

Modeling of fermentation Batch reactor, Fed batch reactor, Modeling a continuous culture: Chemostat, Chemostat with recycles, substrate limited growth in Chemostat

UNIT IV **9 Hours**

MODELING OF FERMENTERS

Modeling of suspended growth reactors, activated sludge systems, theory onagitated and sparged bioreactor, tower-aerobic and anaerobic bioreactors

UNIT V **9 Hours**

SUPERPRO DESIGNER, MATLAB AND SIMULINK: APPLICATION INBIOPROCESS SYSTEMS

Introduction to SuperPro Designer for Material and Energy Balance with andwithout reaction. Solving problems using MATLAB by numerical integration, Euler and fourth order RungeKutta methods. Simulation - Simulation of gravity flow tank - Simulation of CSTR in series.

Total: 45 Hours

Reference(s)

1. Luben W.L. Process Modelling Simulation and Control for ChemicalEngineers, McGrawHill, International New York, 1990
2. Franks RGE. Mathematical Modeling in Chemical Engineering, JohnWiley and Sons, Inc., New York, 2004
3. Biquette W.B. Process Dynamics- Modeling analysis with simulation,Prentice Hall; 1 edition January 15, 1998
4. William J. Palm. Introduction to Matlab 7 for Engineers, III, McGrawHill 2005
5. Kenneth J. Beers. Numerical Methods for Chemical Engineering Applications in MATLAB, Massachusetts Institute of Technology,Cambridge University press 2007 edition

21BT006 BIOPROCESS CONTROL AND INSTRUMENTATION 3 0 0 3

Course Objectives

- To introduce the importance of modelling and simulation in bioprocess
- To expose students to mathematical model for modelling a bioprocess
- To create models and simulate bioprocess for improving the quality of process

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

m.Use the analytical instruments and techniques to separate, purify and characterizebiological compounds

n.Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

o.Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the principles of bioprocess modeling and simulation
2. Apply the knowledge of mathematical models in biochemical engineering systems
3. Analyze the modelling for reactors
4. Analyze the modelling for fermenters
5. Evaluate the application of Superpro Designer, MATLAB and SIMULINK in the bioprocess systems

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MODELING AND SIMULATION

Basic principles of Modeling, definition of Modeling and simulation, Fundamental laws, Continuityequation,

energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics, Model building, application of mathematical modeling, scope of coverage

UNIT II **9 Hours**

MODELS FOR BIOCHEMICALENGINEERING SYSTEMS

Models based on Mass, component, energy and force balance: Batch reactors, PFR, CSTR, Gravity flow systems, Reactors in series, Concept of Heated tanks

UNIT III **9 Hours**

MODELING OF REACTORS

Modeling of fermentation Batch reactor, Fed batch reactor, modeling a continuous culture: Chemostat, Chemostat with recycles, substrate limited growth in Chemostat

UNIT IV **9 Hours**

MODELING OF FERMENTERS

Modeling of suspended growth reactors, activated sludge systems, theory on agitated and sparged bioreactor, tower-aerobic and anaerobic bioreactors

UNIT V **9 Hours**

SUPERPRO DESIGNER, MATLAB AND SIMULINK: APPLICATION INBIOPROCESS SYSTEMS

Introduction to SuperPro Designer for Material and Energy Balance with and without reaction. Solving problems using MATLAB by numerical integration, Euler and fourth order RungeKutta methods. Simulation - Simulation of gravity flow tank - Simulation of CSTR in series.

Total: 45 Hours

Reference(s)

1. Luben W.L. Process Modelling Simulation and Control for Chemical Engineers,McGrawHill, International New York, 1990
2. Franks RGE. Mathematical Modeling in Chemical Engineering, JohnWiley and Sons, Inc.,New York, 2004
3. Biquette W.B. Process Dynamics- Modeling analysis with simulation, Prentice Hall; 1edition January 15, 1998
4. William J. Palm. Introduction to Matlab 7 for Engineers, III, McGrawHill 2005
5. Kenneth J. Beers. Numerical Methods for Chemical Engineering Applications in MATLAB, Massachusetts Institute of Technology, Cambridge University press 2007 edition

21BT007 **TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS** **3 0 0 3**

Course Objectives

- To enable students to apply fundamental knowledge about Heat, Mass and Momentum Transfer in real time problems
- To provide knowledge on application of transport operations.
- To familiarize the students about various boundary conditions in heat, mass and momentum transport.
- To provide knowledge and training to students to apply basic equations of change from heat, mass and momentum transport to solve problems

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

o. Conceive, Plan and Deploy societal projects for environmental protection using Bio-resources.

Course Outcomes (COs)

1. Apply the Newtonian and Non-Newtonian fluids with suitable examples.
2. Apply and calculate the transport properties of gases and liquids.
3. Analyze the problems in momentum, heat and mass transfer through shell balance.
4. Analyze the suitable boundary conditions to solve shell balance equations.
5. Evaluate the transport equations to solve steady flow and heat transfer problems.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MOMENTUM TRANSPORT

Mass conservation principle of macro and microscopic systems; Newton's Law of viscosity-Non-Newtonian Fluid Models-Pressure and Temperature dependency of viscosity. Equation of motion.

UNIT II **9 Hours**

INTRODUCTION TO HEAT TRANSPORT

Fourier's Law – Newton's Law of cooling-Temperature and pressure dependency of thermal conductivity.

UNIT III **9 Hours**

INTRODUCTION TO MASS TRANSPORT

Mass flux; continuity equation; Fick's Law of binary diffusion - Temperature and pressure dependency of diffusivity. Shell momentum balances and boundary conditions for momentum, heat and mass transport

UNIT IV **9 Hours**

STATES OF SYSTEMS

Steady state – Diffusion across tubular walls, radial diffusion; unsteady state; pseudo steady state approximation

UNIT V **9 Hours**

FLOW AND TRANSPORT IN BIOLOGICAL SYSTEMS

Laminar flow, capillary flow, couette flow, pulsatile flow, turbulent flow, Friction factor, simultaneous concentration gradient and velocity gradient.

FOR FURTHER READING

Oxygen delivery in tissues, Erythrocyte dynamics in basic flows, oxygen transport between phases

Total: 45 Hours

Reference(s)

1. Transport Phenomena in Biological Systems, by Truskey, Yuan and Katz, Pearson Prentice Hall (2009).
2. Introduction to Microfluidics, by Patrick Tabeling, Oxford University Press (2005).

21BT008 ASTROBIOLOGY AND ASTROCHEMISTRY **3 0 0 3**

Course Objectives

- To understand the origin, evolution and future life in our solar system
- To analyze the key mechanisms and chemical reaction in the space.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

l. Recognize the need for and have preparation and ability to engage independent and life long learning in the broadest context of technological change.

o. Conceive, Plan and Deploy societal projects for environmental protection using Bio-resources.

Course Outcomes (COs)

1. Apply the in-depth comprehension and mastery of the fundamental concepts and methodology of astrobiology
2. Apply the chemical process in interstellar medium
3. Analyze the synthesis and modeling of astrochemistry
4. Analyze the chemical markers for extraterrestrial life
5. Evaluate the life metabolism and energy in space.

Articulation Matrix

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

UNIT I **9 Hours**

MOLECULAR UNIVERSE

Introduction to atomic structure, chemical elements, energy level spectroscopy, hydrogen bonding.

UNIT II **9 Hours**

CHEMICAL PROCESS IN INTERSTELLUAR MEDIUM

Phases of interstellar medium, molecular clouds, birth and death of starts, evolution of matter, Molecular connection and life origin.

UNIT III **9 Hours**

SYNTESIS AND MODELLING OF ASTROCEMISTRY

Astrochemical models, formation of stars, chemical networks, reaction barriers, Gas phase synthesis.

UNIT IV **9 Hours**

CHEMICAL MARKERS FOR EXTRATERRESTIAL LIFE

Extraterrestrial samples, sample collection techniques, amino acids and life detection, chemical markers for bacteria and other extraterrestrial lives.

UNIT V **9 Hours**

LIFE METABOLISM AND ENERGY

Food selection in spaceflight and analog studies, Energy requirements, protein, carbohydrates, fat and fatty acids, and effects on physiology systems

Total: 45 Hours

Reference(s)

1. Life in the Universe , by Jerffrey Bennett ,Seth Shostak, Nicholas Schneider, Meredith MacGregor, Princeton University Press Hall (2023).
2. Expanding Worldviews: Astrobiology, Big History and Cosmic Perspectives, Springer International Publishing (2021).
3.Handbook of Astrobiology, Vera M.Kolb, CRC Press, 1st Edition (2019).
4.Astrochemistry: From Big Bang to the present Day, Clarie Vallance,World Scientific (2017)
5. Astrochemisty and Astrobiology,lan W.M. Smith, Charles S. Cockell, Sydney Leach, Springer International Publishing (2012).

21BT009 BIOPROSPECTING AND QUALITY ANALYSIS 3 0 0 3

Course Objectives

- To recall the basic concepts of Bioprospecting with respect to Biodiversity.
- To identify the different types of Bioprospecting such as microbial, plants and animals.
- To explain the quality aspects of Bioprospecting.

Programme Outcomes (POs)

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

n. Process designing and production of novel biomolecules for theagricultural, environmental and healthcare sectors

o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the importance of Bioprospecting and its phases.
2. Apply the knowledge of medicinal plants with pharma for new drug development.
3. Analyze the importance of marine resources and its application.
4. Evaluate the concepts of microbial prospecting in new product development.
5. Create the quality aspects of the products developed through various Bioprospecting techniques.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Bioprospecting - Definition- Introduction - Current practices in Bioprospecting for conservation of Biodiversity and Genetic resources. Bioprospecting Act- Introduction - Phases of Bioprospecting - Exemption to Act - Fields of Bioprospecting.

UNIT II **9 Hours**

MEDICINAL PLANTS BIOPROSPECTING/ PHARMACEUTICAL BIOPROSPECTING

New drug development, assays in Bioprospecting. Antioxidant assay – NO free radical scavenging assay, Antigenotoxicity assay – MTT assay, Antiviral activities of plants – SRB assay.

UNIT III **9 Hours**

MARINE BIOPROSPECTING

Sources of marine planktons and their Bioprospecting, Isolation and cultivation of Marine bio resources, Isolation of Marine Yeast and its industrial applications, Bioactive chemicals from Seaweeds and their applications.

UNIT IV **9 Hours**

MICROBIAL BIOPROSPECTING

Isolation of Microbial metabolites and their bio-activity. Endophytic microbial products and their application in pharmaceutical industry.as Antibiotics.

UNIT V **9 Hours**

QUALITY ANALYSIS

Introduction: Concept and evolution and scopes of Quality Control and Quality Assurance, Good Laboratory Practice, GMP, Overview of ICH Guidelines - QSEM, with special emphasis on Queries guidelines.

Total: 45 Hours

Reference(s)

1. Arora, R.K. and Nayar, E.R. (1984), Wild relatives of crop plants in India, NBPGR Science Monograph No.7.
2. Thakur, R.S., Puri, H.S. and Husain, A. (1969). Major medicinal plants of India, Central Institute of medicinal and aromatic plants, Lucknow.
3. Swaminathan, M.S. and Kocchar, S.L. (Es.) (1989). Plants and Society, MacMillan Publication Ltd.,
4. S Ram Reddy and M A Singara Charya -Microbial Diversity: Exploration and Bioprospecting.
5. Mukherjee,P.W. Quality Control of Herbal Drugs : An Approach to Evaluation of Botanicals.Business Horizons Publishers, New Delhi, India, 2002.

21BT010 FOOD PROCESS AND TECHNOLOGY 3 0 0 3

Course Objectives

- To know the processing of foods from harvesting to packaging
- To learn the preserving techniques of various food stuffs
- To study the storage and packaging techniques of foods

Programme Outcomes (POs)

b. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

m. Use the analytical instruments and techniques to isolate, purify and characterize biologicalcompounds

n. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors

o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Analyze the processing techniques to avoid post harvest losses
2. Apply different preservation techniques to enhance shelf life of foods
3. Analyze high temperature processing techniques to enhance the shelf life and quality of food product
4. Analyze low temperature processing techniques to enhance the shelf life and quality of food product
5. Evaluate the factors influencing food packaging and storage during long term storage of Food

Articulation Matrix

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

UNIT I 9 Hours

POST-HARVEST TECHNOLOGY

Post-harvest losses, cleaning, grading and sorting types. Moisture content – free moisture, bound and unbound moisture, Role of moisture content - concept of water activity measurement – direct and indirect method, equilibrium moisture content, EMC determination methods, hysteresis effect. Theory and mechanism of drying, constant rate and falling rate drying, Thin layer and deep bed drying, methods of drying agricultural materials - batch and continuous drying.

UNIT II **9 Hours**

PRESERVATION OF FOOD BY SALT, SUGAR AND CHEMICALS

Preparation of Juices and pulps, concentrates. Theory of gel formation, Preparation of jam, jellies, marmalades. Chemistry of salt preservation - Sauerkraut, and vinegar production, minimal processing, hurdle technology.

UNIT III **9 Hours**

HIGH TEMPERATURE PROCSSSING/PRESERVATION

Methods of applying heat to food. Balancing, Pasteurization and Sterilization. Thermal death time relationships (D, Z and F values). Process calculations: general methods, Ball's formula method .Sterilization – methods and equipments, UHT sterilization.

UNIT IV **9 Hours**

LOW TEMPERATURE PROCESSING / PRESERVATION

Chilling, cold storage and freezing. Thermodynamics of food freezing. Phase diagrams. Formation of ice crystals and its types. Properties of frozen foods. Freezing-time calculations. Freeze concentration,

UNIT V **9 Hours**

PACKAGING AND STORAGE OF FOOD

Testing of packaging material, printing on packages, Bar codes, Nutrition labeling and legislative requirements. Vacuum and Inert Gas Packaging, Gas and water vapour transmission rates. Principles of active packaging, modified atmosphere packaging. Storage of food grains - factors affecting storage - Types of storage - bag and bulk storage - bag storage requirement. Storage under ambient conditions.

FOR FURTHER READING

Water activity and its importance, Osmotic dehydration, Aseptic packaging and its applications

Total: 45 Hours

References

1. P. J. Fellows, *Food Processing Technology: Principles and practice*, Third Edition Wood head Publishing limited, 2009.
2. Paul Singh, R and Dennis R. Heldman, *Introduction to Food Engineering*, Fourth Edition.Academic Press, 2009.
3. K. M. Sahay, and K.K. Singh, *Unit Operations of Agricultural Processing*, Vikas Publishing House Pvt. Ltd., 2003.
4. R. L. Earle, *Unit Operations in Food Processing*, Pergamon Press, 1989.
5. Warren L. McCabe, Julian C. Smith, Peter Harriott, *Unit Operations of Chemical Engineering*, Seventh Edition, McGraw-Hill, 2005.

21BT011 MARINE BIOTECHNOLOGY 3 0 0 3

Course Objectives

1. To provide information about the microbes available in aquatic environment, their role and interaction with the marine environment
2. To impart knowledge of biotechnological applications of marine organisms, important processes and impacts on the marine ecosystems and ways to control them.
3. To identify the potential of bioactive molecules derived from marine organisms and its application in varied sectors
4. To impart a comprehensive understanding on marine fauna from basics to advances in the field of marine biotechnology
5. To teach sustainable use of aquatic resources with various approaches in biotechnology.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

n. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

o. Conceive, Plan and Deploy societal projects for environmental protection using Bio-resources.

Course Outcomes (COs)

1. Apply the principle features of marine ecosystems and the microbial diversity in oceans
2. Apply the by-products obtained from marine resources and categorize them as Pharmaceutics and Nutraceutics.
3. Apply the fundamental principles of aquaculture and integrate it with biotechnological procedures for sustainable production.
4. Analyze the causes of marine pollution, impacts and management technologies and canbring about solutions for conservation of Marine organisms.
5. Evaluate the uses of marine organisms, their significances, interactions, impacts and management technologies to comeup with solutions for their control

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MARINE ENVIRONMENT

Marine microbial habitats and its classification, Specialized microorganisms, Extremophiles, Estuarine Ecosystems, Phytoplankton's, zooplanktons, nektons, benthos, marine mammals, marine algae, mangroves, coral reefs, deep sea animals and adaptation – intertidal zone – fauna and flora.Sea- ranching of economically important marine organisms.

UNIT II **9 Hours**

MARINE PHARMACEUTICS AND NUTRACEUTICS

Seafood microbiology, Spoilage factors in seafood; Toxins influencing food spoilage; Single cell protein (SCP), marine based nutraceuticals, Medicinal compound from marine flora and fauna – marine toxins, antiviral and antimicrobial agents. Sea food processing and Preservation; Freezing and cold storage.

UNIT III **9 Hours**

MARINE ECONOMICS - AQUACULTURE TECHNOLOGY

Bio-floc technology; Aquaponics; Zero water exchange aquaculture system; Aqua mimicry; Hydroponics; Raceway system of aquaculture; Bioremediation in Aquaculture systems; Microalgae- indoor and mass-culture methods, Biotechnological approaches for production of important microalgae and other commercial important products. Culture of seaweeds: Porphyra culture – environmental diseases in culture systems & their prevention & control. Ecofriendly aquaculture practices; probiotics in aquaculture.

UNIT IV **9 Hours**

MARINE POLLUTION AND BIO DETERIORATION

Sources of marine pollution, its dynamics, transport paths and agents. Domestic, industrial and agricultural discharges in the marine environment. Oil pollution: Sources, composition and its toxicity. Thermal and radioactive pollution: sources, effects and remedial measures. Solid dumping, mining and dredging operations: their toxic effects on marine ecosystem. Role of biotechnology in marine pollution control and its treatment. Biofouling and bio deterioration: Agents and protection methods, Ballast water, Red tides

UNIT V **9 Hours**

POTENTIAL OF MARINE BIOTECHNOLOGY

Applications of Marine Organisms, Marine viruses and Giruses, Giant bacteria and their significance, Unculturable bacteria: occurrence, characteristics and exploitation, Barophilic organisms & their applications, Seaweeds for removal of metal pollutants, GFP, RFP characteristics and their applications, Green mussel adhesive protein, Chitosan: products and applications, Biomimetics.

FOR FURTHER READING

Discovery and development cycle of drugs - toxicity evaluation, animal experiments, clinical trails protocols, ethical considerations; Marine derived drugs in preclinical and clinical trial- their source, nature, mode of action and targeted diseases; FDA approved and EMEA approved marine derived drugs and their use and mode of action.

Total: 45 Hours

Reference(s)

1. Munn, C.B. , (2004) Marine Microbiology: Ecology and Applications, BIOS Scientific Publisher.
2. Jeffrey S. Levinton, CD(2001).Marine Biology: Function, Biodiversity . Ecology (515pp)
3. Se-kwon Kim , (2015) Handbook of Marine Biotechnology, Springer
4. Gautam, N,C, (2007) Aquaculture Biotechnology, Shree Publishers and Distributors
5. Le Gal, Y., Ulber, R., &Antranikian, G. (2005). Marine Biotechnology (Vol. 96).
6. Naik, M., Dubey, S. (2017). Marine pollution and microbial bioremediation.

Journal Reference(s)

1. Biotechnology in the marine sciences: Proceedings of the first 49 annual MIT sea grant lecture & seminar. (1984). Colwell, R.D.(Ed)Recent articles from various journals such as Journal of Marine Biotechnology, Nature and Science will be covered.
2. FereidonShahidi et al., (2014) Seafood Safety, Processing and Biotechnology. Taylor and Francis. A CRC press book
3. Recent Advances in Marine Biotechnology. Vol.2 (1998) Fingerman, M., Nagabushanam, R., Thompson.

21BT012 **BIODIVERSITY** **3 0 0 3**

Course Objectives

- To recall the different types of biodiversity across the world.
- To identify the importance of population growth in each taxon and its respective diversity.
- To explain the basic concepts of Bioprospecting with respect to Biodiversity.

Programme Outcomes (POs)

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Course Outcomes (COs)

1. Understand the importance of the Global Biodiversity in current scenario.
2. Understand the importance of the Population growth and effect of environment on the growth.
3. Analyze the concepts of animal and plant taxonomy.
4. Analyze the concepts of microbial taxonomy and its classification.
5. Evaluate the concepts of Bioprospecting with respect to Biodiversity.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Biodiversity -Types of Biodiversity - Biodiversity as a natural resource - Vegetational Zones -Zones of Faunal distribution - Major Biodiversity areas of the world - Biodiversity Hot Spots - Basic Taxonomy - Types of classification - Classification of bacteria, algae, fungi and plants (major families only) - Classification of Protozoans -

Non-chordates (major classes with insects up to orders) and Chordates (major orders).

UNIT II **9 Hours**

ECOLOGY AND EVOLUTIONARY BIOLOGY

Population growth: Growth types and growth models, exponential and logistic models, Effect of environment on population growth - diversity distribution, factors affecting diversity, impact of exotic species. Neo-Darwinism: spontaneous mutation controversy, effects of natural selection on populations, Levels of selection, group selection controversy, selfish gene theory.

UNIT III **9 Hours**

PLANT AND ANIMAL TAXONOMY AND DIVERSITY

Plant Taxonomy - Concept of species, variation - Introduction to major plant groups and evolutionary relationships - History of plant taxonomy - Code of nomenclature - Systems of classification. Animal Taxonomy- Introduction - Principles and rules of Taxonomy, Zoological nomenclature, ICZN regulations - Taxonomical hierarchy (Linnaean hierarchy) - Concepts of Taxon, holotype, paratype, topotype.

UNIT IV **9 Hours**

MICROBIAL TAXONOMY AND DIVERSITY

Microbial diversity: Outline classification of microorganisms. Fungi: Criteria for classification and identification - Types of vegetative forms, Types of spores, fruiting bodies and life cycles - Bacteria: Concept of species - Criteria for classification - Morphology in Actinomycetes, Cyanobacteria and Mycobacteria - Major classes of bacteria. Viruses: Outline classification.

UNIT V **9 Hours**

APPLICATIONS

Applications -Microbes in Agriculture: Rhizosphere, Nitrogen fixation, Mycorrhiza, Cyanobacteria. Industrial Microbiology: Microbial Fermentation-Major industrial products from microbes. Beverages, Antibiotics, Secondary metabolites.

FOR FURTHER READING

Recombinant products from plant and microbial sources.

Total: 45 Hours

Reference(s)

1. An, S., & Verhoeven, J. T. (Eds.). (2019). Wetlands: Ecosystem Services, Restoration and Wise Use (Vol. 238). Springer.
2. Gabriel M. (2000) Biodiversity and conservation Oxford and IBH publishing company Pvt Ltd. New Delhi.
3. Pandey. Angiosperms: Taxonomy, Anatomy, Economic Botany & Embryology.
4. Ashlock., Principles of Animal Taxonomy
5. M. Gadgil., A methodology manual for scientific inventorying, monitoring and conservation of Biodiversity.
6. S Ram Reddy and M A Singara Charya -Microbial Diversity: Exploration and Bioprospecting
7. Tortora, G.J., Funke, B.R. and Case, C.L. (2019). Microbiology an Introduction. 13th Edition. Pearson Education, Inc

21BT013 **BIOSENSORS** **3 0 0 3**

Course Objectives

- To understand the principle, operations and classification of biosensors
- To introduce transducers and physiological property measurement using biosensor
- To espouse the science and engineering by application of biosensors in various fields

Programme Outcomes (POs)

a. An ability to independently carry out research /investigation and development work to solve practical problems
c. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
e. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
n. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors
o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply electrode system for construction of biosensor
2. Analyze the design of transducer for construction of biosensors
3. Analyze bios elective materials and its application for construction of biosensor
4. Evaluate the bio membrane for biosensor fabrications
5. Create the biosensor for the Industrial, analytical, medical and environmental application

Articulation Matrix

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

UNIT I **9 Hours**

ELECTROCHEMISTRY, CLASSIFICATION AND OPERATION

Electrochemistry single electrode potential- Nernst equation Tafel plot Electrical components DC and AC Circuits Operational amplifiers and functions Desired characteristics of biosensors: reliability, simplicity, cost, and related parameters. Classification and components of Biosensor - Advantages and limitations, biocatalysis based biosensors, Types of enzyme electrodes

UNIT II **9 Hours**

TRANSDUCERS IN BIOSENSORS

Types of transducers, principles and applications - Calorimetric, acoustic, optical (absorption, fluorescence, bio/chemiluminescence, surface Plasmon resonance (SPR)), potentiometric / amperometric, conductrometric/ resistor metric, piezoelectric, semiconductor (ion sensitive field effect transistor (ISFET), enzyme field effect transistor (ENFET), impedimetric, mechanical and molecular electronics based transducers. Chemiluminiscence based biosensors.

UNIT III **9 Hours**

BIOSELECTIVE LAYERS

Bioselective layers: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Microbial metabolism; Tissue and organelles (animal and plant tissue); Cell culture; Immuno receptors; Chemoreceptors; Methods for application of bio selective layers in desired patterns- pin-based spotting.

UNIT IV **9 Hours**

BIO MEMBRANES: MASS TRANSPORT AND FABRICATION

Mass transport: Mass transport effect of analytes to the surface of the biosensor transducer on the detected signal and associated kinetics. The design of micro fluid flow systems that interface with biosensors. Different assay types (Displacement, competitive, sandwich, and direct). Biosensor fabrication methods: self-assembled monolayers, Screen printing, photolithography, micro contact printing, micro- electromechanical system (MEMS).

UNIT V **9 Hours**

BIOSENSOR ENGINEERING AND APPLICATIONS

Applications- Case studies: Glucose, urea and cholesterol biosensors; Clark electrode, Implantable sensors forlong-term monitoring; Drug development and detection; Industrial on-line monitoring, Environmental monitoring;Technological process control; veterinary, agriculture, Food quality control

FOR FURTHER READING

Biochips and biosensor arrays; Problems and limitations. Ink-jet dispensing and micro stamp printing, engineering concepts for mass production.

Total: 45 Hours

Reference(s)

1. Ursula Spichiger-Keller, Chemical Sensors and Biosensors for Medical and Biological Applications, Wiley-VCH, 1998

2. D. A. Skoog, F. J. Holler and Nieman A. Timorthy, Principles of Instrumental analysis, 6th edition, 2006

3. D. G. Buerk, Biosensors: Theory and Applications, Technomic, Lancaster, 1993

4. Jon Cooper and Tony cass, Biosensors, Oxford University Press, 2000

21BT014 **BIOMATERIALS** **3 0 0 3**

Course Objectives

- Summarize the classification of biomaterial, their bulk and surface properties and characterization to prepare the students to find a place in biomedical field
- Interpret the various manufacturing processes and testing, cost, sterilization, packaging and regulatory issues of biomaterials
- Motivate and facilitate students to undertake projects and research work in Biomaterials

Programme Outcomes (POs)

a. An ability to independently carry out research /investigation and development work to solve practical problems
b. An ability to write and present a substantial technical report/document
d. Graduates will demonstrate knowledge of professional and ethical responsibilities
g.Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors
o.Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the essential concepts, classifications and properties of biomaterials
2. Apply the knowledge of different characterization techniques in biomaterial fabrication
3. Analyze the bio compatibility of biomaterials under biological environment
4. Analyze the need of tissue replacement implants in organ regeneration
5. Evaluate the biological requirements for developing artificial organs

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION AND CLASSIFICATION

Introduction and classifications; Metals: different types, properties and interaction with the tissue, Polymers: classification and properties, Ceramics: Types, properties and interactions with the tissue, Composites: matrix and reinforcing agents/fillers and properties, Cell adhesion, host- tissue reactions. Tissue derived biomaterials: Structure and properties of collagen and collagen-rich tissues, Biotechnology of collagen, design of resorbable collagen-based medical implants soft. Bioactive glasses and hollow fiber membranes

UNIT II **9 Hours**

BULK AND SURFACE CHARACTERIZATION

Bulk Characterization: XRD, FT-IR, SEM, energy dispersive X-ray (EDX), DSC, TGA, dielectric analysis (DEA);

Surface analysis: XPS, SIMS, AES, surface enhances Raman spectroscopy (SERS), AFM/STM; Structural properties of tissues-bone, teeth and elastic tissues. Effects of sterilization on biomaterial properties. Cell-surface interaction by fluorescence and reflection confocal microscopy and protein- surface interactions. Non-co-operative cell-surface interactions. Phenotype changes due to cell adhesion.

UNIT III **9 Hour**

TESTING

Biocompatibility: blood and tissue compatibility; degradation of biomaterials in biological environment,toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests; In vitro and In vivo testing, implant associated infections, biocompatibility enhancement using carona discharge and plasma processes, surface coatings; Ethical considerations. Good manufacturing practice, standards, Regulatory issue

UNIT IV **9 Hours**

TISSUE REPLACEMENT IMPLANTS

Tissue replacements, wound dressings and sutures, surgical tapes, adhesives and sealants, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, Joint replacements, implants for bone regeneration. Naturally occurring extracellular matrix-structure and function and use in dermal regeneration

UNIT V **9 Hours**

ARTIFICIAL ORGANS

Artificial heart, prosthetic cardiac valves, limb prosthesis, externally powered limb prosthesis. Dental implants. Biomaterials in wound dressings, nephrology, neurology, ophthalmology, stem cell research, bio-artificial pancreas, repair of tendon and ligament injuries and resorbable osteosysnthesis materials in cranio maxilliofacieal surgery, and controlled drug delivery

FOR FURTHER READING

Surface analysis: XPS, SIMS, AES, surface enhances Raman spectroscopy (SERS), AFM/STM

Total: 45 Hours

Reference(s)

1. D. Shi , Ed., Biomaterials and Tissue Engineering, Berlin, New York: Springer, 2004
2. B. Joon Park, D.B. Joseph and Boca Ration, Biomaterials: principles and applications, CRC, press, 2003
3. L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering, Woodhead Publishing in Materials, 2002
4. Kay C. Dee, David A. Puleo and Rena Bizios, An Introduction to Tissue-Biomaterial Interactions, John wiley, 2002
5. Ratner, B. D., et al, (eds.), Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, 2004
6. Saltzman W M,Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues, Oxford University Press, 2004

21BT015 PROGRAMMES FOR BIOINFORMATICS 3 0 0 3

Course objectives:

- Understand the history and basics of python.
- Gain knowledge about the different data types and control flow statements.
- Impart knowledge about the functions, files, list, set tuples and dictionaries.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering andIT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

n.Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors.

o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply profound knowledge in python for biology
2. Analyze the protocols used in python for biology
3. Analyze the relationship between various libraries in python
4. Evaluate the recent advancements in biopython and its libraries
5. Evaluate the emerging new libraries in python for biological applications

Articulation Matrix

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

UNIT I 9 Hours

INTRODUCTORY CONCEPTS

Introduction to computational thinking; Python language- features, overview of syntax, data types, operators, I/O statements, control structures, arithmetic data structures, list, tupules, dictonaries and sets, looping constructs, list comprehension, functions and examples in computers and biology

UNIT II 9 Hours

STRING MANIPULATION AND FILES

Fundamentals of characters and string-string presentation, and formatting- searching strings-joining and splitting strings. Files- Introduction, file processing, working with text files working with csv file.

UNIT III **9 Hours**

OBJECT ORIENTED PROGRAMMING

Object oriented programming- Introduction, data abstraction and reusability, methods as class functions;implementing a time abstract data type with a class- special attributes using default arguments with constructors- deconstructors-class attributes. Operators overloading. Polymorphism. Implemetation of point vector, currency class

UNIT IV **9 Hours**

BIOPYTHON

Introduction-biopython objects, alphabet, sequence, sequence records, multiple sequence alignments. Sequence databases – Entrez and Swissprot, Protein Data Bank. Functions and I/O with sequence objects, and working with BLAST, multiple sequence alignments.

UNIT V **9 Hours**

APPLICATIONS

Database application programming interface - Python DB-API specification-creating MySQL database-database query example-quering the database-reading, inserting and updating a database. Python modules for scientific programming-plotting library (matplotlib), random library and numpy

Total: 45 Hours

Reference(s):

1. Bassi, S Python for Bioinformatics, Chapman and Hall CRC press, 2nd edition, 2018
2. Guttag, J.V Introduction to computation and programming using python, MIT press, 2nd edition, 2016

21BT016 **FUNDAMENTALS OF ALGORITHMS FOR BIOINFORMATICS** **3 0 0 3**

Course Objectives

- Identify various algorithm design techniques
- Impart knowledge on runtime analysis of algorithms
- To understand the theory and background of commonly available bioinformatics tools

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

m. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors

Course Outcomes (COs)

1. Apply the importance of algorithms for biological applications
2. Apply the knowledge of bioinformatics in sequence analysis
3. Analyze the structure of RNA for informatics analysis
4. Analyze the concepts of clustering methods in biological applications
5. Evaluate the tree algorithms for informatics-based applications

Articulation Matrix

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

UNIT I **9 Hours**

STRINGS, GRAPHS AND SEQUENCE COMPARISON ALGORITHMS

Strings: Rabin Karp, finite automata, KMP algorithm, Boyer Moore algorithm and suffix tree. Interval graphs, Mapping-Restriction site mapping algorithms, Partial digest, Double Digest Problem (DDP)-Simulated annealing, circular maps, Fitting data to maps. Radiation hybrid mapping and optical mapping. Longest common substring and longest common subsequence

UNIT II **9 Hours**

METHODS FOR AIDING ALIGNMENT

Sequence alignment algorithm, Global, local and semi global alignment; affine gaps, time warping. Similar matrices -PAM and BLOSSUM derivation, BLAST algorithm. MSA-scoring MSA methods (global and local)-CLUSTAL W, Muscule. Hidden Markov Model (HMM), Algorithm for HMM. Finding genes with HMM

UNIT III **9 Hours**

PREDICTION OF SITES AND RNA SECONDARY STRUCTURE

Finding instances of known sites, finding instances of unknown sites - Greedy approach, Gibbs sampler, Maximum-subsequence problem; RNA secondary structure prediction- approaches to look at changes in the sequence: Minimum free energy and maximum base pair matching, MFOLD predictions, Pseudoknots.

UNIT IV **9 Hours**

CLUSTERING METHODS

Gene expression analysis - Hierarchical clustering, k-means, Clustering and Functional Analysis of coordinately Regulated Genes, Gene finding and annotation

UNIT V **9 Hours**

TREE ALGORITHMS

Evolutionary Models Jukes-Cantor, Kimura, Distance-based tree reconstruction with problems - Reconstruction of trees from additive matrices-Evolutionary trees and hierarchical clustering, Character based tree reconstruction.

Total: 45 Hours

TEXTBOOKS

1. Waterman, M. Introduction to Computational Biology: Maps, Sequences and Genomes. Chapman and Hall, 1 edition, 1995.

REFERENCES

1. Kelly, S.T and Didulo D. Computational Biology: A Hypertextbook. American society for microbiology, 2018 2. Eidhammer, I, Jonassen, I and Taylor, W.R. An Algorithmic approach to sequence and structural analysis. John Wiley and Sons, 2004.

21BT017 MOLECULAR MODELLING 3 0 0 3

Course Objectives

- Interpret the basic concepts of computational / theoretical chemistry / biology for drug designing
- Apply modelling tools and docking programme for predicting the three- dimensional structure of biomolecules
- Analyse how drugs interact with macromolecules and strategies used in designing novel drugs and prodrugs

Programme Outcomes (POs)

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

c. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

d. Graduates will demonstrate knowledge of professional and ethical responsibilities

g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

n. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors

o.Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the theoretical and software skills to model biomolecules
2. Apply the concept of molecular model
3. Analyze the new molecules with therapeutic values
4. Evaluate the development of new biomolecules by modification
5. Create new lead molecules in drug design

Articulation Matrix

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

UNIT I 9 Hours

QUANTUM MECHANICS

Introduction - coordinate systems - potential energy surfaces - introduction to quantum mechanics - postulates - Schrodinger wave equation - hydrogen molecule - Born-Oppenheimer approximation, introduction to computer hardware and software

UNIT II 9 Hours

MOLECULAR MECHANICS AND ENERGY MINIMIZATION

Empirical force field models - Bond stretching - angle bending - torsional term - nonbonding interactions - thermodynamics properties using a forcefield - derived and non-derived energy minimization method -simplex – sequential univariate method - steepest descent method - conjugate gradient method- Newton- Rapson method

UNIT III **9 Hours**

MOLECULAR DYNAMICS

Basic principles of molecular dynamics and Monte Carlo Simulation for conformational analysis - Ab initio - Density-Functional Theory and semi empirical methods

UNIT IV **9 Hours**

MACROMOLECULAR MODELING

Identification and mapping of active sites - Design of ligands for known macromolocular target sites. Drug-receptor interactions. Classical SAR/QSAR studies and their Implications to the 3-D modeler. 2-D and 3- D database searching -pharmocophore identification and novel drug design

UNIT V **9 Hours**

STRUCTURE PREDICTION AND DRUG DESIGN

Structure Prediction - Introduction to Comparative Modeling. Sequence Alignment. Constructing and Evaluating a Comparative Model. Predicting Protein Structures by Threading, Molecular Docking, AUTODOCK and HEX. Structure based DeNovo Ligand design, Drug Discovery - Chemoinformatics -QSAR, Drug Design - Analog and Structure based drug design.

Total: 45 Hours

FOR FURTHER READING

Database searching, Simulations for conformational analysis, Comparative Modeling

Reference(s)

1. Andrew Leach. Molecular modeling: principles and applications. 2nd ed. Pearson Education. 2001
2. R.Leach - Molecular Modeling Principles and Application, 2nd edition, Longman Publications, 1996
3. Burkert U and Allinger NL, Molecular Mechanics, ACS Monograph 177. Washington D.C., American Chemical Society, 1982
4. McCammon J A. and Harvey S C, Dynamics of Proteins and Nucleic Acids, Cambridge University Press, 1987
5. Hans Pieter H and Folkens G, Molecular Modelling, VCH, 1999 Claude Cohen. N, Guide book on molecular modeling in drug design Synergix drug design, Israel,1999

21BT018 COMPUTER AIDED DRUG DESIGN 3 0 0 3

Course Objective:

This course provides a broad overview of the most important approaches used in protein and ligand structure-based drug design. Also, the course aims to state how these approaches are currently being applied in drug discovery efforts

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

n.Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors

o. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the basic terms in the field of drug designing and drug discovery.
2. Apply pharmacophore modelling methods for drug discovery
3. Analyze the new molecules with therapeutic values based on their structure activity relationship
4. Evaluate the development of new biomolecules by analyzing their Pharmacology
5. Create new lead molecules, antibiotics, antiviral and anticancer drugs

Articulation Matrix

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

UNIT I 9 Hours

INTRODUCTION TO DRUG DESIGN AND DISCOVERY

Drug Discovery Therapeutic targets-identification and validation, Drug development process -An outline Discovery of drug candidates. Sources of hits, leads and candidate drugs. Basic principles in leaddevelopment and

optimization, Membrane penetration-Lipinski Rule of five Stereochemistry in Drug Design and the importance.

UNIT II **9 Hours**

DOCKING AND PHARMACOPHORE MODELLING

Role of X-ray crystallography in structure guided drug design, molecular docking and scoring methods, de novo ligand design, fragment-based drug design. Pharmacophore-based ligand design, pharmacophore concept, basic principles and step by step procedure, pharmacophore elements and their representations, receptor excluded and receptor essential volumes solvation effect. Benzodiazepine site of GABA receptors, 3D-Pharmacophore model.

UNIT III **9 Hours**

STRUCTURE ACTIVITY RELATIONSHIP-QSAR MODELS

Quantitative structure activity relationships and experimental design: Hamm equation, Free Wilson analysis, Hansch analysis hydrophobic correlations, multifactorial correlations physiochemical properties (electronic desorptors hydrophobic parameters, st descriptors, biological relevance applications of Hansch equations (hydrophobic factors steric factors, electronic factors, ionization constant prediction from equations, blood-brain barrier penetration relations to molecular modeling: 3D-QSAR methodologies, Pharmacophore guided optimization of compounds

UNIT IV **9 Hours**

RECEPTORS, ION CHANNELS AND ENZYMES- PHARMACOLOGY

Receptor structure and function: G-protein coupled receptors, ligand gated ion channel receptors, tyrosine kinase receptors, nuclear receptors Receptor pharmacology, lon channels: Structure and function of ion channels, classification of ion channels, ion channels and diseases. Inhibitors acting at the active site of an enzyme inhibitors acting at allosteric binding sites, uncompetitive and non-competitive inhibitors, transition state analogues, suicide.

UNIT V **9 Hours**

DESIGN OF ANTIVIRAL ANTICANCER AND ANTIBIOTICS

Anticancer Agents: Hallmarks of malignant cancer, currently used anticancer agents and their mode of Antibiotics affecting bacterial cell wall formation, cytoplasmic membrane, nucleic acid synthesis, and synthesis. Antiviral Drugs: And HIV compounds Nucleoside reverse transcriptase inhibitors; nucleotide transcriptase inhibitors; non-nucleoside reverse transcriptase inhibitors, protease inhibitors. Viral entry in and HBV compounds, Anti-herpes virus compounds, and influenza virus compounds.

Total: 45 Hours

TEXTBOOKS

1. Han, Kamber, and Pel, J. Data Mining: Concepts and Techniques. Publishers. USA, 3 edition, 2012.

REFERENCES

1. Bak, P. Brak 5. Bioinformatics: the machine leaming approach, MIT Press, 2 edition, 2001.

2. https:/www.coursera.org/learn/machine learning

21BT019 METABOLOMICS AND GENOMICS - BIG DATA ANALYTICS

Course Objectives

- Understand and apply the basic scientific principles behind metabolic network in living system
- Understand the uses and limitations of metabolomics
- Introduce methods and strategies commonly used in metabolic engineering

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

n. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors

o.Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the principles and various techniques used to analyze the metabolism in living system
2. Analyze the collection, segregation and processing techniques for metabolonomics
3. Analyze various methods to control the material and energy balance in cellular metabolism
4. Analyze the laws pertaining to the handling of metabolic flux
5. Evaluate the process involved in the metabolic pathways and its application in disease treatment

Articulation Matrix

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

4		1	3			2								2	2
5				3	2			2						3	2

UNIT I **9 Hours**

INTRODUCTION TO METABOLONOMICS

Introduction to metabolonomics - metabolites, and metabolism-Types of metabolism-primary and secondary, Structural diversity of metabolites-physical and chemical properties, metabolites in the biological system, metabolons, Metabolites isolation from the biological system -separation methods for metabolomics-Gas Chromatography (GC), HPLC, Capillary electrophoresis (CE); Detection methods GC-MS, Secondary ion mass spectrometry (SIMS), NMR-1D and 2D.

UNIT II **9 Hours**

CELLULAR METABOLISM

Review of cellular metabolism: Transport mechanisms and their models; Enzyme kinetics, Mechanisms and their dynamic representation, Regulation of enzyme activity versus regulation of enzyme concentration, Regulation of metabolic networks, Regulation of at the whole cell level, Examples of important pathways, Case studies and analytical-type problems.

UNIT III **9 Hours**

INTRODUCTION TO GENOMICS

Whole Genome Sequencing and Analysis: Concept, methods, assembly methods (de novo and reference-based) and algorithms, genome annotation (structural and functional), comparative genomics.

UNIT IV **9 Hours**

HIGH-THROUGHPUT TRANSCRIPTOME PROFILING

High-throughput Transcriptome Profiling: Concept, methods and applications; transcriptome constructio(de novo and reference-based), differential gene expression.

UNIT V **9 Hours**

SINGLE NUCLEOTIDE POLYMORPHISM

Single nucleotide polymorphisms: Genome resequencing; data processing and SNP prediction; applications in agriculture/ human health.

Total: 45 Hours

FOR FURTHER READING

Cancer Metabolic Pathways, Targeted therapy, Growth signaling pathway metabolism, Metabolic network in living system, Differential expression of genes involved in metabolic pathways.

Reference(s)

1. Metabolomics- Ute Roessner, 2012. InTech Publishers
2. Metabolomics, A Powerful Tool in Systems Biology. Jens Nielsen, Michael C Jewett, 2007. Springer.
3. Metabolic Engineering: Principles and Methodologies- George Stephanopoulos, Aristos A. Aristidou, Jens Nielsen, 1998
4. Nielsen, Jens H. Biotechnology for the Future. Berlin: Springer, 2011.
5. Stephanopoulos, G, Aristos A. Aristidou, and Jens H. Nielsen. Metabolic Engineering: Principles and Methodologies. San Diego: Academic Press, 1998.
6. Sussulini, Alessandra. Metabolomics: from Fundamentals to Clinical Applications. , 2017.
7. Voet, Donald, and Judith G. Voet. Biochemistry. Hoboken, NJ: John Wiley and Sons, 2011

21BT020 DATA MINING AND MACHINE LEARNING FOR INFORMATICS 3 0 0 3

Course Objectives:

To understand the fundamental processes, concepts and techniques of data mining in biology with particular emphasis on data warehousing classification, clustering

To develop the ability to select methods and techniques appropriate for a given biological data mining problem

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. PSO1: Demonstrate the knowledge and technical skills in software development.

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

Course Outcomes (COs)

1. Apply the problems for machine learning and select the either supervised, unsupervised or reinforcement learning.
2. Apply cluster analysis methods for machine learning
3. Analyze the theory of probability and statistics related to machine learning
4. Analyze the concept learning, ANN, Bayes classifier, k nearest neighbor.
5. Evaluate big data analyze for biological applications

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO DATA MINING

Types of attributes, basic statistical descriptions of data, measuring data similarity and dissimilarity, data pre-processing data cleaning: missing values; data integration and transformation, data reduction: dimensionality reduction (PCA), numerosity reduction (near regression).

UNIT II **9 Hours**

CLUSTER ANALYSIS

Introduction to cluster analysis; requirements for cluster analysis; clustering methods: partition-based methods- k-means algorithm, k-medoids method, hierarchical methods- agglomerative and divisive clustering, evaluation of clustering.

UNIT III **9 Hours**

CLASSIFICATION AND PREDICTION

Linear regression Decision tree induction - attribute selection measures-tree pruning- scalability and decision tree induction: Random Forests: Bayesian classification: Bayes theorem naive Bayesian classification, Neural network-back propagation algorithm, Support Vector Machine Introduction accuracy and error measures: evaluating classifier accuracy. improving classification accuracy.

UNIT IV **9 Hours**

ASSOCIATION MINING

Basic concepts: apriori algorithm, methods to improve efficiency of apriori method, FP growth method,patient evaluation methods, comparison of partum evaluation methods.

UNIT V **9 Hours**

BIG DATA ANALYTICS

Introduction to big data: Introduction to Big Data Platform – Challenges of Conventional Systems -Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting.

Total: 45 Hours

TEXTBOOKS

1. Han, Kamber, and Pel, J. Data Mining: Concepts and Techniques. Publishers. USA, 3 edition, 2012.

REFERENCES

1. Bak, P. Brak 5. Bioinformatics: the machine leaming approach, MIT Press, 2 edition, 2001.
2. https:/www.coursera.org/learn/machine learning

21BT021 SYSTEMS AND SYNTHETIC BIOLOGY 3 0 0 3

Course Objectives

- To expose the students to bottom-up and top-down design and analysis strategies for systems and synthetic biology
- To render knowledge of how to perform research in interdisciplinary fields like systems biology and synthetic biology.
- To work in multi-disciplinary teams for both computational and wet-lab projects

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

m. Use the analytical instruments and techniques to isolate, purify and characterize biological compounds.

Course Outcomes (COs)

1. Apply the basic cellular and molecular biological concepts
2. Apply the biological networks and alignments
3. Analyze synthetic biological molecules and networks
4. Analyze the modern tools in systems and synthetics biology
5. Evaluate the ethical principles in systems biology

Articulation Matrix

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

UNIT I 8 Hours

INTRODUCTION TO BASIC CELLULAR AND MOLECULAR BIOLOGY

Central dogma of biology, mechanisms of gene expression, Kinetics of Enzyme Action, Rate Processes, Raw laws, Stoichiometric, Introduction to cell metabolism, Metabolic pathways, Protein signalling, Enzymatic reaction kinetics.

UNIT II **10 Hours**

BIOLOGICAL NETWORKS

Introduction to systems and synthetic biology, Biological networks: metabolic, signaling, regulatory, Network alignment and comparisons, network organization, Designing, simulating and building gene circuits, Genome design and synthesis.

UNIT III **9 Hours**

SYNTHETIC NETWORKS

Simple synthetic networks, Noise in gene expression, Structure of biological networks, Synthetic Networks, Design of promoters, Design of RNAs, Design of circuits, Characterization and optimization of devices, Examples and Applications of Synthetic Networks, Building synthetic networks, Monitoring outputs.

UNIT IV **10 Hours**

TOOLS IN SYSTEMS AND SYNTHETIC BIOLOGY

Flux analysis FBA, Computer aided design tools for metabolic engineering (lenera programs, retrosynthesis), Development of a flux theoretical model, correlation of the model with experimental data, Simulating synthetic networks, Manipulating DNA and measuring network responses.

UNIT V **8 Hours**

ETHICS IN SYSTEMS AND SYNTHETIC BIOLOGY

Biosafety introduction, Reengineering living organisms, ethical questions of synthetic biology, Current science-society situation and the place of synthetic biology, Controversies around key concepts: novelty, perfection, intentionality, complexity, life, Scientist's responsibility - Dual-use research and its implications from ethics to biosecurity.

FOR FURTHER READING

Biological sequence analysis, metabolic engineering, strain design optimisation, Genetic models, bottom-up approach to gene regulation, Business and Synthetic Biology.

Total: 45 Hours

Reference(s)

1. Pengcheng Fu, Sven Panke, "Systems Biology And Synthetic Biology", Wiley-Blackwell Publisher, 2009.
2. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall, 2006.
3. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw-Hill, 1986.

21BT022 **PLANT TISSUE CULTURE AND TRANSFORMATION TECHNIQUE** **3 0 0 3**

Course Objectives

- To gain ample knowledge on different plant culture types involved
- To learn the techniques involved in plant tissue culturing
- To have an exposure on the various real time applications of culturing techniques in GM crop production and sustainability.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

m.Use the analytical instruments and techniques to isolate, purify and characterize biologicalcompounds

Course Outcomes (COs)

1. Apply the historical developments in plant cell culture and learn to handle the techniques in aseptic conditions.
2. Apply the existing and recent developments with the knowledge of basic plant tissue culture techniques
3. Analyze the recent methodologies of plant tissue and cell culture to develop a whole plant.
4. Analyze the recent methodologies of plant tissue and cell culture to develop a whole plant.
5. Evaluate the concepts of plant tissue culture in agricultural science for crop improvement

Articulation Matrix

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

5			3					2			1	1	2		

UNIT I **9 Hours**

INTRODUCTION TO PLANT TISSUE CULTURE

History of plant tissue culture, Laboratory requirements and organization; Types of media and its composition - inorganic nutrients, organic supplements, carbon source, vitamins, gelling agents,, Explants and sterilization techniques- filter, heat, wet and chemical, Plant Growth hormones; Commonly used culture media.

UNIT II **9 Hours**

BASICS OF CULTURE TYPES AND TECHNIQUES

Suspension culture - Batch and continuous, Synchronisation of suspension culture, Micro propagation - Factors affecting morphogenesis and proliferation rate, technical problems in micropropagation; Protoplast isolation and fusion technology and its Viability test

UNIT III **9 Hours**

CELL CULTURE TECHNIQUES FOR REGENERATION OF CROPS

Organogenesis -formation of shoots and roots, production of virus free plants by Meristem and shoot-tip culture , Embryogenesis - Process of somatic embryogenesis, structure, stages of embryo development, factors affecting embryogenesis; production of artificial seeds; Cryopreservation

UNIT IV **9 Hours**

COMMERCIAL CROPS USING PLANT TISSUE CULTURE

Herbicide resistance; Pest resistance - BT Crops; Genetic engineering for male sterility- Barnase-Barstar; Delay of fruit ripening - Polygalacturanase, ACC synthase, ACC oxidase

UNIT V **9 Hours**

APPLICATIONS OF TISSUE CULTURE

Application of plant tissue culture in mutant selection, Secondary metabolite production and clonal propagation. Plant products of industrial importance, Recent advances in plant tissue culture.

FOR FURTHER READING

Hybrid plants - Embryo transfer techniques

Total: 45 Hours

Reference(s)

1. M. K. Razdon, Introduction to Plant Tissue Culture, Oxford &IBH Publishing Company, 2006.
2. S. Narayanaswamy, Plant Cell & Tissue Culture, Tata Mc Graw-Hill, 2008
3. A. Slater, N. Scott and M. Fowler, Plant Biotechnology: The genetic manipulation of plants, Oxford University Press, 2003

21BT023 TRANSGENIC TECHNOLOGY IN AGRICULTURE 3 0 0 3

Course Objectives

- To gain ample knowledge on different biotech techniques
- To learn the techniques involved in Crop improvement
- To have an exposure on the various real time applications for crop production and sustainability.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

o. Conceive , Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the biology being crop culture techniques
2. Apply the need of various physio chemical conditions in plant Tissue culture
3. Apply the recent methodologies of plant tissue and cell culture to develop a whole plant
4. Analyze the commercial significance of plant tissue culture
5. Evaluate the need of various interdisciplinary domains in Plant tissue culture procedures.

Articulation Matrix

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

UNIT I 9 Hours

PLANT ORGAN, TISSUE AND CELL CULTURE

Totipotency; micro-propagation and its uses; somaclonal variation and its use in crop improvement; embryo culture; anther culture; somatic embryo; artificial seeds; techniques of protoplast culture, regeneration and somatic cell hybridization, achievements and limitations, utility in improvement of crop plants; application in production of secondary metabolites and transformations.

UNIT II 9 Hours

COMMERCIAL APPLICATIONS OF PLANT TISSUE CULTURE

Disease free seed production technology, Hybridization & mutant selection, Secondary metabolite production, GMO & transgenic Crops, organ culture for production of active ingredients in food andcosmetics, Regulations in PTC derived plantlets. Biosensors for agriculture. Post-transcriptional gene

silencing (PTGS): VIGS and RNAi and their use in functional genomics and crop improvement. Bio fertilizers and bio insecticides:

UNIT III **9 Hours**

METHODS OF GENE TRANSFER IN PLANTS

Agrobacterium mediated gene transfer (dicots and monocots), direct DNA delivery methods (microinjection, particle gun method electroporation); gene targeting (including zinc finger nucleases). Transgenic plants in dicots and monocots: Utility of transgenics in basic studies and in crop improvement (resistance for biotic and abiotic stresses; barnase and barstar for hybrid seed production)

UNIT IV **9 Hours**

MOLECULAR PHARMING

Molecular farming for production of foreign proteins and edible vaccines; marker-assisted selection (MAS) in plant breeding. Molecular mapping and tagging of agronomic important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding. Genomics and genoinformatics for crop improvement; Marker-assisted backcross breeding for rapid introgression

UNIT V **9 Hours**

BIOSAFETY AND REGULATORY ISSUES

Biosafety issues including risks associated with transgenic crops; biosafety regulations (role of IBC, RCGM and GEAC or NBRA).International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights MOs and related issues (risk and regulations); Intellectual property rights

FURTHER READING

Selectable markers and clean transformation techniques, vector-mediated gene transfer, Biotechnology applications in male sterility/hybrid breeding, molecular farming.

Reference(s)

1. Satbir Singh Gosal and Shabir Hussain Wani (2018) Biotechnologies of Crop Improvement, Volume 1, Springer
2. Satbir Singh Gosal and Shabir Hussain Wani (2018) Biotechnologies of Crop Improvement, Volume 3 , Springer
3. S.M. Paul Khurana & Narendra Kumar (2022). Plant Biotehnology: A Text Book Scientific Publisher
4. M. K. Razdon, (2006)Introduction to Plant Tissue Culture, Oxford &IBH Publishing Company,

21BT024 **BIOFERTILIZERS AND BIOPESTICIDES PRODUCTION** **3 0 0 3**

Course Objectives

- To understand the types and mechanisms of fertilizers
- To formulate and production of biofertilizers
- Production, formulation and study of regulations of bio pesticides

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

n. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

o. Conceive, Plan and Deploy societal projects for environmental protection using Bio-resources.

Course Outcomes (COs)

1. Apply the classifications of fertilizers and the contribution of microorganism to soil facility
2. Apply the types of fertilizers and the contribution of microorganism to soil facility
3. Analyze the commercial production of Biofertilizers
4. Analyze the concept of Bio pesticides, Bio fungicides, Bioinsecticide
5. Analyze the regulation policies on Bio pesticides

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO BIOFERTILIZERS

Definition and Classification of fertilizers (synthetic fertilizers & natural fertilizers), Organic Fertilizers, Advantages of Biofertilisers over synthetic fertilizers, Microbial inoculants in Agriculture - contributions of microorganisms to soil fertility, Rhizosphere concept.

UNIT II **9 Hours**

TYPES OF BIOFERTILIZERS

Different groups of biofertilizers - bacterial, fungal and algal biofertilizers; Phosphorus Biofertilisers - Rock phosphate solubilisation; Phosphorus mobilization – mycorrhiza -types– endo, ectomycorrhiza and orchidaceous mycorrhiza, Problems and prospects of biofertilizers. BSI standards of biofertilizers, Economics of biofertilizers.

UNIT III **9 Hours**

COMMERCIAL PRODUCTION OF BIOFERTILIZERS

Principles of Mass production - growth characteristics - Fermentation- Principles and techniques - inoculum preparation. Large-scale production of bacterial biofertilizers, *Azolla*- Blue green algae, VAM fungi and Ectomycorrhiza; Field performance of biofertilizers - method of application; Carrier materials - Types and quality, characteristics of an ideal carrier.

UNIT IV **9 Hours**

INTRODUCTION TO BIO PESTICIDES

Bio pesticides - present status and future prospects; bio fungicides - commercial development of bio fungicides, microbial action for disease control, bioinsectides - neem and related natural products, commercialization of neem products; Bt: natural and recombinant bio insecticide products, Bt transgenic plants.

UNIT V **9 Hours**

BIO PESTICIDES PRODUCTION - REGISTRATION AND MANAGEMENT PROTOCOLS

Pesticide policy influences on bio pesticides technologies; environmental and regulatory aspects: industry view and approach; formulations of bio pesticides; delivery systems and protocols for bio pesticides; analysis, monitoring and some regulatory implications; principles of dose acquisition for bio insecticides; strategies for resistance management.

9 Hours

FOR FURTHER READING

Biofertilizers -Storage, shelf life, quality control and marketing. Factors influencing the efficacy of bio fertilizers. Storage of Pesticides, care and precautions during handling of pesticides, safety and protective measures during application.

Total: 45 Hours

References:

1. S.Kannaiyan , *Biotechnology of Biofertilizer*,Narosa Publishing House, 2002.
2. R.H.Franklin and J.M.Julius, *Biopesticides - Use and Delivery.* Humana Press Inc., 1999.
3. S.S.Purohit, *Agricultural Biotechnology*,AgrobiosIndia, 2003.
4. P.S.Nutman, *Symbiotic nitrogen fixation in plants*, Cambridge Univ. Press, London, 1976.
5. N.S.SubbaRao, *Advances in Agricultural Microbiology*, Oxford and IBH, Publn. Co., New Delhi, 1982.

21BT025 **MUSHROOM CULTIVATION AND VERMICOMPOSTING** **3 0 0 3**

Course Objectives

- Understand the basic concepts, principles, potentials and limitations of mushroom cultivation and vermiculture techniques
- Apply the active compounds of mushroom for developing a solution for health care problems
- Develop mushroom cultivation and vermiculture skills for entrepreneurial activity

Programme Outcomes (POs)

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

n. Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

o. Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the active compounds of mushroom in food and pharmaceutical industry
2. Apply the cultivation techniques for mushroom production
3. Apply post-harvest technology to preserve the quality of the product
4. Analyze the significance of earthworms in increasing the soil fertility
5. Evaluate the techniques of vermicomposting for large scale production and marketing

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction and Importance of mushrooms; History of mushroom cultivation; Present status of mushroom industry in India; Cultivable edible mushroom; Biology of mushroom; Food value of edible mushrooms; Uses of mushrooms, Poisonous mushrooms, and Medicinal mushrooms.

UNIT II **9 Hours**

MUSHROOM CULTIVATION AND BIOLOGICAL IMPORTANCE

Mushrooms farm structure; design and layout; Spawn principles, techniques of spawn production; Principle and techniques of compost and compositing; Cultivation techniques of White button mushroom, oyster mushroom.

UNIT III **9 Hours**

DISEASE AND POST-HARVEST TECHNOLOGY

Management of fungal, bacterial and viral diseases in mushroom; Competitors, pests and nematodes in mushrooms. Post-harvest technology,: Freezing, Dry freezing , Drying, Canning.

UNIT IV **9 Hours**

VERIMICULTURE TECHNOLOGY

Permaculture Technology; organic farming, soil fertility; Distribution and Ecology of Earthworms Earthworm taxonomy -Morphological and Anatomical characteristics of Earthworm -Food habits, excretion and life cycle. Types of Earthworms -Exotic and native species

UNIT V **9 Hours**

METHODS OF VERMICOMPOSTING

Collection and preservation of earthworms for vermicomposting and culturing techniques of earthworms.Preparation of vermicomposting requirement, different methods of Vermicompositing (Heap method, Pot method, and Tray method).Changes during vermin compositing, Nutrient value of Vermicompositing; Problems in vermicomposting preparation; Earthworm as bioreactors. Influence of chemical inputs on earthworms activities. Large scale manufacture of Vermicomposting, packaging; financial supporting (Government and NGOs for vermi culture work)

FOR FURTHER READING

Nutritional value of mushrooms, South Indian and North Indian species used for vermin compositing, Vermicomposting and its marketin

Total: 45 Hours

Reference(s)

1. NPCS Board of Consultants & Engineers, The Complete Technology Book on Vermiculture and Vermicomposting, 2004
2. Keshav Singh, Textbook of Vermicompost: Vermiwash and Biopesticides, 2014
3. Robin Gogoi Yella Rathaiah T R Borah, Mushroom Cultivation Technology, Scientific Publishers, 2006
4. S.C. Tiwari & Pankaj Kapoor, Mushroom Cultivation, 2018

21BT026 FUNGAL AND ALGAL TECHNOLOGY 3 0 0 3

Course Objectives

- This course aims to develop skills of the students in the r esear c h ar eas o f M yco lo g y a nd Algae
- To execute the bioprocess techniques in Mycology and algae
- To acquire prerequisite knowledge for all Bioprocess Technology processes

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.

i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

m. Use the analytical instruments and techniques to separate, purify and characterizebiological compounds

Course Outcomes (COs)

1. Apply the General Characteristic features of Fungi
2. Apply the fungal forms and it's associations
3. Analyze the economic importance of fungi
4. Analyze the Algal classification, Lifecycle and reproduction
5. Evaluate the economic importance of Algae

Articulation Matrix

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

UNIT I **9 Hours**

GENERAL CHARACTERS OF FUNGI

Introduction to the Fungi, Diversity of fungi and fungus-like organisms, History of mycology the fungal body and cells, and growth, fungal physiology, nutrition, and growth. Mushrooms, Mushroom poisoning, Rust and smut fungi, Range of structure and organization of vegetative and reproductive bodies. Ontogeny of conidia,

Saccardo's classification system, conidial fungi, sterile technique; isolation and growing fungi

UNIT II **9 Hours**

FUNGAL FORMS AND ASSOCIATIONS

Structure and reproduction with reference to the following fungal forms (no developmental stage) Rhizopus, Aspergillus, Saccharomyces, Neurospora, Types, structure, reproduction. Mycorrhizae Clinical mycology: Structure, reproduction, diagnoses and control measures of the following: Dermatophytoses : (Trichophyton); Systemic mycoses (Candida), Fungal toxins.

UNIT III **9 Hours**

Economic importance of Fungi

Economic importance. Lichens: Habitat, Structure and organization of lichens. Method of reproduction. Physiological relationship of mycobiont and phycobiont. Economic importance of lichens, Mycorrhizae: Habitat, Structure and organization of Mycorrhizae s. Types of Mycorrhizae and its economic importance

UNIT IV **9 Hours**

ALGAE - Introduction

A general account and classification of Algae – distribution - range of thallus organization – pigmentation-flagellation- reserve food – Reproduction(vegetative-asexual-sexual) ; Lifecycle patterns salient features of algal divisions,phylogeny - Fossil algae,Algae -Structure and reproduction with reference to the following algal forms – Anabaena, Chlorella, Volvox,

UNIT V **9 Hours**

ALGAE - APPLICATIONS

Algal biotechnology: single cell proteins (SCP): Spirulina as single cell protein-production and harvesting of algal biomass – factors affecting biomass production. Cyanobacterial inoculants (BGA): Isolation, preparation of starter culture, mass cultivation, field applications and crop response. Economic importance of algae: Algae as food and fodder, use of algae in agriculture and space research, commercial products of algae: Agar Agar, Alginates, Carrageenin, diatomite, mucilage, minerals and elements - Algae in medicine and biofuels

Total: 45 Hours

References:

1. Srivastava, H.N. 1999. Algae. Pradeep publications, Meerut.
2. Sharma, O.P. 2004. A Textbook of Algae. Tata McGraw- Hill publishing Company Limited, New Delhi.
3. Bilgrami, K.S. and Saha, L.C. 2012. A Textbook of Algae. CBS Publishers & Distributors Pvt. Ltd., New Delhi
4. Vashista, B.R. 2000. Fungi, Chand & Co. New Delhi
5. Harold C. Bold, 1982. Morphology of plants. Weiley- Eastern Ltd.
6. Sathyanarayana, U. 2010. Biotechnology; Books and allied (P) Ltd. Kolkatta

21BT027 PHYTOTHERAPEAUTICS 3 0 0 3

Course Objectives

- To understand and apply the basic scientific and sustainability principles behind phyttherapeauitcs
- To analyse the fundamental principles of existing and emerging technologies for the treatment of diseases
- To appreciate the increasing importance of bioavailability of phytocompounds

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

o. Conceive, Plan and Deploy societal projects for environmental protection usingBioresources

Course Outcomes (COs)

1. Apply the scope and importance of medicinal plants
2. Apply the classification of herbal drugs
3. Analyze the importance of ethanobotany
4. Evaluate the Phytotherapeutic compounds
5. Create the bioavability and pharmacokinetic aspects for herbal drugs

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Key Historical events, Scope and importance of medicinal plants. Traditional medicinal systems: Siddha, Ayurveda, Homeopathy, Chinese medicine, Unani, Naturopathy and Aromatherapy. Status of Indian medicinal plant trade, medicinal plants prohibited from export, leading companies in India in trade of medicinal plants.

UNIT II **9 Hours**

CLASSIFICATION OF HERBAL DRUGS

Classification of herbal drugs based on the Alphabetical, Morphological, Taxonomical, Chemical and pharmacological. Collection and processing of herbal raw materials for drugs preparation-Post Harvesting care, Drying, Dressing, Packing and Storage. Conservation and mass propagation of important medicinal plantsthrough In vitro propagation methods. Role of NMPB, CDRI and CIMAP on medicinal plants conservation and research development. WHO regulation and Guidelines for quality control and trade of herbal me

UNIT III **9 Hours**

ETHANOBOTANY

Ethno botany - concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Role of ethnobotany in modern Medicine Medico-Ethnobotanical sources – Eg. Contribution of Kani Tribes. Ethnobotany and plant genetic resources conservation of medicinal plants with special reference to India. Major tribes of South India and their ethno botanical knowledge.

UNIT IV **9 Hours**

PHYTOTHERAPEUTIC COMPOUNDS OF MEDICINAL PLANTS

Phytotherapeutic compounds of medicinal plants - Alkaloids, Glycosides, Terpenoids, Tannins, Flavonoids and Phenols. Patent guidelines for Phytotherapeutic compounds. Identification and utilization of the medicinal herbs in curing various ailments – *Catharanthus roseus* (Anti-cancer), *Aegle marmelos* (Cardiotonic), Withania somnifera (Drugs acting on nervous system), *Cardiospermum halicacabum* (Anti-rheumatic) and *Centella asiatica* (Memory booster), *Phyllanthus emblica* (Rejuvenating) and (Hepato-protective).

UNIT V **9 Hours**

BIOAVABILITY & PHARMACOKINETIC ASPECTS FOR HERBAL DRUGS

Preparation of liquid orals, tablets, capsules, ointments, creams and cosmatics, Methods involved in monoherbal and polyherbal formulation with their merits and demerits. Excipients used in herbal formulation, Compatibility studies, Stability studies, Bioavability & Pharmacokinetic aspects for herbal drugs with examples of well-known documented, clinically used herbal drugs. Quality Control of finished herbal medicinal products.

Total: 45 hours

FURTHER READING

Medicinally useful plant parts: Root – *Hemidesmus indicus* and *Rauvolfia serpentina*; Rhizome – Acorus calamus and Curcuma longa *Phyllanthus niruri*; Stem- *Tinospora cordifolia* and *Santalum album*,; Bark – *Terminalia arjuna* and *Saraca asoca*; Leaf – *Andrographis paniculata* and *Cynodon dactylon*; Flowers – *Crocus sativus* and *Syzygium aromaticum* ; Fruits - *Piper longum* and *Terminalia chebula*; Seeds – *Azadirachta indica* and *Trigonella foenum-graecum*.

Reference(s):

1. Iqbal Ramzan, (2020) Phytotherapies: Efficacy, Safety, and Regulation, 015 John Wiley & Sons, Inc.

2. Michael Heinrich, Joanne Barnes, Jose Prieto-Garcia , Simon Gibbons Elizabeth and M. Williamson, (2018) Fundamentals of Pharmacognosy and Phototherapy, 3rd Edition, Elsevier
3. Williamson, E. M. ; Okpako, D. T. ; Evans, F. J. (1996)Pharmacological methods in phytotherapy research: volume 1: Selection, preparation and pharmacological evaluation of plant material. John Wiley & Sons Ltd.

Web Resources

1. http://www.gallowglass.org/jadwiga/herbs/preparations.html
2. http://shawnacohen.tripod.com/thetribaltraditions/id51.html
3. http://www.emea.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC5

21BT028 ANIMAL PHYSIOLOGY AND METABOLISM 3 0 0 3

Course Objectives

- To learn about the physiology of blood, mammalian digestive system, urinary system and neuronal system
- To understand the role of hormones in mammalian physiology
- To study the metabolic pathways and energy generation in biological systems.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

n. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

Course Outcomes (COs)

1. Apply the physiological principles related to mammalian digestive and urinary system.
2. Apply the physiology of blood and neuronal system
3. Analyze the role and interactions of hormones
4. Analyze the concepts of coenzymes, and energy generation in biological systems
5. Evaluate the interrelationship of metabolic pathways in relation to overall physiological states

Articulation Matrix

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

UNIT I 9 Hours

PHYSIOLOGY OF DIGESTION AND EXCRETION

Hydrolysis and resorption of food components; Digestive processes: formation of HCl, Zymogen activation, fat digestion; Bile salts- composition and functions, Biotransformation, Cytochrome P450 system. Liver function and diagnostic tests; Formation and acidification of urine, acid-base balance and maintenance, mechanism of action of diuretics, tests of renal function, composition of urine.

UNIT II **9 Hours**

PHYSIOLOGY OF BLOOD, AND NEURONAL SYSTEM

Blood composition, plasma proteins, lipoproteins, Buffer systems of plasma, Blood clotting and fibrinolysis; Gas transport, Cerebrospinal fluid; Neurons- types and functions, blood-brain barrier, resting and action potentials; transmission of nerve impulses; neurotransmitters.

UNIT III **9 Hours**

BIOCHEMISTRY AND FUNCTIONS OF HORMONES

Organization and regulation of secretions and function of: Anterior and Posterior pituitary, Thyroid, Adrenal cortex and medulla, Parathyroid, Pancreas; sex hormones; Clinical orientation.

UNIT IV **9 Hours**

BIOENERGETICS AND BIOLOGICAL OXIDATION

Role of High energy phosphates in Bioenergetics and energy capture; Role and mechanism of action of NAD+/NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions; Respiratory chain and its role in energy capture. Mechanism of oxidative phosphorylation.

UNIT V **9 Hours**

REGULATION OF INTERMEDIARY METABOLISM

Major and unique features of metabolism of the principal organs (liver, brain, muscle, kidney) in various metabolic states- fed and starved states; Coordinated Regulation of glycolysis and glycogenesis; Regulation of gluconeogenesis; Regulation of fatty acid synthesis, and degradation; ketogenesis; Metabolic interrelationships between adipose tissue, the liver, and extrahepatic tissues. Disorders of intermediary metabolism – glycogen storage diseases, diabetes, fatty liver.

Total: 45 Hours

Reference(s)

1. Nelson, D. L. and Cox, M. M., Lehninger's Principles of Biochemistry, 5th Ed, Worth Publishers. 2008.
2. Murray, R. K., Granner, D. K., Mayes, P. A., Rodwell., Harper's Illustrated Biochemistry by, V.W., 26th Ed, The McGraw-Hill Companies, Inc. 2006.
3. Guyton., Textbook of Medical Physiology, 11th Ed, A. C., H. Sanders Philadelphia. 2005.

21BT029 **ANIMAL HEALTH AND NUTRITION** **3 0 0 3**

Course Objectives

- To learn about the animal health, nutrition, pathology, toxicology and epidemology
- To understand the concepts of animal pathology and animal toxicology
- To study the epidemiological methods in livestock disease management and disease forecasting.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
n. Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

Course Outcomes (COs)

1. Apply the ruminant and non-ruminants nutritional requirement.
2. Apply the microbial basics in pathogenesis of livestock diseases.
3. Apply the biotechnological techniques in enhancing animal health and its production.
4. Analyze the utilization of livestocks for developing commercially important novel products.
5. Evaluate the concepts of toxicity caused by heavy metals, plants and agrochemicals affecting livestock health.

Articulation Matrix

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

UNIT I **9 Hours**

PHYSIOLOGY OF DIGESTION AND EXCRETION

Basic concept of food and nutrition; Biochemistry of carbohydrate, proteins, lipids, minerals and vitamins; Feeding standards for maintenance and growth: Nutrient requirements for maintenance and growth, Nutritional control of growth;Feeding standards for reproduction: Nutrition requirements for reproduction; Lactation: Nutrient requirements of the lactating dairy. Voluntary intake of food: Feeding behaviour.

UNIT II **9 Hours**

ANIMAL PATHOLOGY

Food and Water borne infections: Bacterial, Viral and Parasitic infections - its causative agent, sources of infection, symptoms and prevention.Biosecurity-Disease transmission and management.

UNIT III **9 Hours**

SUSTAINABLE ANIMAL PRODUCTION AND HEALTH

Genetically modified organisms - Nuclear Transplantation, Retroviral Method, DNA microinjection ; Transgenic Animals- Production of Pharmaceuticals, production of donor organs, Expressing cloned genes in mammalian cells.Conservation Biology - Cryopreservation : In vitro fertilization and embryo transfer in farm animals, Artificial insemination; Gene Therapy

UNIT IV **9 Hours**

ANIMAL VACCINES & THERAPEUTICS

Introduction to the concept of vaccines; Conventional methods of vaccine production; Recombinant approaches to vaccine production; Recombinant cytokines and monoclonal antibodies : their use in the treatment of animal infections; Therapeutic cloning.

UNIT V **9 Hours**

ANIMAL TOXICOLOGY

Toxicity caused by metals and non-metals; Poisonous plants; plants causing thiamine deficiency. plants causing photosensitization and lathyrism.Toxicity caused by Agrochemicals; Common adulterants and feed additives of concentrates and fodders and its uses.

Further Reading

National and international regulations on livestock disease .Role of OIE and laws on international trade of animal and animal products. Animal disease epidemiology.

Total: 45 Hours

Reference(s)

1. Wu G. Principles of animal nutrition. crc Press; 2017 Nov 22.
2. McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., Morgan, C.A., Sinclair, L.A. and Wilkinson, R.G., 2010. Animal nutrition 7th edition.
3. D'Mello, J.F. ed., 2000. Farm animal metabolism and nutrition. Cabi.

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21BT030 ANIMAL CELL CULTURE TECHNIQUES 3 0 0 3

Course Objectives

- To impart the knowledge on basic tissue culture techniques
- To train students on theoretical and practical aspects of animal cell culture
- To demonstrate knowledge of cell lines used in mammalian tissue culture, their origins and applications

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

n. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

Course Outcomes (COs)

1. Apply the fundamental knowledge of cell culture techniques and their competence in laboratory techniques
2. Apply the knowledge of cell isolation, maintenance and characterization in organ culture
3. Analyze the proficiency in establishing and maintaining of cell lines
4. Analyze cell cytotoxicity in regard to cell proliferation and viability
5. Evaluate the potential benefits of cell culture techniques in disease management

Articulation Matrix

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

UNIT I 9 Hours

INTRODUCTION TO CELL CULTURE

Introduction, importance, history of cell culture development, Equipments for cell culture, Aseptic techniques, Layout of animal tissue culture laboratory, Safety protocols and sterilization techniques.

UNIT II **9 Hours**

CELL CULTURE MEDIA AND REAGENTS

Different type of cell culture media, Growth supplements, Serum free media, Balanced salt solution, and Advantages, disadvantages and their applications

UNIT III **9 Hours**

CELL CULTURE TECHNIQUES

Different cell culture techniques including primary and secondary culture, Continuous cell lines, suspension culture and organ culture, Subculture and propagation, Cell lines, nomenclature, cell line designations, Routine maintenance and immortalization of cell lines

UNIT IV **9 Hours**

DEVELOPMENT AND MAINTENANCE OF CELL LINES

Development of cell lines, Characterization and maintenance of cell lines, Cryopreservation, Common cell culture contaminants, Measurement of viability and cytotoxicity

UNIT V **9 Hours**

APPLICATIONS OF CELL CULTURE

Gene transfer techniques in mammalian cells, Viral and non-viral methods, Production of transgenic animals, ES and microinjection, retroviral method, applications of transgenic animal technology

FURTHER READING

Animal cell staining: Histological and Immunohistochemical analysis, Adaptation of virus in cell culture

Total: 45 Hours

Reference(s)

1. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
2. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
3. Ed. Martin Clynes, Animal Cell Culture Techniques. Springer, 1998.

21BT031 BIO-TECHNIQUES IN ANIMAL BREEDING 3 0 0 3

Course Objectives

- To educate the students about the basic tools requirement for cell culture and Micromanipulation
- To provide depth knowledge about micromanipulation and application.
- To teach the importance of stem cell mediated production and guidelines

Programme Outcomes (POs)

a. Demonstrate problem analyzing ability to develop solutions for the shortcomings encountered in biological science sector

b. Design and perform precise investigations on complex problems and contemporary issues of life science domain using modern technological innovations

c. Excel in research blended academic learning and exhibit a higher degree of attributes which is necessary for both industrial and research sector

d. Carry out research /investigations independently and develop explicit solutions for solving real-world problems

e. Apply the acquired technical knowledge and ethical principles to realize the professional and ethical responsibilities

f. Write and present an extensive technical report/document that disseminate the knowledge to the academic and research community

n.Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors

o. Conceive, , Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the concept of basic tools requirement for cell culture and micromanipulation
2. Apply the knowledge on micromanipulation and its application
3. Analyze the concept of stem cells and ES cell of transgenic animals.
4. Analyze the research importance in transgenic animals.
5. Evaluate the knowledge on ethical CPCSEA guidelines

Articulation Matrix

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

UNIT I **9 Hours**

BASIC TOOLS REQUIREMENTS FOR CELL CULTURE AND MICROMANIPULATION

Biosafety levels, safety equipments, personal protective equipments, safe laboratory practices. Cell culture equipments: basic equipments - centrifuge, Inverted microscope, confocal microscope, flow cytometer, Hemocytometer, cell culture vessels, bioreactors. Cell culture laboratory: Aseptic work area, Cell culture hood, Incubator, cryostorage,cell counter, aseptic technique, Maintenance of nutrients, prevention of cross contamination. Micromanipulation tools: micromanipulator, pipette puller, pipette grinder, holding pipette,

UNIT II **9 Hours**

MICROMANIPULATION AND ITS APPLICATION

Enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

UNIT III **9 Hours**

STEM CELLS AND TRANSGENIC ANIMALS

Stem cells – sources, types, uses, ES cells, pluripotent stem cells, adult stem cell, epithelial stem cell, bone marrow and hematopoietic, neural stem cell, transgenic techniques, Stem cell mediated transgenic animals

UNIT IV **9 Hours**

TRANSGENIC ANIMALS IN RESEARCH

Ethics of transgenic technology, Dolly (transgenic sheep), Transgenic mice, rat, sheep, goat, rabbit, pig, fish, cow-case studies.

UNIT V **9 Hours**

ETHICAL GUIDELINES ON ANIMAL BREEDING

Justification on research, care and housing of laboratory animals, acquisition of laboratory animals, experimental procedure, CPCSEA guidelines. Animal integrity and ethical limits to breeding. Animal welfare issues. Record Maintenance as per guidelines.

Total: 45 Hours

Reference(s)

1. Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007
2. Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003
3. Lewin, B. Genes VIII, Pearson Prentice Hall, 2004.

21BT032 FUNDAMENTALS OF ANIMAL TRANSGENICS 3 0 0 3

Course Objectives

- To provide the fundamentals of animal cell culture, details of the diseases and therapy
- To analye the cellular and molecular level of animal cells
- To offer the knowledge about the micromanipulation and transgenic animals

Programme Outcomes (POs)

a. Demonstrate problem analyzing ability to develop solutions for the shortcomings encountered in biological science sector

b. Design and perform precise investigations on complex problems and contemporary issues of life science domain using modern technological innovations

c. Excel in research blended academic learning and exhibit a higher degree of attributes which is necessary for both industrial and research sector

d. Carry out research /investigations independently and develop explicit solutions for solving real-world problems

e. Apply the acquired technical knowledge and ethical principles to realize the professional and ethical responsibilities

f. Write and present an extensive technical report/document that disseminate the knowledge to the academic and research community

m.Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors

o. Conceive, , Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the evolution of life and animal diversity
2. Analyze the level of animal diversity and evolution
3. Analyze the cellular and molecular levels of animal cells
4. Analyze in vitro fertilization and embryo transfer techniques
5. Evaluate the concepts of micromanipulation technology and transgenic animal technology

Articulation Matrix

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

UNIT I 9 Hours

ORIGIN AND EVOLUTION OF LIFE

Theories of the origin of life, early earth, modern self-assembly theories, Oparin Haldane theory of chemical evolution, The Miller Urey experiment, Organic evolution, Development of evolution theory, Darwin's theory, Origin and evolution of human being.

UNIT II **9 Hours**

ANIMAL DIVERSITY

Basis of classification, levels of organization (Symmetry, diploblastic and triploblastic organization), Coelom, segmentation, Notochord. The nature of natural selection, Examples of natural selection, levels of selection, selection of organisms and groups, species selection.

UNIT III **9 Hours**

STRUCTURAL ORGANIZATION AND CELL CULTURE TECHNIQUES

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

UNIT IV **9 Hours**

MICROMANIPULATION OF EMBRYOS

Micromanipulation technology; equipment used in micromanipulation; enrichment of x and y bearing spermsfrom semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

UNIT V **9 Hours**

TRANSGENIC ANIMALS

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

Total: 45 Hours

Reference(s)

1. Sue Dallas, Emily Jewell. Animal Biology and Care Wiley-Blackwell; 3rd edition.
2. Franklin Shull A, George R. Larue, Alexander G. Ruthven. Principles of animal biology. Mc GrawHill agricultural and Biological publications.
3. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
   Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997.

21BT033 STEM CELL TECHNOLOGY 3 0 0 3

Course Objectives

- To gain knowledge on the basics of stem cells and their origin
- To learn the methods of stem cell identification and various sources
- To give way to the therapeutic treatment using stem cells

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

n. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

o. Conceive, Plan and Deploy societal projects for environmental protection using Bio-resources.

Course Outcomes (COs)

1. Apply the different types of stem cells and their origin
2. Analyze the differentiation process of premature stem cells
3. Analyze the characteristic features of Embryonic and adult stem cells
4. Evaluate the methods of stem cell identification and various sources
5. Evaluate the therapeutic functions of stem cells in human diseases

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO STEM CELL

Introduction to stem cells; Stem cell niche - embroyonic stem cells, hematepoitic stem cells, bone marrow stem cells, germline stem cells, cancer stem cells, neural stem cells, adult stem cells, muscle and cardiac stem cell; Properties potency and self renewal Epigenetics

UNIT II **9 Hours**

DIFFERENTIATION OF STEM CELLS

Differentiation status of cells - Primordial germ cell, Skin cell, Gastrointestinal cells; Embryonic stem cell differentiation as a model to study haematopoetic cell development. Endothelial cell development

UNIT III **9 Hours**

GENERATION OF STEM CELLS

Testing and generation of embryonic stem cells; testing for adult stem cells and differentiation. Animal models of regeneration

UNIT IV **9 Hours**

MANIPULATION OF EMBRYONIC STEM CELLS

Integration of transgenes into a defined locus in human embryonic stem cells; Genetic manipulation of embryonic stem cells; Genetic manipulation through DNA delivery by electroporation, , chemical-based reagents and viruses Nucleofection

UNIT V **9 Hours**

APPLICATIONS OF STEM CELLS

Uses of Stem cells; Human stem cells; Renewal of stem cells; Stem cells and Tissue engineering; Embryonic stem cells and Gene therapy; Therapeutic Cloning

Total: 45 Hours

FOR FURTHER READING

Ethical issues associated with stem cell research

Reference(s)

1. MD. Steward Sell, Stem cells, Human Press Inc., 2004
2. Ariff Bongso and Eng Hin Lee, Stem cells, World Scientific Publication Co. Pvt. Ltd., 2005.
3. Robert Paul Lanza, Essentials of stem cell biology, Academic Press, 2006
4. Harvey F. Lodish, Arnold Berk and Chris A. Kaiser, Molecular cell Biology, W. H. Freeman and Co., 2008.

21BT034 **TISSUE ENGINEERING** **3 0 0 3**

Course Objectives

- To develop the skill of the student in the emerging field of Regenerative medicine
- To familiarize students with the various techniques used in Tissue engineering
- To make the students think about higher studies and careers in the field of Tissue engineering

Programme Outcomes (POs)

a. Demonstrate problem analyzing ability to develop solutions for the shortcomings encountered in biological science sector

b. Design and perform precise investigations on complex problems and contemporary issues of life science domain using modern technological innovations

c. Excel in research blended academic learning and exhibit a higher degree of attributes which is necessary for both industrial and research sector

d. Carry out research /investigations independently and develop explicit solutions for solving real-world problems

e. Apply the acquired technical knowledge and ethical principles to realize the professional and ethical responsibilities

f. Write and present an extensive technical report/document that disseminate the knowledge to the academic and research community

n.Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors

o. Conceive, , Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the different biomaterials and generate ideas for their use in tissue engineering
2. Apply the concepts of biomechanical connections underlying cell and tissue biology at the molecular level
3. Apply the knowledge of mechanobiology in designing bioreactors
4. Analyze the existing ethical concerns in regard to tissue regeneration
5. Evaluate the efficacy, limitations and applications of stem cells technology

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION AND SCOPE OF TISSUE ENGINEERING AND REGENERATIVE MEDICINE

The History of Tissue Engineering and current perspectives of Regenerative Medicine, Cell culture; primary cultures & cell lines; cell quantification; cells as therapeutic agents with examples; Growth factors and signals for tissue engineering; extracellular matrix (ECM) (structure, function and applications); typical tissue-engineered device Ethical Issues in Tissue Engineering.

UNIT II **9 Hours**

BIOMATERIALS IN TISSUE ENGINEERING

Biomaterials: Definition, Classification: Polymers, ceramics (biosorbable and bioactive), hydrogels and metallic implants. Surface, Scaffold fabrication and tailoring Biomaterials; physical and chemical properties of materials - mechanical properties of implants. Bulk analysis- FTIR, SEM; Surface analysis - AES. Sterilization techniques: ETO, gamma radiation, autoclaving. Effects of sterilization on material properties.

UNIT III **9 Hours**

BIOREACTORS IN TISSUE ENGINEERING

Establishment of spatially uniform cell distributions on 3D scaffolds; Maintenance of desired nutrient and gas concentrations in the medium; Expose the developing tissue to physical stimuli; Types of bioreactors for tissue engineering applications (Spinner flask bioreactor, Rotating wall bioreactor, Direct perfusion bioreactors, Hollow fiber bioreactor, Hydrostatic pressure bioreactors, Biomimetic bioreactors); bioreactors for various tissues, e.g. cartilage, muscle, tendon, bone and blood vessels.

UNIT IV **9 Hours**

GROWTH FACTOR DELIVERY, STEM CELLS AND GENE TRANSFER IN REGENERATIVE MEDICINE

Growth factor delivery systems; Introduction to stem cells- different types of stem cells, the plasticity of stem cells; cell separation methods and treating cells individually; mesenchymal stem cells, hematopoietic stem cells & tissue-derived stem cells in tissue engineering applications. Gene transfer and its applications in tissue engineering

UNIT V **9 Hours**

TISSUE ENGINEERING APPLICATIONS IN CLINICS

Current clinical applications & research in (with its limitations) - Artificial blood vessels, artificial pancreas, liver, skin, corneal and bone tissue engineering.

Total: 45 Hours

FOR FURTHER READING

Translational Applications in Neurodegenerative Diseases and Tissue-Engineering Approaches to Restore Kidney Function

Reference(s)

1. Atala & R. P. Lanza, Methods of Tissue Engineering, Academic Press, 2002
2. J. P. Fisher, A.G. Mikos and J.D. Bronzino, Tissue Engineering, CRC Press, 2007
3. Ratner, Hoffman, Schoen and Lemons, Biomaterials Science - An Introduction to Materials in Medicine, Academic Press, 1996.
4. V. Yannas, Tissue and Organ Regeneration in Adult, Springer, 2001
5. R. P. Lanza, R. Langer, and W. L. Chick, Principles of Tissue engineering, Academic Press, 1997.
6. W. M. Saltzman, Drug Delivery: Engineering Principles for Drug Therapy, Oxford University Press, 2001

21BT035	BASIC PRODUCTION ON MEDICAL BIOTECHNOLOGY	3 0 0 3

Course Objectives

- Understand the principles and fundamental concepts of medical biotechnology production
- Apply the knowledge of the regulatory requirements and ethical consideration associated with the production of medical biotechnology products
- Analyze the various biotechnological components and techniques employed in medical sciences

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

m.Use the analytical instruments and techniques to separate, purify and characterizebiological compounds

o. Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the regulatory requirements and ethical considerations in medical biotechnology production.
2. Apply critical thinking skills to troubleshoot technical issues and optimize molecular diagnostic assays.
3. Analyze the scientific rationale and evidence supporting the use of specific modern therapeutics for different diseases.
4. Evaluate the scientific literature, clinical trial data, and epidemiological studies related to vaccines and vaccine technologies
5. Evaluate and interpret scientific literature, guidelines, and regulatory requirements in the field of clinical trials.

Articulation Matrix

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

UNIT I **9 Hours**

DRUG DISCOVERY AND DEVELOPMENT

Introduction, worldwide market in medical biotechnology, revolution in diagnosis, changing approaches of therapy, FDA – Organization chart and regulatory measures for drug discovery: Investigational new drug. Drug discovery: Overview, rational drug design, combinatorial chemistry in drug development, computer assisted drug design, role of bioinformatics in genome – based therapy, antisense DNA technology for drug designing.

UNIT II **9 Hours**

MOLECULAR DIAGNOSIS

Biochemical disorders; Immune, Genetic and Neurological disorders; Molecular techniques for analysis of these disorders; Assays for the Diagnosis of inherited diseases; Bioinformatics tools for molecular diagnosis, Antibody based diagnosis; Monoclonal antibodies as diagnostic reagents; Production of monoclonal antibodies with potential for diagnosis; Diagnosis of bacterial, viral and parasitic diseases by using; ELISA and Western blot.

UNIT III **9 Hours**

MODERN THERAPEUTICS

Stem cells in therapy, Gene Therapy: basic approaches to gene therapy, vectors used in gene therapy, applications of gene therapy in cancer, genetic disorders and AIDS. Therapeutic proteins, interleukins, interferon – principle, production and applications. Biotechnological approaches to obtain blood products: Tissue plasminogen activator and erythropoietin. Nutraceuticals- Food derived bioactive peptides. Production of single cell protein. Chiral technology - Principle and applications

UNIT IV **9 Hours**

VACCINES AND VACCINE TECHNOLOGIES

History of vaccines, Conventional vaccines: Bacterial and Viral vaccine. Vaccine based on routes of administration. Minicells as vaccines, impact of genetic engineering on vaccine production. New Vaccine Technologies - Rationally designed vaccines, DNA vaccination, Mucosal vaccination, New approaches for vaccine delivery, Engineering virus vectors for vaccination, Vaccines for targeted delivery systems. Disease specific vaccines: Tuberculosis vaccine, Malaria vaccine, HIV/AIDS vaccine. New Emerging diseases and vaccine needs –Ebola, Zika

UNIT V **9 Hours**

CLINICAL TRAILS AND LICENSING

Clinical trials: Phase I, Phase II, Phase III and Phase IV trail norms, ICMR guidelines for design and conducting

clinical trials, licensing procedure in India, intellectual Property Rights and patents in biotechnology.

Total: 45 Hours

FOR FURTHER READING

Emerging issues: Biotechnology Impact on Society; DNA on the Witness Stand - Use of genetic evidence in civil and criminal court cases; Challenges to Public Policy - To Regulate or Not to Regulate; Improving public understanding of biotechnology products to correct misconceptions.

Reference(s)

1. Pongracz J, Keen M. Medical Biotechnology. First Edition, Churchill Livingstone, Elsevier Publication, UK, 2009.
2. Trivedi PC. Medical Biotechnology, First Edition, Aavishkar Publisher Distrib. Jaipur, India, 2008.
3. Albert Sasson. Medical Biotechnology: Achievements, Prospects and Perceptions. United Nations University Press, 200mu5.
4. Kun LY. Microbial Biotechnology – Principles and applications. World Science publications, 2004
5. Glick BR & Patten CL. Molecular Biotechnology: Principles and applications of Recombinant DNA, Fifth Edition, ASM press, 2017.

21BT036 MOLECULAR THERAPEAUTICS AND DIAGNOSIS 3 0 0 3

Course Objectives

- Introducing students to a new and developing science which involves recombinant DNA technology, protein production and purification, molecular biology and biotechnology.
- students who are interested in exploring possible careers in the science of therapeutics and translational science, whether in academia or industry

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for development.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

m. Use the analytical instruments and techniques to separate, purify and characterizebiological compounds

o. Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the knowledge of recent developments in molecular therapeutics research specifically in the areas of G protein-coupled receptors, transcription factors and molecular drug development.
2. Apply the contribution of recent advances in molecular therapeutics have made (or may make in the future) to human health specifically in the areas of G-protein-coupled receptors, transcription factors and molecular drug development
3. Analyze the in-depth knowledge of recent developments in molecular therapeutics research specifically in the treatment of cancer, immune diseases and pain.
4. Evaluate the concepts of basic biology and chemistry to the science of the discovery of therapeutics and vaccines.
5. Create a background in therapeutic sciences that can help a student prepare for a future career in industr.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

An Historical Perspective on the Clinical Diagnostic Laboratory.Basic Molecular Biology: Nucleic Acid Blotting Techniques: Theory and Practice, The Polymerase Chain Reaction.Bioinformatics: Computer-Based Approaches to Genetic Analysis.

UNIT II **10 Hours**

MOLECULAR DIAGNOSTIC TECHNOLOGIES

PCR-Based Methods for Mutation Detection, Alternative Methods for Mutation Detection and DNA Sequencingfor Disease Association,Microarray Approaches to Gene Expression Analysis, Methods for Analysis of DNA Methylation, Other Clinical Diagnostic Technologies: Flow Cytometry, Medical Cytogenetics, Fluorescence In Situ Hybridization, Immunohistochemistry, Laser Capture Microdissection (FFPE).

UNIT III **7 Hours**

QUALITY ASSURANCE IN THE MOLECULAR DIAGNOSTICS LABORATORY

Framework for Quality Assurance in Molecular Diagnostics, Verification of Molecular Assays, Standards and Standardization of Molecular Diagnostics, Laboratory-Developed Tests in Molecular Diagnostics.

UNIT IV **10 Hours**

APPLICATIONS OF MOLECULAR DIAGNOSTICS

Genetic Diseases, Molecular diagnostics of Coagulation, Cystic Fibrosis; Prenatal Genotyping for Identification of Fetuses at Risk for Immune CytopenicDisorders. Applications of Molecular Diagnostics for Human Cancers. Applications of Molecular Diagnostics for Infectious Diseases, for Identity-Based Testing

UNIT V **10 Hours**

DIAGNOSIS

HLA Typing Using Molecular Methods. Molecular Analysis for Forensic Casework and Parentage Testing, Molecular Assessment of Bone Marrow Transplant Engraftment. Personalized Medicine., Genetic Counseling Considerations in Molecular Diagnosis, Ethical, Social, and Legal Issues Related to Molecular Genetic Testing.

Total: 45 Hours

Reference(s)

1. Molecular Diagnostics: For the Clinical Laboratorian / Edition 2 William B. Coleman (Editor), Gregory J. Tsongalis (Editor) Publisher: Springer-Verlag New York, LLC.
2. Buckingham and Flaw's, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", F.A. Davis Company; First edition, 2007

21BT037 **BIONANOTECHNIQUES** **3 0 0 3**

Course Objectives

- To develop the skills of the student in the area of nano biotechnology and its application
- To familiarize student with different techniques for synthesizing and characterizing of various nanoparticles
- To motivate and facilitate student to undertake the project and research work in nanobiotechnology

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds

n. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sector

Course Outcomes (COs)

1. Apply the profound knowledge in Nanoparticle synthesis and characterization process
2. Apply the suitable methods in the preparation of DNA and peptide nanostructures
3. Analyse the usage of analytical tools in nanobiotechnology
4. Analyse the applications of nanoparticles in drug delivery
5. Evaluate the strategies in the preparation of biomaterials in nanomedicine

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO NANOBIOTECHNOLOGY

Synthesis and Characteristics of nanoparticles; Characterization of Nanoscale materials, Strategies for Nano architecture- bottom up, top down and functional approaches; Quantum dots, Carbon nanotubes- properties, synthesis and application.

UNIT II **9 Hours**

DNA AND PROTEIN BASED NANOSTRUCTURES

DNA-gold particle conjugates; DNA nanostructrures for mechanics and computing; Polymer nanocontainers; Peptide nanotubes and their applications electronics, antibacterial agents, DNA microarrays; Nanobiosensors.

UNIT III **9 Hours**

NANOANALYTICS AND NANO-STRUCTURED MATERIALS

UV-visible spectrophotometer; Particle size analyzer; Zeta sizer; X-Ray Diffractometer, Transmission electron microscopy, Scanning electron microscopy; Energy-dispersive X-ray spectroscopy; Atomic force microscopy; Mass spectroscopy; Fourier transform infrared spectroscopy; X-ray photoelectron spectroscopy, Thermogravimetric analysis

UNIT IV **9 Hours**

NANOPARTICLES IN DRUG DELIVERY

Applications and Hazards of Nanobiotechnology in drug delivery; Polymeric nanoparticles for drug and gene delivery; Liposomes; Micelles for drug delivery; Nanotoxicology- Cyto-toxicity, Geno-toxicity In vivo tests/assays etc.

UNIT V **9 Hours**

NANOMATERIALS AND NANOMEDICINE

Cardiavascular implants,Biomaterials for optamology,Structure, property of Biological Materials: tissues, bones and teeth, collagen rich,tissues, elastic tissues, nanostructured collagen mimics in tissue Engineering. Biopolymers: Preparation of nanobiomaterials Polymeric scaffolds collagen, Elastins:Mucopolysaccharides, proteoglycans, cellulose and derivates; Dextrans; Alginates;Pectins; Chitin, nanosurgery.

Total: 45 Hours

FOR FURTHER READING

Synthesis of nanoparticles bacteria, fungi, yeast and plants, chemical Transformation of Biomaterials. protein self-assembly,nanochips, nanopolymers.instruments for thermal characterization of nanomaterials. Synthesis of nanodrugs, nanocomposites. Nanotechnology in cancer research.

Reference(s)

1. C. M. Niemeyer and C. A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, Weiheim: Wiley-VCH Verlag GmbH and Co. KGaA, 2004
2. T. Pradeep, Nano: The Essentials Understanding Nanoscience and Nanotechnology, New Delhi: Tata McGraw- Hill, 2008.
3. H. S. Nalwa, Encyclopedia of Nanoscience & Nanotechnology, California: American Scientific Publishers, 2004
4. Bhusan, Handbook of Nanotechnology, Berlin, Heidelberg, Germany: Springer-Verlag, 2004
5. P. M. Ajayan, L. S. Schadler, and P. V. Braun, Nanocomposite Science and Technology, Weiheim: Wiley-VCH Verlag, GmbH & Co. KGaA, 2003
6. M. Kohler and W. Fritzsche, Nanotechnology: An Introduction to Nanostructuring Techniques. Weiheim: Wiley-VCH Verlag GmbH & Co. KgaA, 2004.

21BT038 CANCER AND NEUROBIOLOGY 3 0 0 3

Course Objectives

- To Develop in depth knowledge in molecular biology of cancer and brain to Identify different cancer causing agents in our day to day life and potential of neurons.
- To Compute about the diagnosis and prevention of cancer and to Assess the recent techniques in cancer treatment and functional of Neural system.
- To Develop new approaches in the emerging field of computational neurology by implementing the concepts of AI/ML and develop new techniques in identification and mitigation of cancer based on high throughput screening.

Programme Outcomes (POs)

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

m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds.

o.Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the basics of Brain,its neuronal functions and basics of cancer
2. Apply the significance of brain biology in neuroanatomy and physiology and analyze role of signaling pathways in causing cancer
3. Analyze the role of various biomolecules in Neuroscience and also relationship between genes and cancer
4. Evaluate the importance of neurology in cognitive science and the recent advancements in cancer diagnosis
5. Evaluate the emerging computational interventions in Neuroscience and the emerging new strategies for the treatment of cancer.

Articulation Matrix

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

UNIT I **9 Hours**

BIOLOGY OF BRAIN AND CANCER

Brain anatomy and physiology, The neuron: Neurotransmitters and Secondary messengers, Brain Development: Birth of neurons and Brain wiring, Sensation and perception, State of sleep and stress, Neuron Aging Mitosis, Regulation of cell cycle - Check points, Cell proliferation and Apoptosis, Theory and mechanism of carcinogenesis- Chemical, physical & radiation carcinogenesis, Causes of cancer

UNIT II **9 Hours**

NEUROANATOMY AND BIOLOGY OF CANCER

Structure and function of neurons, Synapses, Glial cells, Myelination, Neuronal differentiation and characterization. Resting and Action potential, Voltage dependent channels, Nodes of Ranvier, Effects on receptor, signal switches, signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, mechanism of oncogenes activation, retroviruses and oncogenes, detection of oncogenes; tumor suppressor genes - Rb, p53, APC, BRCA paradigms.

UNIT III **9 Hours**

MOLECULAR NEUROBIOLOGY AND PRINCIPLES OF CANCER METASTASIS

Neuronal Junction: Tight and Gap, Neuropathology: Gap junction perspective, G-protein coupled receptors, Ligand gated Ion channels: nACh Receptors & $GABA_A$ Receptors, Voltage-gated Channels: KcsA Channel & Voltage-Sensitive Chloride Channels, Chemoreceptors, Photoreceptors and mechanoreceptors.Mechanism of spread; Clinical significances of invasion, heterogeneity of metastatic phenotype, basement membrane disruption,

three step theory of invasion, proteinases and tumour cell invasion; Angiogenesis

UNIT IV **9 Hours**

COGNITIVE NEUROLOGY AND DETECTION OF CANCER

Cognition, Neurochemistry of cognition, Cognitive disorders and dysfunctions, Memory disorders, Dementia: Epidemiology and neuropathology & Alzheimer's Disease, Neurosurgery for cognitive disorders.Cancer detection: Detection using biochemical assays and molecular; Different types of tumour markers, tumour imaging and molecular imaging, Gene expression profiling.Diagnostics- Imaging (MRI, PET) &Biopsy.

UNIT V **9 Hours**

COMPUTATIONAL NEUROSCIENCE AND CANCER THERAPY

Dynamical systems and its types, Basic notation and techniques, Molecular dynamics & Brownian dynamics, Single neuron modelling, Artificial Intelligence and Machine learning in Computational Neurology. Therapy forms surgery, chemotherapy &radiation, Hyperthermia and magnetic hyperthermia;New approaches of cancer therapy: Monoclonal antibodies, vaccines, gene therapy, Stem cell therapy

Total: 45 Hours

FOR FURTHER READING

Behaviour Science, Control of feeding, sleep, hearing and memory; Disorders associated with the nervous system

Reference(s)

1. Eric R. Kandel. *Principles of Neural Science*. (2000).
2. Smith, Christopher U. M. *Elements of molecular neurobiology*. (J. Wiley, 2002).
3. Husain, M. & Schott, J. M. *Textbook of Cognitive Neurology and Dementia*. (2016).
4. Abbott, L. *Theoretical Neuroscience*. (2000).
5. Purves, D. *Neuroscience, 3rd Edition*. (2004).
6. Jian Feng. *Computational Neuroscience a Comprehensive Approach*. (2004).
7. Baars, B. J. & Nicole Gage. *Cognition, Brain, And Consciousness Second Edition*. (2010).
8. Robin A. Murphy & Robert C. Honey. *Handbook on the Cognitive Neuroscience of Learning*. (2016).
9. Mark D' Esposito. *Neurological Foundations of Cognitive Neuroscience*. (2003).

21BT039 HUMAN GENETICS 3 0 0 3

Course Objectives

- Impart the principle and pattern of segregation of genes and its characters
- Gain knowledge about the mechanism of crossing over, linkage of genes and identification of genetic material
- Learn about genetic material and genetic transfer
- Gain an insight on mutations and inheritance of various genetic conditions
- Enlighten the students about evolutionary genetics

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

o. Conceive, Plan and Deploy societal projects for environmental protection using Bioresources.

Course Outcomes (COs)

1. Apply the principles of Mendel's experiment, pattern of segregation of genes and its characters
2. Analyze the mechanism of sex determination, linkages and crossing over
3. Analyze and understand the variation in chromosomal patterns occurring at evolution and speciation
4. Analyze and apply the chromosomal Inheritance in life forms
5. Evaluate the genetic basis of normal and abnormal functioning of human body

Articulation Matrix

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

UNIT I **9 Hours**

MENDELIAN GENETICS AND BASICS OF HUMAN GENETICS

Mendel's study of heredity – Monohybrid crosses and Dihybrid crosses; The Punnett square methods; The Chi-square test; Mendelian segregation in human families; Allelic variation and Gene function; Law of segregation Law of independent assortment; History of Human Genetics; Pedigrees- gathering family history, pedigree symbols, construction of pedigrees; Monogenic traits - Autosomal inheritance-dominant and recessive

UNIT II **9 Hours**

CHROMOSOMAL BASIS OF INHERITANCE

Sex Chromosomes and determination in Drosophila and human, X linked genes, Pedigree analysis; linkage and crossing over; Cytogenetics – Techniques, polyploidy and aneuploidy. Non-Mendelian inheritance; Genetic and Physical mapping; heredity and environment (twin studies).

UNIT III **9 Hours**

MOLECULAR GENETICS

Human gene therapy; DNA fingerprints in forensic applications; Human genome project; Reverse Genetics: Antisense RNA; Transposable elements in humans; RNA interference; Activation and inactivation of whole chromosomes.

UNIT IV **9 Hours**

CLINICAL GENETICS

Muscle genetic disorders, mitochondrial syndromes, Genetic disorders of eye.

UNIT V **9 Hours**

MOLECULAR GENETICS

Genetic basis of male and female inferitilty, Diagnostic Molecular Genetics, Neurogenetic disorders

Total: 45 Hours

FOR FURTHER READING

Genetics in agriculture and medicine, Reverse Genetics, Genetics basis of cancer.

Reference(s)

1. M.J. Simmons and. D.P. Snustad, Principles of Genetics, John Wiley, 2012
2. EJ Mongia and AP Mongia, Basic Human Genetics , Sinauer Associates Inc.,U.S. 1993.
3. E.J. Gardner, M.J. Simmons and. D.P. Snustad, Principles of Genetics, John Wiley, 2006
4. H.T. Robert, Principles of Genetics, Tata McGraw Hill, 2002
5. L. Daniel, Hartl and W. Elizabeth, Essential Genetics, Jones and Bartlett publishers, Massachusetts, 2002.

21BT040 VACCINE TECHNOLOGY 3 0 0 3

Course Objectives

- To study the various forms of vaccines
- To learn the techniques of vaccine production and their delivery methods
- To give an exposure on the regulatory and biosafety measures of vaccine

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering

n. Design and synthesis of the novel biomolecule for the agriculture and healthcaresector

o. Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the principle of vaccination for immunization processes
2. Apply the types of vaccines and their applications
3. Analyze the vaccine purification, preservation and formulation techniques
4. Analyze the advanced methods of vaccine delivery
5. Evaluate the quality measures and regulatory issues concerned with vaccine production

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Vaccines - definition, History of vaccine development, requirements for immunity, Basics of immunization- Epitopes, linear and conformational epitopes, characterisation and location of APC, MHC and immunogenicity; immunization programs and role of WHO in immunization programs

UNIT II **9 Hours**

TYPES AND METHODS OF APPLICATION

Active and passive immunization; Viral/bacterial/parasite vaccine differences, methods of vaccine preparation - Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, edible vaccines, reverse vaccinology, combination vaccines, therapeutic vaccines; Peptide vaccines,conjugate vaccines; Cell based vaccines. Uses of nanoparticles in vaccine application. Reverse Vaccinology.

UNIT III **9 Hours**

TECHNIQUES IN VACCINE PRODUCTION

Purification, preservation and formulation techniques. Commercial production of DPT, TT, polio, rabies and hepatitis vaccines.

UNIT IV **9 Hours**

DELIVERY METHODS

Needle free Vaccine delivery, ISCOMS, Adjuvant delivery systems, Intranasal and inhaled vaccine delivery, liquid jet and solid dose injectors, development of gene-based vectors.

UNIT V **9 Hours**

REGULATORY AND BIOSAFETY MEASURES

Quality assurance in vaccine production. Regulatory issues - Environmental concerns with the use of recombinant vaccines - Disease security and biosecurity principles and OIE guidelines.

FOR FURTHER READING

Principles of vaccination, Peptide vaccines, Commercial production of malarial vaccine, Delivery of immunogens through microsperes, Biosafety aspects of vaccine production.

Total: 45 Hours

Reference(s)

1. P. Ramadass, Animal Biotechnology - Recent concepts and Developments, MJP Publications, 2008.
2. T. J. Kindt, R. A. Goldsby, B. A. Osborne and J. Kuby, Kuby Immunology, W.H. Freeman & company, 2007.
3. S. A. Plotkin, W. A. Orenstein and P. A. Offit, Vaccines, W B Saunders Company, 2012.
4. Cheryl Barton, Advances in Vaccine Technology and Delivery, Espicom Business Intelligence, 2009.
5. Ronald W. Ellis, New Vaccine Technologies, Landes Bioscience, 2001.

21BT041 **BIOPHARMACEUTICS AND ITS BIOSIMILARS** **3 0 0 3**

Course Objectives

- Introduction to Pharmacokinetics and Pharmacodynamics.
- Expose students to the importance of biosimilar and generic drugs.
- Build a deeper understanding of the application of biotechnology tools in the world of medicine.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and cultural, societal, and environmental considerations.

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

n. Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors

Course Outcomes (COs)

1. Apply the basic concepts of drugs & biosimilar and to differentiate generic from branded drugs and biosimilars.
2. Apply the need for biosimilar in Indian and Global scenarios and also regarding the drug patents.
3. Analyze the knowledge of pharmacokinetic models and parameters to describe the process of drug absorptionand distribution.
4. Analyze the knowledge of pharmacokinetic models and parameters to describe the process of drug metabolismand elimination.
5. Evaluate the dosage regimens of the drugs using pharmacodynamics parameters and evaluate the drugperformance based on bioavailability and bioequivalence.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO BIOGENERICS

Definition: Drug, Generics and its advantages, Biogenerics and Biosimilar, Generic vs Branded, Biosimilar vs Generic, Protein-based biopharmaceuticals, Manufacturing processes, Industries dealing with biogenerics and its market value, Indian Market and Global Market.

UNIT II **9 Hours**

INTRODUCTION TO BIOSIMILARS

Introduction to biologics and biosimilar, Applicable Regulations and Guidelines, Principles for Development of Similar Biologics, Data Requirements for Preclinical Studies, Clinical Trial Studies and for Post Market Surveillance, Pharmacovigilance, GMP.

UNIT III **9 Hours**

FUNDAMENTAL ON DRUG ABSORPTION AND DISTRIBUTION

Introduction to Pharmacokinetics, Drug Absorption - Mechanisms of drug absorption through GIT, factors influencing drug absorption though GIT, Drug Distribution -Tissue permeability of drugs, binding of drugs, volume of drug distribution, plasma and tissue protein binding of drugs, factors affecting protein-drug binding.

UNIT IV **9 Hours**

FUNDAMENTAL ON DRUG METABOLISM AND ELIMINATION

Drug Metabolism - Biotransformation of drugs, Phase I and Phase II reactions - pathways and enzymes of drug metabolism, factors affecting the metabolism of drugs. Drug Excretion - Basic understanding of excretory pathways – renal and non-renal routes, factors affecting renal excretion of drugs

UNIT V **10 Hours**

DRUG PRODUCT PERFORMANCE AND PHARMACODYNAMICS

Bioavailability and Bioequivalence: Definition and Objectives of bioavailability, absolute and relative bioavailability, measurement of bioavailability, bioequivalence studies, methods to enhance the dissolution rates and bioavailability of poorly soluble. Pharmacodynamics - Definitions – agonist/antagonist, antagonism as a mechanism of drug action, classification of antagonists, drug-receptor interactions, factors affecting drug-target interactions, quantifying drug-target interactions: dose-response relationships - graded dose and quantal dose-responses.

Total: 45 Hours

Reference(s)

1. Biopharmaceutics and Clinical Pharmacokinetics by Milo Gibaldi, 4th edition, Philadelphia, Lea and Febiger, 1991.
2. Biopharmaceutics and Pharmacokinetics, A. Treatise, D .M. Brahmankar and Sunil B. Jaiswal., Vallab Prakashan, Pitampura, Delhi.
3. Gary Walsh, Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley & Sons, Inc., 2nd Edition, 2003.
4. Rodney J. Y. Ho, Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, John Wiley & Sons, Inc., 2nd Edition, 2013.
5. Textbook of Biopharmaceutics and Pharmacokinetics, Dr. Shobha Rani R. Hiremath, Prism Book.
6. Oliver Kayser and Heribert Warzecha, Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, John Wiley & Sons, Inc., 2nd Edition, 2012.

21BT042 **CLINICAL TRIALS AND HEALTHCARE POLICIES IN BIOTECHNOLOGY** **3 0 0 3**

Course Objectives

- To learn the basics of clinical trails and regulatory
- To understand the biotechnology national policies
- To analyze the national and international policies in biotech practices

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
o. Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the clinical trails and its organizatiom.
2. Apply the clinical research and its regulatories
3. Analyze the biotechnology national policies
4. Analyze the biotechnology global practice
5. Evaluate the international policies for biotechn

Articulation Matrix

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

UNIT I **9 Hours**

CLINICAL TRIALS - OVERVIEW AND ORGANIZATIONS

Clinical Trial - Definitions and usage of ethical practice; Phases of clinical trials and practice; Organizations for ensuring ethical clinical practice in India; Central Drugs Standard Control Organization - role and importance in clinical trials; Drugs Controller General of India - Overview and responsibility; Indian Council of Medical Research - roles and responsibilities; Research funds regulation for clinical trials.

UNIT II **9 Hours**

CLINICAL TRIALS - REGULATORY REQUIREMENTS

Acts related to Biotechnology and Pharmaceutical sector: Drugs and Cosmetics act (1940) - Rules (1945) - Ethical Guidelines of ICMR (2006) - Good Clinical Practice Guideline (2001) - Regulatory changes in Indian landscape - 2005 - 2016); Regulatory requirements for ccase studies.

UNIT III **9 Hours**

BIOTECHNOLOGY NATIONAL POLICIES

Clinical trial in India - Definitions - conduct - research - approval - registration - reports -
Building Capacities – A Skilled Workforce And Strengthened State Of The Art Infrastructure; Unati Biotech Missions – Aligned With National And Global Priorities -Building A Self-Reliant India (Atmanirbhar Bharat) Through Biotech Interventions – Affordable And Accessible Products And Technologies A. Moving Technology From Lab To Market B. Scaling The Innovation Ecosystem.

UNIT IV **9 Hours**

BIOTECHNOLOGY GLOBAL PRACTICE

Leveraging The Strength Of Strategic Partnerships – National And International; Preparing For The Future – Building The Knowledge Base; Taking Science To Society – Empowering The Rural Sector; Effective Outreach And Communication– Building The Public Trust; Global Benchmarking And Performance Measurement – A Measurement Matrix To Build Quality; Policy Enablers.

UNIT V **9 Hours**

INTERNATIONAL POLICIES FOR BIOTECHNOLOGY PRACTICE

U.S. Food & Drug Administration: Agency responsible for enforcing laws and policies on food, drugs, medical devices in the U.S.; US Centers for Medicare & Medicaid Services -Information on Medicare and Medicaid enrollment, coverage, reimbursement policies, etc

Total : 45 Hours

Reference(s)

1. https://www.google.co.in/books/edition/Pharmaceutical_Biotechnology/A_VWwihjS1AC?hl=en&gbpv=1&dq=clinical+trials+regulations+in+biotechnology+book&printsec=frontcover
2. https://www.google.co.in/books/edition/Drugs/h09_BwAAQBAJ?hl=en&gbpv=1&dq=clinical+trials+regulations+in+biotechnology+book&printsec=frontcover
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5372399/
4. https://dbtindia.gov.in/sites/default/files/NATIONAL%20BIOTECHNOLOGY%20DEVELOPMENT%20STRATEGY_01.04.pdf
5. https://libguides.mit.edu/c.php?g=175946&p=1160854

21BT43 BIOTECH PRODUCTS AND ITS VALIDATION 3 0 0 3

Course Objectives

- To understand the significance of biological resources and its role in product formulation
- To understand about validation and how it can be applied to industry and thus to improve the quality of the products.
- To describe the complete information about validation, types, methodology and application.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

n. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

o. Conceive, Plan and Deploy societal projects for environmental protection using Bio-resources.

Course Outcomes (COs)

1. Apply the importance of bio resources in product formation
2. Analyze the aspect of validation
3. Apply the knowledge of validation to instruments and equipments
4. Apply the validation of manufacturing processes
5. Evaluate the manufacturing facilities

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

Definition of Qualification and Validation, Advantage of Validation, Streamlining of Qualification &Validation process and Validation Master Plan.

UNIT II **10 Hours**

QUALIFICATION

User Requirement Specification, Design Qualification, Factory Acceptance Test (FAT)/ Site Acceptance Test (SAT), Installation Qualification, Operational Qualification, Performance Qualification, Re – Qualification (Maintaining status-Calibration Preventive Maintenance, Change management),Qualification of Manufacturing Equipments, Qualification of Analytical Instrumentsand Laboratory equipments..

UNIT III **9 Hours**

QUALIFICATION OF ANALYTICAL INSTRUMENTS

Electronic balance, Ph meter, UV-Visible spectrophotometer, FTIR, GC, HPLC, HPTLC Qualification of Glassware: Volumetric flask, pipette, Measuring cylinder, beakers and burette.

UNIT IV **10 Hours**

VALIDATION OF UTILITY SYSTEMS:

Pharmaceutical Water System &pure steam, HVAC system, Compressed air and nitrogen. CleaningValidation: Cleaning Validation – Cleaning Method development, Validation and validation of analytical method used in cleaning. Cleaning of Equipment, Cleaning of Facilities. Cleaning in place (CIP).

UNIT V **8 Hours**

ANALYTICAL METHOD VALIDATION

General principles, Validation of analytical method as per ICH guidelines and USP

FOR FURTHER READING

Manufacturing records, electronic data in GMP, Data integrity, Proof of product quality, product tracking.

Total : 45 Hours

References

1. Validation Master plan by Terveeks or Deeks, Davis Harwood International publishing.
2. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider
3. Analytical Method validation and Instrument Performance Verification by Churg Chan, Heiman Lam, Y.C. Lee, Yue. Zhang, Wiley Inter Science.

21BT044 QA AND QC IN BIOTECHNOLOGY 3 0 0 3

Course Objectives

- To understand the quality management system followed in biotech industries
- To demonstrate the knowledge of quality assurance and regulatory
- To analyze the quality control systems and FDA regulations in biotechnology

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
o. Conceive, Plan and Deploy societal projects for environmental protection usingBioresources.

Course Outcomes (COs)

1. Apply the GMP and GLP concepts in biotechnology industry.
2. Apply the quality management system in biotechnology industries
3. Analyze the test and evaluate the quality of materials or finished products.
4. Evaluate and calibrate laboratory or technical equipment
5. Create the documentation related to legal or regulatory matters

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to bio products and quality; Concept and evolution and scopes of Quality Control and Quality Assurance for drugs and biologics, Good Laboratory Practice, GMP, Definitions, Overview of ICH Guidelines, CPCSEA guidelines.

UNIT II **9 Hours**

QUALITY MANAGEMENT SYSTEM IN BIOTECH INDUSTRIES

Definitions-QMS in biotech industries; Essential components of QMS-Document management, Reporting management, Inspection management, Audit management, Learning management, Product life cycle management; Practice of QMS in biotech industries; Validation services; Quality Management software tools-applications in biotech and biopharma industries.

UNIT III **9 Hours**

QUALITY ASSURANCE IN BIOTECH

QA – Definition, fundamentals, importance of QA in biotech industries; QA's responsibilities; QA checklists, Methods-Failure testing, Statistical process control (SPC), Total quality management-concepts, principles, tools & techniques; QA standards, career opportunities of quality assurance in biotechnology industries.

UNIT IV **9 Hours**

QUALITY CONTROL IN BIOTECH

QC-Definitions, terminologies in QC, fundamentals, importance of QC in biotech industries, QC's responsibilities; QC procedures-Batch inspection, Sampling, Validation, Laboratory testing-analytical method, compendial and Non-compendial methods; FDA regulations and ICH regulations; career opportunities of quality control in biotechnology industries.

UNIT V **9 Hours**

REGULATIONS OF BIOLOGICS

Regulatory affairs-Introduction, history, terminologies, Biologics product categories; FDA Regulations-role, guidelines ; Biologics product approvals & clearance-submitting application, purple book, BPCI Act; Approval pathways- characterization, biologics quality activities.

FURTHER READING

FDA Enforcement, regulations of food & other products.

Total: 45 Hours

Reference(s):

1. Quality Assurance & Regulatory Affairs for the Bioscience-Austin community college-2021-Jack Grady.

2.Biotechnology:Quality Assurance and Validation(Drug Manufacturing Technology Book)- CRC Press-2020 -Kenneth E. Avis , Carmen M. Wagner, Vincent L. Wu

3. Quality control Training Manual-CRC press- -2011-Syed Imtiaz haider-Erfan Asif Syed

21BT045 **PATENT DESIGN, IPR IN BIOTECHNOLOGY AND BIOENTREPRENEURSHIP** **3 0 0 3**

Course Objectives

- To inculcate the entrepreneurship skill among the student community by converting their research ideas into commercial product
- To demonstrate the knowledge of entrepreneurship skill in biotechnology
- To study the patent design and technology transfer

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
o. Conceive, Plan and Deploy societal projects for environmental protection using Bioresources **Course**

Outcomes (COs)

1. Apply entrepreneurship skills to convert their research ideas into commercial products
2. Analyze the history of pioneer biotech companies and start effective biotech venture
3. Analyze the functions of business models to transfer technology from laboratory into market
4. Evaluate the effectiveness of business plan through feasible business strategies
5. Evaluate the importance of Intellectual property rights to protect the biotechnology inventions

Articulation Matrix

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

UNIT I **9 Hours**

FORMS OF PATENT

Introduction to Patents; Types of patent applications: Ordinary,, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of Prior art; Patentdatabases; Searching International Databases; Country-wise patent searches.

UNIT II **9 Hours**

PATENTING PROCEDURES

National and Patent Cooperation Treaty filing procedure; Time frame and cost; Status of the Patent applications filed; Precautions while patenting - disclosure/non-disclosure; Financial assistance forpatenting, Existing schemes, Patent licensing and agreement Patent infringement meaning, scope, litigation, case studies.

UNIT III **9 Hours**

INTELLECTUAL PROPERTY RIGHTS

Types of Intellectual property: Patents, Trademarks, Copyright and Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs, IP as a factor in R&D; IPs ofrelevance to Biotechnology Agreements and Treaties. History of GATT and TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty IndianPatent Act 1970 and recent amendments Case Studies

UNIT IV **9 Hours**

INTRODUCTION AND COMPONENTS OF A BIOTECH COMPANY

Entrepreneurship, Definition; Factors necessary for Entrepreneurship, Attributes in an Entrepreneur, Bioentrepreneurship; Indicators of Bio entrepreneurship. Paths for starting new Biotech ventures, History of establishment of pioneer biotechnology companies, Key for success, Mission and Strategy, product selection for new Biotech venture

UNIT V **9 Hours**

BUSINESS PLAN, BUSINESS STRATEGIES AND TECHNOLOGY TRANSFER

General considerations, Business plan – Doe's and don't'ts, How to write Business proposal, Checklist for Business proposal writing, Intellectual property in biotech - Licensing, Accessing University technology, Licensing of Biotechnological invention.

FURTHER READING

Building of a Bioentrepreneur, Successful Bioentrepreneur in India., Product Model,Deficiencies in start up Business Plan, Funding agencies in India

Total: 45 Hours

Text Book(s)

FOR FURTHER READING

GMOs, Biosafety Committee, GATT and TRIPS Agreement, WIPO Treaties

Reference(s):

1. S. N. Jogdand, Entrepreneurship and Business of Biotechnology, Himalaya Publishing Home, 2007.
2. R Oliver, The coming biotech age: The business of biomaterials. New York: McGraw Hill, 2000
3. S. Shaleesha. Bioethics, Wisdom educational service, Chennai, 2008.

21BT046 **BIOSAFETY AND HAZARD MANAGEMENT** **3 0 0 3**

Course Objectives

- Identify potential hazardous biological materials and the risks associated with them.
- Select appropriate means to minimize risk and to protect against or prevent exposure.
- Recognize applicable legal requirements and prepare the necessary documents to obtain authorizations.
- Understand how to run a biorisk management program

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
m. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
o. Conceive, Plan and Deploy societal projects for environmental protection using Bioresources

Outcomes (COs)

1. Apply the insight into Biosafety guidelines
2. Analyze and Manage the Risks involved with GMOs
3. Analyze the International Agreements and Regulations with respect to Biosafety
4. Apply and gain Knowledge of working principles in a laboratory taking all safety measures,
5. Evaluate and handle the live cultures, disposal of infectious waste, care of the equipment requiring safety audit

Articulation Matrix

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

UNIT I **9 Hours**

NEED FOR BIOSAFETY

Introduction; the history and incidence of laboratory-acquired infections (LAI) ,incidents of secondary transmission from the laboratory, Outline the types of laboratory accidents leading to LAIs, Explain the role of

aerosols in LAIs, Illustrate the importance of biosafety and biocontainment in minimizing the risk of LAIs

UNIT II **9 Hours**

RISK ANALYSIS

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 firefire ball

UNIT III **9 Hours**

QUALITY CHECKS & BIOSAFETY GUIDELINES

Implementation of safety procedures – periodic inspection and replacement; Accidents -identification and prevention; promotion of industrial safety; Biosafety guidelines – Government of India; Definition of GMOs and LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMO

UNIT IV **9 Hours**

HAZARDOUS OPERATIONS AND SAFETY AUDITS

Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system. Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras- Vizag Bopal analysis

UNIT V **9 Hours**

BIOCONTAINMENT AND CERTIFICATION

Describe the progression of building a new biocontainment laboratory from conceptualization through to certification. Outline the concepts to be addressed during the laboratory programming phase, architectural and engineering biocontainment features, key security features and control systems, commissioning and certification process and understand the difference between them

FURTHER READING

NIH guidelines for research involving recombinant or synthetic nucleic acid molecule
Control of communicable diseases manual 20th Edition

Total: 45 Hours

Text Book(s):

1. Fawatt, H.H. and Wood, W.S., Safety and Accident Prevention in Chemical Operation, Wiley Interscience, 1965.
2. Biosafety in Microbiological and Biomedical Laboratories, 5th ed. 2009
3. Biological Safety, Principles and Practices, 4th ed. (Fleming and Hunt) ASM Press 2006
4. Collins, C.H., and Kennedy, D.A. Laboratory-acquired infections. In: Laboratory acquired infections: history, incidence, causes and preventions. Oxford, UK: Butterworth-Heinemann, 1999;1-37.
5 .Hyatt, N., Guidelines for process hazards analysis, hazards identification and risk analysis, Dyadem Press, 2004.

Reference(s):

1. Handley, W., Industrial Safety Hand Book , 2nd Edn., McGraw-Hill Book Company,1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., Industrial Accident Prevention, McGraw-Hill Book Co., 1980.
3. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prentice Hall, NJ, 1990.
4. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

21BT047 **GOOD MANUFACTURING PRACTICES** **3 0 0 3**

Course Objectives

- To develop in depth knowledge in concepts of Good Manufacturing Practice
- To describe quality assurance, design of quality systems, risk analysis and risk assessment
- To describe new standards in production under GMP and preparation of monographs, standard operating procedure, SOP, batch protocols quality control.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

n. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

o. Conceive, Plan and Deploy societal projects for environmental protection using Bio-resources.

Course Outcomes (COs)

1. Apply profound knowledge in basic concepts of Good Manufacturing Practice
2. Analyze the role of microbiological quality control in aseptic production
3. Analyze the relationship between risk analysis and hazard
4. Evaluate the recent advancements in design of quality systems
5. Evaluate the emerging new strategies for the aseptic productionand analysis of protocols

Articulation Matrix

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

UNIT I **9 Hours**

FUNDAMENTALS

Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP), Historic Events and Milestones in the Development of GMP, Components & Principles of cGMP.

UNIT II **9 Hours**

QUALITY CONTROL

Quality control introduction.In process quality control, Sampling procedures of product and equipmentin biopharmaceuticals industries, Microbiological test and air quality control in Aseptic productionlocalities, Personal hygiene,clothing&gowning,clean room entry exit procedures.Cleaning and sanitation, Housekeeping.

UNIT III **9 Hours**

QUALITY ASSURANCE

Quality assurance introduction, Principles for documentation in GMP, Risk analysis and Risk assessment.Near miss, Deviation investigation& report - Corrective and Preventive Actions. SOP framing. Regulatory compliance - FDA regulations, EU directives Certification systems - ISO 22000:2009.

UNIT IV **9 Hours**

DESIGN OF QUALITY SYSTEMS

Introduction to Cleanroom - types, Basic clean room design requirements and considerations, equipment, and personnel flow in cleanrooms. AHU, HVAC systems in cleanrooms. Classification of cleanrooms in terms of air quality.

UNIT V **9 Hours**

PROCESS VALIDATION& MAINTANENCE

Qualification Procedures (IQ, OQ & PQ), Process validation introduction - concept, Cleaning in place, Sterilization in place, Fumigation. - Equipment cleaning validation. Preventive maintenance, Equipment Maintenance & Calibration tracking

FOR FURTHER READING

Manufacturing records, electronic data in GMP, Data integrity, Proof of product quality, product tracking.

Reference(s)

1. Graham P. Bunn, Good Manufacturing Practices for Pharmaceuticals, 2019
2. Ramkumar Dubey, Manohar A Potdar, CGMP Current Good Manufacturing Practices for Pharmaceuticals, 2019
3. B. N. Cooper, Good Manufacturing Practices for Pharmaceuticals, 2017
4. W. Whyte, Clean room Technology: Fundamentals of Design, Testing and Operation, 2001
5. Gail Sofer, Anurag Rathore, Process Validation in Manufacturing of Biopharmaceuticals: Guidelines, Current Practices, and Industrial Case Studies, 2000
6. Dale A. Siberling, Clean-In-Place for Biopharmaceutical Processes, 2007

PHYSICS ELECTIVES

18GE0P1 NANOMATERIALS SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on Nanoscience
- Explore different techniques of producing nanomaterials
- Create expertise on the applications of nanomaterials in various fields

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Summarize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Explain the physical properties exhibited by nanomaterials
5. Organize the nanomaterials developed for advanced technological applications

Articulation Matrix

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

UNIT I **9 Hours**

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future -classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -differences between bulk and nanomaterials and their physical properties.

UNIT II **9 Hours**

NANOMATERIALS SYNTHESIS METHODS

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process - physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

UNIT III **9 Hours**

CHARACTERIZATION TECHNIQUES

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

UNIT IV **9 Hours**

SEMICONDUCTOR NANOSTRUCTURES

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes- structure, synthesis and electrical properties -applications- fuel cells - quantum efficiency of semiconductor nanomaterials

UNIT V **9 Hours**

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- organic LED: basic processes, carrier injection, excitons, optimization - organic photovoltaic cells- particulate and geometrical nanomagnets-magneto resistance.

Total: 45 Hours

Reference(s)

1. Willam A. Goddard, Donald W.Brenner, "Handbook of Nanoscience, Engineering, and Technology", CRC Press, 2012
2. Charles P. Poole Jr and. Frank J. Owens, "Introduction to Nanotechnology", Wiley Interscience, 2007
3. Guozhong Cao, Y. Wang, "Nanostructures and Nanomaterials-Synthesis, Properties & Applications", Imperials College Press, 2011.
4. T. Pradeep, "NANO: The Essentials Understanding Nanoscience and Nanotechnology", McGraw - Hill Education (India) Ltd, 2012
5. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley and Sons Ltd, 2006
6. Viswanathan B, Aulice Scibioh M, "Fuel cells: Principles and Applications", University Press, 2009.

18GE0P2 SEMICONDUCTOR PHYSICS AND DEVICES 3 0 0 3

Course Objectives

- Impart knowledge in physical properties of semiconducting materials
- Analyze the factors affecting the operation of semiconductor devices
- Apply the physics of semiconductors to develop semiconductor devices

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Exemplify the band gap, drift and diffusion current densities due to carrier transport in semiconductors
2. Analyze the energy band diagram in thermal equilibrium and space charge width of PN junction
3. Illustrate the operation of Bipolar Junction transistor at different modes and different configurations
4. Illustrate the operation of metal oxide field effect transistor and their memory devices
5. Represent the working mechanism of opto-electronic devices

Articulation Matrix

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

UNIT I **9 Hours**

ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES

Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density

UNIT II **9 Hours**

P-N JUNCTION

Basic structure and fabrication process of p-n junction - current - voltage characteristics - energy band diagram - equilibrium Fermi levels - depletion region - junction breakdown phenomena - zener - avalanche breakdown.

UNIT III **9 Hours**

BIPOLAR JUNCTION TRANSISTOR

The basic transistor action - operation in the active mode - current gain - static characteristics - carrier distribution in emitter, base and collector region - modes of operation - current - voltage characteristics of common base and emitter configuration - frequency response and switching of bipolar transistor

UNIT IV **9 Hours**

MOSFET

The ideal MOS diode - basic fundamentals and characteristics - types - CMOS and BiCMOS - CMOS inverter - MOSFET on insulator - thin fil m transistor (TFT) - silicon on insulators (SOI) devices - MOS Memory structures - DRAM and SRAM

UNIT V **9 Hours**

PHOTONIC DEVICES

Radiative transitions and optical absorption-light emitting diodes-organic LED - infrared LED - semiconductor laser - temperature effect - photo detector - photo diode - silicon and compound semiconductor solar cells - efficiency

Total: 45 Hours

Reference(s)

1. Donald A Neamen, "Semiconductor Physics and Devices", Tata McGraw Hill, 2012
2. S. M. Sze and M. K. Lee, "Semiconductor Devices, Physics and Technology", John-Wiley & Sons, 2015
3. Ben. G. Streetman and S. K. Banerjee , "Solid State Electronic Devices", Pearson Education Ltd, 2015
4. C. Kittel, "Introduction to Solid State Physics", John-Wiley & Sons, 2012
5. J. Millman and C. Halkias, "Electronic Devices and Circuits", Tata McGraw Hill, 2010
6. Hagen Klauk, "Organic Electronics: Materials, Manufacturing and Applications", Wiley-VCH, 2006

18GE0P3 APPLIED LASER SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Illustrate the transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

Articulation Matrix

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

UNIT I **9 Hours**

LASER FUNDAMENTALS

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion. Components of lasers - pumping methods - pumping mechanisms - optical resonator

UNIT II **9 Hours**

LASER BEAM CHARACTERISTICS AND TYPES

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homojunction laser).

UNIT III **9 Hours**

LASERS IN SCIENCE

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement - holography

UNIT IV **9 Hours**

LASERS IN MEDICINE AND SURGERY

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

UNIT V **9 Hours**

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting. Lasers in electronics industry: information storage - bar code scanner. Lasers in defence: laser based military weapons - laser walls.

Total: 45 Hours

Reference(s)

1. K. Thiyagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015
2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013
3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006
4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009
5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006
6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006.

CHEMISTRY ELECTIVES

18GE0C1 CORROSION SCIENCE AND ENGINEERING 3 0 0 3

Course Objectives

- Understand the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism.
- Apply various methods of corrosion control, corrosion testing and monitoring.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. calculate the rate of corrosion on metals using electrochemical methods of testing
5. propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

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

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages.

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion. Catastrophic oxidation corrosion.

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filliform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces.

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing and eddy current testing.

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control.

FOR FURTHER READING

Corrosion issues in supercritical water reactor (SCWR) systems.

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, Introduction to Corrosion Engineering, CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, Corrosion Engineering, Tata McGraw Hill, Singapore, 2008.
5. David E.J. Talbot (Author), James D.R. Talbot, Corrosion Science and Technology, Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. http://corrosion-doctors.org/Corrosion-History/Eight.htm

18GE0C2 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- Understand the concept, working of different types of batteries and analyze batteries used in electric vehicles.
- Identify the types of fuel cells and to relate the factors of energy and environment.
- Analyze various energy storage devices and fuel cells.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Explain the parameters required for operation of a cell to evaluate the capacity of energy storage devices
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications
3. Differentiate fuel cells based on its construction, production of current and applications
4. Compare different methods of storing hydrogen fuel and its environmental applications
5. Relate energy and environmental based on the importance and types of renewable energy for sustainable development

Articulation Matrix

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

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid batery - charge efficiency- charge rate - charge retention - closed circuit voltage, open circuit voltage current density - cycle life - discharge rate-over charge-over discharge.

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries - zinc-carbon, magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries - introduction, cell reactions, cell representations and applications - lead acid, nickel-cadmium and lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide, lithium anode cell, photogalvanic cells. Battery specifications for cars and automobiles.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells - description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate and direct methanol fuel cells.

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen - electrolysis - photocatalytic water splitting - methods of hydrogen storage- high pressurized gas - liquid hydrogen type - metal hydride - hydrogen as engine fuel - features, application of hydrogen technologies in the future - limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second third and fourth generation solar cell - photobiochemical conversion cell.

FOR FURTHER READING

Energy conservation, over utilization, energy demanding activities.

Total: 45 Hours

Reference(s)

1. M. Aulice Scibioh and B. Viswanathan, Fuel Cells: Principles and Applications, University Press, India, 2009.
2. F. Barbir,PEM fuel cells: Theory and practice, Elsevier, Burlington, MA, Academic Press, 2013.
3. M. R. Dell Ronald and A. J. David, Understanding Batteries, Royal Society of Chemistry, 2001.
4. J. S. Newman and K. E. Thomas-Alyea, Electrochemical Systems, Wiley, Hoboken, NJ, 2012.
5. Shripad T. Revankar, Pradip Majumdar, Fuel Cells: Principles, Design, and Analysis, CRC Press, 2016.
6. Thomas B. Reddy, Linden's Handbook of Batteries, 4th Edition, McGraw Hill Professional, 2010

18GE0C3 POLYMER SCIENCE 3 0 0 3

Course Objectives

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers and its processing
- identify suitable polymers for various industrial applications

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Characterize the polymers to identify the structural, thermal ,mechanical and electrical features for specific applications
4. Apply the polymer processing methods to design polymer products
5. Identify and analyze the polymers used in electronic and biomedical applications

Articulation Matrix

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

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization – copolymerization - condensation polymerization (nylon-6,6) -ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides.

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation.

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point. Test for electrical resistance, dielectric constant, dissipation factor, arc resistance and dielectric strength - water absorption.

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion.

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers. Polymer for biomedical applications: artificial organs, controlled drug delivery, hemodialysis and hemofiltration.

FOR FURTHER READING

Biodegradable polymers

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd., New Delhi, 2015.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014
3. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2007
4. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008
5. George Odian , Principles of Polymerization, John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011

LANGUAGE ELECTIVES

18HSH01 HINDI **1 0 2 2**

Course Objectives

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To teach them how to converse in Hindi on simple day- to -day situations

Programme Outcomes (POs)

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Construct simple sentences and use vocabulary required for day- to -day cversaontion
2. Distinguish and understand the basic sounds of Hindi language
3. Appear for Hindi examinations conducted by Dakshina Bharat Hindi Prachar Sabha

Articulation Matrix

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

UNIT I **9 Hours**

Hindi Alphabet: Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II **9 Hours**

Nouns: Genders (Masculine & Feminine Nouns)- Masculine & Feminine - Reading Exercises.

UNIT III **9 Hours**

Pronouns and Tenses: Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

UNIT IV **9 Hours**

Classified Vocabulary: Parts of body, Relatives, Spices, Eatables, Fruit & Vegetables - Clothes - Directions Seasons - Professions.

UNIT V **9 Hours**

Speaking: Model Sentences and Rhymes Speaking practice for various occasions.

Total: 45 Hours

Reference(s)

1. Dakshin by Dakshin Bharat Hindi Prachar Sabha Chennai

18HSG01 GERMAN **1 0 2 2**

Course Objectives

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

Programme Outcomes (POs)

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. listen and identify individual sounds of German
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

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

UNIT I **9 Hours**

Introduction to German language: Alphabet - Numbers - Greetings - Days and Seasons- Working with Dictionary.

UNIT II **9 Hours**

Nouns - articles - Speaking about one self - Listening to CD supplied with the books, paying special attention to pronunciation

UNIT III **9 Hours**

Regular & Irregular verbs - Personal pronouns - family - Introduction to types of sentences

UNIT IV **9 Hours**

Question words-Types of Questions - Nominative case- Verb Conjugation - country - nationalities

UNIT V **9 Hours**

Verbs - to be & to have - conjugation - Hobbys - Framing basic Questions and answers

Reference(s)

Total: 45 Hours

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015
2. Langenscheidt Eurodictionary - German - English / English - German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

18HSJ01 JAPANESE **1 0 2 2**

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquettes

Programme Outcomes (POs)

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Recognise and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

Articulation Matrix

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

UNIT I **9 Hours**

Introduction to Japanese , Japanese script, Pronunciation of Japanese(Hiragana), (Katakana) Long vowels , Pronunciation of in,tsu,ga Letters combined with ya,yu,yo Daily Greetings and Expressions Numerals. N1 wa N2 desu N1 wa N2 ja arimasen S ka N1mo N1 no N2 san Kore Sore Are Kono N Sono N Ano N Sou desu Souja Arimasen S1 ka S2 ka N1 no N2 Sou desu ka Koko Soko Asoko Kochira Sochira Achira Ni wa N2 (place) desu Doko Dochira N1 no N2 Ko So A Do (Demonstrative words) O kuni Kanji10 Technical Japanese Vocabulary (30 Numbers)

UNIT II **9 Hours**

Introduction to time Ji Fun Pun Introduction of verbs V Masu V Masu V Masen V Mashita V Masendeshita N (Time) Ni V N1 Kara N2 Made N1 to N2 S Ne N (Place) e Ikimasu Kimasu Kaerimasu Doko (e) Mo Ikimasen Ikimasendeshita N (Vechile) de Ikimase Kimasu Kaerimasu No (Person / Animal) to V Itsu S Yo N o (transitive) N o Shimasu Nani o Shimasuka Nan and Nani N (place) de V V Masenka V Mashou o Kanji 10 Technical Japanese Vocabulary (30 Numbers) .

UNIT III **9 Hours**

N (tool/means) de V Word/Sentence wa Go de Nani desu ka N (person) Ni Agemasu, etc N (person) Ni Moraimasu etc Mou V Mashita Introduction to Adjectives N wa Na adj (Na) desu N wa II adj (II) desu Na adj Na n II adj (II) N Totemo Amari N wa Dou desuka N1 wa Donna N2 desuka S1 Ga S2 Dore N ga Arimasu Wakarimasu N Ga Sukidesu Kiraidesu Jozu desu Heta desu Donna N Yoku Daitai Takusan Sukoshi Amari Zenzen Ã¢?? S1 kara S2 Doushite Kanji 10 Technical Japanese Vocabulary (30 Numbers)

UNIT IV **9 Hours**

N ga Arimasu Imasu N1 (place) Ni N2 ga Arimasu Imasu N1 (thing/person/place) no N2 (position) N1 ya N2 Word (s) desuka Chirisosu wa Arimasuka Saying numbers Quantifier (period) Ni kai V Quantifier Dake N dake Past tense of Noun sentences and Na adjective sentences Past tense of ii adjective sentences N1 wa N2 yori adjective desu N1 to N2 to dochira ga adjective desu ka N1/N2 no houga adjective desu Kanji 10 Technical Japanese Vocabulary (30 Numbers)

UNIT V **9 Hours**

N ga hoshi desu V masu form tai desu N (place) e V masu form N Ni ikimasu kimasu kaerimasu N ni V N o V dou ko ka nani ka go chuu mon Verb conjugation Verb groups Verb te form V te form kudasai V te form imasu V masu from mashouka S1 ga S2 N ga V V te form mo ii desu V te form wa ikemasen V te form imasu V te form imasu Shrimasen Kanji 10 Technical Japanese Vocabulary (30 Numbers)

Total: 45 Hours

Text Book(s)

1. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

Reference(s)

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

18HSC01 CHINESE **1 0 2 2**

Course Objectives

- To help students appear for HSK Level 1 Exam
- To help students acquire the basics of Chinese language
- To teach the students how to converse in Chinese in various situations

Programme Outcomes (POs)

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. listen and identify individual sounds of Chinese
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

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

UNIT I **6 Hours**

Hello
Initials and Finals of Chinese
b,p,m,f,d,,n,l,g,k,h,j,q,x
Tones Four
Chinese Syllables
Tone S

UNIT II **6 Hours**

Thank you -
Initials and Finals of Chinese
The Neutral Tone
Rules of Tone Marking and Abbreviation

UNIT III **6 Hours**

What's your name - In the school; -In the classroom; -In the school
The Interrogative Pronoun
The Sentence
Interrogative Sentences with

UNIT IV **6 Hours**

She is my Chinese teacher -
In the library
The Interrogative Pronouns
The Structural Particle
The interrogative Particle

UNIT V **6 Hours**

Her daughter is 20 years old this year -
The Interrogative Pronoun
Numbers below 100
Indicating a Change
The Interrogative Phrase

Total: 30 Hours

18HSF01 FRENCH 1 0 2 2

Course Objectives

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

Programme Outcomes (POs)

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. To help students acquire familiarity in the French alphabet & basic vocabulary
2. listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and understand short passages on familiar topics
5. Understand and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

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

UNIT I **9 Hours**

ENTRER EN CONTACT

La langue francaise, alphabets, les numeros, les jours, les mois.- Grammaire Les verbes s"appeler,etre, avoir, les articles definis, indefinis -Communication - Saluer, s"informer sur quelqu"un, demander de se presenter - Lexique - Les alphabets, les nationalites, l"age, les pays, les couleurs, les jours de la semaine, les mois de l"annee, les professions

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

Les francais et leur habitat, des habitations insolites -Grammaire - Verbes - Conjugaison : Present (Avoir / etre / ER, IR, RE : Regulier et Irregulier) - Adjectifs les propositions de lieu - Communication - Chercher un logement, d"ecrire son voisin, s"informer sur un logement - Lexique - L"habitat, les pieces, l"equipement, la description physique

UNIT III **9 Hours**

VIVRE AU QUOTIDIEN

Grammaire - Articles contractes, verbes vouloir, pouvoir, devoir, adjective interrogative, future proche - Communication- Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique - le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT - OUVRIR LA CULTURE

Grammaire - Verbes - Finir, Sortir, les adjectifs demonstratifs, le passe compose, l"imparfait Communication - Propose a quelqu'un de faire quelque chose, raconter une sortie au passe parler un film - Lexique - Les sorties, la famille, art, les vetements et les accessoires

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite - Communication Accepter et refuse rune invitation, donner des instructions, commander au restaurant - Lexique Les services et les commerces, les aliments, les ustensiles, argent

Total: 45 Hours

Reference(s)

1. Saison A1, Methode de francais
2. Hachette FLE

ONE CREDIT COURSE

18BT0XA MOLECULAR MARKER TECHNOLOGIES 1 0 0 1

Course Objectives

- To understand the role of molecular marker technology in breeding of animals and Plants
- To understand the sequencing and mapping techniques

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Build their carrier on DNA finger printing techniques
2. Work in genomics and bioinformatics research filed which is fast developing in the animal and agricultural science

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1								2						
2	2										1				

UNIT I **4 Hours**

MOLECULAR MARKERS INTRODUCTION

Organization & Molecular dissection of different genomes (Nuclear, Chloroplast and Mitochondrial)Morphological, Physiological and Genetic markers and their role in evolution and Taxonomy Merits and demerits

UNIT II **4 Hours**

HISTORY AND TYPES

-History of Molecular markers and Types of Molecular markers - Hybridization based markers RFLP and it's applications

UNIT III **4 Hours**

PCR BASED MARKERS

PCR based markers RAPD, AFLP, SSR and STS markers, new generation marker and their application - Development of new DNA markers - Principles of genetic linkage - Linkage relationship among different markers - Construction of linkage maps with different markers

4 Hours

UNIT IV

MICROARRAY TECHNOLOGY

Microarray technology and application - Synteny among different genome with respect to markers - QTL mapping with molecular markers and related software - Finger printing of fungi, insects and other organisms - Tagging of economic importance using molecular markers MAS success story

4 Hours

UNIT V

PRACTICAL SESSION

Demonstration of molecular marker usage in the laboratory

Total: 20 Hours

Reference(s):

1. Brown. T. A. Genomes, 3rd edition. University of Manchester, U.K. Garland Sciences. 2006
2. Phillips and I.K. Vasil. DNA based markers in plants. Second Edition, Klewer academic Publishers, and London. 2001.
3. Henry, R. J. Plant genotyping "The DNA finger printing of plants". CABI Publications. New York. 2001.
4. Patterson, Molecular dissection of complex traits. CRC Publication. Washigton. 1998
5. Rastogi, S.C. N. Mendiratta, and P. Rastogi. Bioinformatics "Methods and application Pretice" Hall Pvt. New Delhi. 2006.

18BT0XB TRANSLATIONAL RESEARCH AND TECHNOLOGY TRANSFER **1 0 0 1**

Course Objectives

- To enable students to get an insight of translating Ideas and to evaluate and predict the role of technology in creating wealth or value
- To empower graduates and researchers to distinguish between Abrasive/Breakthrough technologies and lay a foundation for productive research for societal transformation.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Address the questions/challenges/problems/ pain statements of the society or demand area
2. Analyze the tools (Software and Legal instruments) for evaluating the technology
3. Build and stimulate a business model around ones idea/invention, which will enable to decide the best mode of translating idea/invention to value or wealth

Articulation Matrix

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

UNIT I **4 Hours**

TECHNOLOGY TRANSFER INTRODUCTON
Technology Transfer as a process Stages of Technology Transfer

UNIT II **4 Hours**

TRANSLATIONAL RESEARCH
Translational Research defined- Basic Components of Translational Research - Stages of invention and where does Translational research fit

UNIT III **4 Hours**

CLASSIFICATIONS OF INVENTIONS
Classifications of Inventions overview of protecting technology Strategies of Transferring technology Technology Valuation Methods Communication in Technology Transfer

4 Hours

UNIT IV

MARKETING

-Documentation for Technology Transfer Technology Landscaping- Technology Presentation for Marketing Legal Instruments Involved in Technology Transfer.

4 Hours

UNIT V

PRACTICAL SESSION

Ability to write a model technology transfer/ translational document procedure

Total: 20 Hours

Reference(s):

1. Technology Transfer: A Communication Perspective (1990), Eds. Frederick Williams and DavidV. Gibson, SAGEPublications (ISBN:0-8039-3741-5
2. Biotechnology Intellectual Property Manual (2001) Spruson and Ferguson Patent Attorneys. (ISBN:0-642-72129-
3. Journal of Commercial Biotechnology http://www.palgrave-journals.com/jcb/index.html.
4. Intellectual Property in Health and Agricultural Innovations A Hand Book of Best Practices

18BT0XC MARINE FOOD TECHNOLOGY 1 0 0 1

Course Objectives

- To provide a concise and unified approach to marine flora, fauna and molecular properties
- To impart knowledge on various sea foods and its medicinal and nutritional values

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Explain about marine environment and marine organisms
2. Apply different techniques followed for marine resource assessment and evaluation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2														
2	1								2						

4 Hours

UNIT I

MARINE ENVIRONMENT

Marine environment -Marine Bioresources, Biodiversity-Marine Flora and fauna -Phytoplankton

4 Hours

UNIT II

BIODIVERSITY

seaweeds, sea grasses and mangroves -Ocean Technology Tides,Currents and remote sensing techniques -Marine resource assessment and evaluation -Marine pharmacology "Terms and definitions,

4 Hours

UNIT III

MEDICINAL COMPOUNDS FROM MARINE FLORA

Medicinal compounds from marine flora and fauna, toxins, antiviral and antimicrobial agents -Sea foods shrimps, prawns, skewers, octopus, crabs, fish, squid

4 Hours

UNIT IV

CERTIFICATIONS

and its processing with nutritional values Certifications like HACCP, EU, USFDA, ISO, BRC, ACC for sea foods

4 Hours

UNIT V

PRACTICAL SESSION

Exposure to the marine biotechnology applications

Total: 20 Hours

Reference(s):

1. M. Fingerman, Recent advances in Marine Biotechnology, Science Publishers, 2000.
2. D. L. Krichman, Microbial Ecology of the Oceans,Wiley-Liss, 2000

18BT0XD BEVERAGE, BAKING AND CONFECTIONARY TECHNOLOGY

1 0 0 1

Course Objectives

- To impart knowledge to the students about food processing and various unit operations
- To apply the technology in processing, preservation, and packaging.
- To acquire practical knowledge on value addition of food products

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Explain about the process and products in a beverage industry
2. Apply different techniques followed in beverages., baking and confectionery technology

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2								1						
2	2								1						

UNIT I **4 Hours**

BASIC INDUSTRIAL CALCULATIONS

Basic industrial calculation and procedures, Entrepreneurship development

UNIT II **4 Hours**

METHODOLOGY IN FOOD PROCESSING

Methodology in Food Processing, Technologies in food processing - High Pressure Processing, Pulsed electric fields processing, Osmotic dehydration,

UNIT III **4 Hours**

FOOD PROCESSING

At hermal membrane concentration of liquid foods and colours, Ultrasound processing, Alternate thermal processing, Radiofrequency processing,

UNIT IV **4 Hours**

ADVANCE INDUSTRIAL TECHNOLOGY

Hybrid drying technologies. Value addition of fruit and vegetable products-squashes, pickles, jam, sauce, Ready to serve Beverages. Baking& Confectioner products- bread, rusk, cookies, chikkies.

4 Hours

UNIT V

PRACTICAL SESSION

Making of beverage, baking and confectionery

Total: 20 Hour

References

1. P. J. Fellows, Food Processing Technology Principles and practice, Third Edition Wood head Publishing limited,
2. Paul Singh, R and Dennis R. Heldman, , Introduction to Food Engineering, FourthEdition.Academic Press, 2009
3. M.Lewis and N.Heppell, Continuous Thermal Processing of Foods, Aspen Publisher,2000
4. V. A. Vaclavik and E. W. Christian, Essentials of Food Science, Springer, 2007
5. G. Campbell-platt, Food Science and Technology, Wiley-Blackwell, 2009
6. C.M.Weaver and J.R.Daniel, The Food Chemistry Laboratory: A Manual forE xperimental foods, Dietetics, Food
7. Press, 199

18BT0XE APPLIED SYSTEMS BIOLOGY **1 0 0 1**

Course Objectives

- To provide students practical applications of system biology in biotechnology
- To understand the modeling theories, databases and tools

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Explain about the process and Concepts in systems biology
2. Apply different techniques followed in genomics and bioinformatics research filed which is fast developing in the biotechnology.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2								1						
2	1										2				

4 Hours

UNIT I

INTRODUCTION TO SYSTEMS BIOLOGY

Systems biology - Systems level understanding of biological systems - Basic principles and concepts Applications, Scope and Future.

4 Hours

UNIT II

MODELING THEORY

Linear Algebra - Ordinary differential equations - Difference Equations - Numerical Integration Graph and Network Theory Stochastic processes Statistics

4 Hours

UNIT III

CASE STUDIES

Systems biology Approaches for Enhanced Biofuel Production,Models for Recombinant Protein Production, Systems approaches for Host Pathogen Interactions, Systems Biology Approaches for Drug Discovery,Systems Approaches for Personalized Health Care

4 Hours

UNIT IV

AVAILABLE DATABASES AND TOOLS FOR MODELLING

Internet Databases Modelling-Pathway databases - Kinetics databases Model database Gene expression databases and other data resources.

4 Hours

UNIT V

PRACTICAL SESSION

Simulation Techniques and Tools-Petri nets - Mathematica -Matlab - Systems biology platforms: Copasi, CellDesigner, PyBioS, ScrumPy. Data formats for Modelling-Systems Biology Markup Language (SBML) BioPAX Systems Biology Graphical Notation Standards of Systems Biology Computer Practical-Mathematical modelling using Copasi (or) Matlab

Total: 20 Hours

Reference(s)

1. Systems Biology,EddaKlipp, Wolfram Liebermeister, ChristophWierling, Axel Kowald, Hans Lehrach, Ralf Herwig,ISBN: 978-3-527-31874-2,2009, Wiley-Blackwell
2. An Introduction to Systems Biology Design Principles of Biological Circuits,UriAlon,ISBN:1584886420, 2006, Chapman&Hall/CRC, Taylor and Francis Group
3. Foundations in Systems Biology,Kitano, H.(ed.), ISBN 0262112663,2001 The MIT Press
4. Systems Biology : Properties of Reconstructed Networks,BernardPalsson ISBN: 0521859034,2006, Cambridge Univ. Press
5. Stochastic Modelling for Systems Biology,Darren James Wilkinson ISBN:1-58488-540-8,2006, Chapman & Hall/CRC Press

18BT0XF FUNDAMENTALS OF LIQUID CHROMATOGRAPHY **1 0 0 1**

Course Objectives

- To provide students practical applications of HPLC in biotechnology
- To understand the practical familiarization of HPLC

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Apply the industrial concepts of HPLC in advance purification process
2. Equip with the skills for analyzing the biotechnology products.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2								2						
2	1								1						

4 Hours

UNIT I

BASICS OF HPLC

HPLC instrumentation, theory of chromatography, properties of stationary phase, selectivity, efficiency, Retention, resolution, Vandeemter equation, Isocratic/gradient mode of elution, mobile phase and importance of ion pairing reagent

4 Hours

UNIT II

MODES OF CHROMATOGRAPHY

Reverse phase chromatography, hydrophobic interaction chromatography, Ion exchange chromatography, size exclusion chromatography, and affinity chromatography

4 Hours

UNIT III

DETECTORS USED IN HPLC

UV-vis, PDA/DAD, CAD, refractive index, fluorescence

4 Hours

UNIT IV

APPLICATION AND ADVANCEMENT OF LIQUID CHROMATOGRAPHY

Separation and quantification of proteins and related substances, process control, Advances application by using LCMS and 2D liquid chromatography

4 Hours

UNIT V

PRACTICAL SECTION

Familiarization of HPLC setup

Total : 20 Hours

Reference(s)

1. Basic HPLC and CE of biomolecules by Robert L. Cunico, Karen M. Holding and Tim Wehr.

18BT0XG PROCESS VALIDATION AND QUALITY ASSURANCE FOR BIOPRODUCTS **1 0 0 1**

Course Objectives

- To understand the importance of quality assurance and validation strategies in food and Pharmaceutical industries
- To appreciate the skills / devices / practices which assures the safety and quality of the finished products

Programme Outcomes (POs)

g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Explain the HACCP principles and Validation in the Food and Pharmaceutical industries
2. Apply their knowledge in the arena of Quality Assurance

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1							2					1			
2							1		2	2	1				

8 Hours

UNIT I

QUALITY ASSURANCE

Quality Assurance introduction, Regulatory compliance - FDA regulations, EU directives Certification systems - ISO 22000:2009 and BRC Global Standard for Food Safety Issue. The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP).

12 Hours

UNIT II

PROCESS VALIDATION

Validation introduction, HACCP Principles and Hazard Analysis.Concepts of Process Validation & how it Differs from Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation including the use of Statistical Process Control (SPC)

Techniques.Audits - Requirements. Process Validation for pharmaceutical industries, Pilot Plant, Scale-Up Techniques.Analytical methods and tests for various drugs -Physicochemical and bioanalytical considerations. Validation of analytical methods. Product Development Strategies in food and Pharmaceutical industries. Shelf Life Evaluation, Data Analysis, Documentation, Registration, and Diagnostics Start-Ups.

Total: 20 Hours

Reference(s)

1. Pharmaceutical Process Validation by Robert Nash and Alfred Wachter, Marcel Dekker.
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control from Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker.
3. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker
4. Handbook of Food science, Technology and Engineering, (Vol 1) Y.H. Hui, Taylor and Francis Publications

18BT0XI CLINICAL RESEARCH **1 0 0 1**

Course Objectives

- To make the participants understand how the clinical research field develops useful products and methodologies
- To kindle the students to involve in clinical research for their research works

Course outcomes

1. Understanding of clinical research practices
2. Aware of various guidelines and protocols of clinical research
3. Plan and design of Clinical trial managements
4. Clinical research Methods and data managements

Clinical Research: **15 Hours**

Definition, Types and Scope of Clinical Research, Good Clinical Practices, ethics in clinical research, Roles and Responsibilities of Clinical Research Professionals - Historical guidelines in Clinical Research: Nuremberg code, Declaration of Helsinki, Belmont report. Clinical Trial Protocol and Protocol Amendments, Essential Documents for Clinical Trial - History of Regulations in Clinical Research, INDIAN Regulatory system, Indian GCP guidelines (CDCSO guidelines), ICMR Guidelines - Project Management, Protocol in Clinical Research, Informed Consent, Case Report Form, Investigator's Brochure, Contract Research Organization, Site management organizations - Designing of Protocol, CRF, e-CRF, IB, ICF, SOP, CDM, CRF Design, Clinical Data Entry and Validation, Clinical Data Coding,

Total 15 Hours

Reference:

1. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
2. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
3. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes
4. Deborah Rosenbaum, Michelle Dresser. Clinical Research Coordinator Handbook Second Edition Practical Clinical Trials Series GCP Tools and Techniques Interpharm/CRC New York Washington, D.C.© 2002

ADDITIONAL ONE CREDIT COURSE

18GE0XA ETYMOLOGY **1 0 0 1**

Course Objectives

- To increase vocabulary and enhance use, knowledge, and understanding of the English language.
- To stimulate an appreciation for the English language, including how it developed, how new wordsenter the language, and how it continues to be dynamic.
- To demonstrate the importance of a broad-based vocabulary for effective oral and written communication.

Course Outcomes (COs)

1. Examine prefixes, roots, and suffixes of Latin, Greek, Germanic, and Anglo-Saxon origin.
2. Explore the historical aspects of language, including the infusion of Indo-European languages, semantic changes, and the influence of world events.

UNIT I **7 Hours**

CONVENTIONS

Acronyms, Abbreviations, Initialises, Jargon Neologisms - Idiomatic Expressions, Euphemisms Spoonerisms Malapropisms ; Mondegreens - Words Derived from Latin - Words Derived from Greek - Words Derived from - Germanic/Anglo-Saxon - Abstract word Acronym - Affix Analogy - Antonym Apheresis - Blend word Assimilation - Colloquial language Clipped word.

UNIT II **8 Hours**

WORD ANALYSIS

Concrete word Derivative - Dialect Diminutive suffix - Dissimilation Doublet - Etymology Euphemism - Figurative word Homonym - Hybrid word Inflection - Informal language Infusion - Jargon Linguistics - Loan words Metathesis ; Modify - Philology Onomatopoeia - Romance language Prefix - Semantics - Root-base word - Suffix Slang - Word component Synonym.

Total: 15 Hours

Reference(s)

1. Norman, Lewis. Word Power Made Easy, Goyal Publisher. Edition 2. 2014.
2. C T Onions. The Oxford Dictionary of English Etymology, Volume 11, Issue 1.70, Wynford Drive, Don Mills, Ont, Oxford University Press.1965.
3. Nurnberg W, Maxwell and Rosenblum, Morris, How to build a better Vocabulary, Completely Revised and Updated, Popular Library. 1961.

18GE0XB GENERAL PSYCHOLOGY **1 0 0 1**

Course Objectives

- To provide a basic understanding of psychology.
- Defining Psychology and the subject matter of psychology.
- To provide an awareness of various methods and branches of psychology.
- To explain social and work psychology of people and the need for mental health.

Course Outcomes (COs)

1. Understand the basics of human behavior in the workplace and society at large.
2. Understand the different fields of psychology and its uses.
3. Deal people effectively in their personal and social life.

UNIT I **15 Hours**

GENERAL PSYCOLOGY

Psychology - Introduction - Mind body relationship - Methods and Scope of Psychology -Motivation- Types of Needs- Motivational Cycle- Intelligence: Concept of Intelligence and IQ- measurement - Social psychology: individual behavior and group behavior - Group dynamics- group formation- social influence-social cognition, stereotypes- prejudice- discrimination - Definitions, formation of attitude, factors of attitude formation-change of attitude.

Total: 15 Hours

Reference(s)

1. Atkinson & Atkinson, Introduction to Psychology, 6th Ed McGraw-Hill Publications. 1975
2. Mishra, B. K, Psychology: The study of human behavior, 2nd Ed New Delhi: Prentice Hall of India Learning Pvt. Ltd. 2016.
3. Baron, R.A., Branscombe. N.R, Social Psychology, 14th Ed. New Delhi; Pearson Education. 2016
4. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, 7th Ed. New Delhi: Tata McGraw Hill. 1993

18GE0XC NEURO BEHAVIORAL SCIENCE **1 0 0 1**

Course Objectives

- To provide an introduction to the Cognitive Neuro Science of languages.
- To provide an understanding of the Cognitive processes.

Course Outcomes (COs)

1. Identify the psychological problems that will impact mental health.
2. Value ethical conduct in professional and personal life.
3. Recognize the need for rationale and evidence in decision-making.

UNIT I **8 Hours**

INTRODUCTION TO PHYSIOLOGY

Introduction to physiology - Anatomy - Neuro Biology - Psycho Neuro Science.

UNIT II **7 Hours**

PSYCHOLOGICAL BEHAVIOR

Behaviour and Hormones - Behaviour Modifications - Relaxation Therapy - Psycho Education for minds.

Total: 15 Hours

Reference(s)

1. Beck. Robert. Handbook of Physiology. Vol I.
2. Horon C Philip. Sexology and Mind.

18GE0XD VISUAL MEDIA AND FILM MAKING 1 0 0 1

Course Objectives

- To acquire fundamental knowledge on development of filmmaking as an art
- To provide students a basic understanding of the techniques and nuances of visual medium
- To inculcate an ability to plan and produce a short film

Course Outcomes (COs)

1. Understand the significance and techniques of visual medium
2. Analyse and produce visual clippings

UNIT I **7 Hours**

INTRODUCTION

History of Cinema (Origin and Narrative). Cinema as a visual medium - Significance of Editing. Styles of Editing - Editing as a methodology (Hollywood"s Invisible Editing)-Technical Aspects of Editing (Final Cut Pro (FCP), AVID and Premire Pro) - Basics of video production (pre-production to post-production)

UNIT II **8 Hours**

FUNDEMENTALS OF FILMMAKING

Different types of shots and angles-Film style and Narrative-(Italian Neo-realism, Avant Garde, Russain Formalism, Alternative Cinema etc.,)- Regional Cinema to National Cinema - Basics of Script Writing (Double and Single Column)- Basics of Video Production (script to screen)- Final submission of a script for five minutes short film.

Total: 15 Hours

Reference(s)

1. Monaco, James, How to Read a Film: Movies, Media, and Beyond. Auckland: OUP, 2009.
2. Belavadi, Vasuki, Video Production. India: OUP, 2013.

18GE0XE YOGA FOR HUMAN EXCELLENCE 1 0 0 1

Course Objectives

- To know about the history and schools of yoga
- To know the difference between supreme consciousness and individual consciousness
- To apply the knowledge by the way of practice and introspection

Course Outcomes (COs)

1. Understand the historical aspects and schools of yoga
2. Ensure their physical & mental wellness through yoga practice
3. Develop the power to concentrate and have stress free mind

UNIT I **15 Hours**

INTRODUCTION

What is Yoga? - History of Yoga- Yoga in todays scenario - Schools of Yoga - Eight Limbs of Yoga - Sathvic, Rajasic, Tamasic Foods and Thoughts - Science of Yoga -Loosening Exercises - Yogasanas & Benefits - Super Brain Yoga - Surya Namaskar - Standing Asanas - Sitting Asanas - Prone Asanas - Supine Asanas - Mudras-Relaxation - Pranayama? Meditation.

Total: 15 Hours

Reference(s)

1. Vethathiri Publications, Yoga Practices-2, Erode, 2012.
2. Iyengar B.K.S. Yoga: Wisdom & Practice, B.K.S. Iyengar, 2009.
3. Ramesh Partani, The Complete Secret, Ru Education, 2013.

18GE0XF VEDIC MATHEMATICS 1 0 0 1

Course Objectives

- To improve their calculation speed, analytical thinking and numerical skills

Course Outcomes (COs)

1. Solve problems creatively in mathematics and its applications

UNIT I **15 Hours**

VEDIC MATHEMATICS

Addition- Subtraction- System of Multiplication- Squaring numbers- Cube roots- Square roots- Solution of simultaneous equations- Solutions of Quadratic equations

Total: 15 Hours

Reference(s)

1. Dhaval Bathia, Vedic Mathematics, JAICO Publishing House, 29th Edition, Mumbai, 2014
2. Jagadguru Swami Sri Bharathi Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Private Limited, New Delhi, 1997

18GE0XG HEALTH AND FITNESS 1 0 0 1

Course Objectives

- To understand the fundamental concepts about physical fitness & its types, training and assessment of physical fitness

Course Outcomes (COs)

1. Acquire the knowledge and training of the individual physical, mental and social concepts
2. Understand the fundamental concepts of yogic practice and physical fitness
3. To acquire the knowledge about nutrition and health consciousness

UNIT I **5 Hours**

FITNESS

Meaning & Definition -Need & importance of Physical fitness - Types Physical fitness - Exercise, Training and Conditioning and it is important

UNIT II **5 Hours**

YOGA AND MEDITATION

Meaning and definition - Principles of practicing - Basic Asana and it important - Pranayama and Meditation - Relaxation Techniques

UNIT III **5 Hours**

NUTRITION AND BALANCE DIET

Nutrition and Balance Diet: Needs and Important - Significant of Nutritional Food - Tips for balance diet. Common Diseases for IT professionals: Common diseases - cause - prevention - First aid for common sports injuries.

Total: 15 Hours

Reference(s)

1. Anderson, Bob., Pearl, Bill.,&Burke, Edmund R., (2001). Getting in Shape Workout Programs for Men&Women. Mumbai: Jaico Publishing House
2. Baechle, Thomas. R, & Earle, Roger. W., (2000). Essentials of Strength Training and Conditioning. Champaign: Human Kinetics
3. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers
4. Singh, Hardayal, (1995). Science of Sports training. New Delhi: D.V.S. Publications
5. Begum, Raheena. M., (2002). A Textbook of Foods, Nutrition and Dietetics. New Delhi: Sterling Publishers Private Limited

18GE0XH CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING **1 0 0 1**

Course Objectives

- To understand the importance of safe methods of treating solid wastes generated through various human activities
- To appreciate the skills / devices / practices associated with the compact proceedures of biodegradation of unwanted solid residues

Course Outcomes (COs)

1. Understand the role of recycling of garbage leading to the sustenance of our health and environment
2. Recognize the organic farming practices and production of healthy food products
3. Prepare and maintain tips for small scale compost units and thereby becoming more environmentally conscious

VERMICOMPOSTING TECHNOLOGY **15 Hours**

Ecological roles and economic importance of earthworms - need for earthworm culture, scope and importance of vermiculture , limiting factors - types of worm culturing and the relative benefits Small scale and commercial methods: process & advantages , Vermicomposting equipments, devices, Design and maintenance of vermi bed - Products from vermiculture (matter & humus cycle) , vermicastings in organic farming/horticulture Marketing the products of vermiculture quality control, market research, marketing techniques , Applied vermiculture: use of urban solids & farm/ industrial residues for vermicomposting - Constraints of vermiculture and its future perspectives Artificial Earthworm as a standalone biodegradation assembly.

Total: 15 Hours

Reference (s)

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
2. Vermiculture Technology; Earthworms, Organic Wastes and Environmental Management, 2011, Edited by Clive A Edwards, Norman Q Arancon & Rhonda Sherman, CRC Press
3. www.organicgrowingwithworms.com.au
4. New York Times , Scientists Hope to Cultivate and Immune System for Crops

18GE0XI BLOG WRITING **1 0 0 1**

Course Objectives

- To sharpen and improve writing skills, including draft writing, voice, and format.
- To develop general and global knowledge.
- To experiment with non-written forms of online communications, including images, audio and video.
- To be able to add content to your website without the assistance of a web designer.

Course Outcomes (COs)

1. Understand the flow of language in natural manner.
2. Understand the elements of a blog and be able to use them effectively.
3. Find a niche for a long-term blog.
4. Gain insight into the strategies, methods and writing of successful bloggers.
5. Develop creative thinking.

UNIT I **7 Hours**

CONCEPT

What is blog writing? Types of blog posts personal experience, opinion, reviews, advice, news/updates. Focusing your blog concept, audience, uniqueness, posts. Company blogs. Structure: Types of structure inverted pyramid, feature article, list, story, other options. Creating effective openings. Planning a post.

UNIT II **8 Hours**

VOICE RELIABILITY

Defining and achieving voice. Exploring various voices. Stylistic tips rhythm, verbs, interesting words, senses, emphasis. Smartness and sarcasm. Reliability - accuracy, provability, specificity. Transparency about payments. Sample Blogs and Activities

Total: 15 Hours

Reference(s)

1. The Elements of Blogging: Expanding the Conversation of Journalism, by Mark Leccese and Jerry Lanson. (Taylor & Francis, 2015) ISBN: 978-1-13-802154-9. $29.95 paperback.
2. Blogging Heroes, by Michael Banks. Choose 15 of the 30 interviews/profile segments to read, be sure to include the segments on Chris Anderson and Brian Lam.
3. Complete Guide to Blogging, Huffinghton Post

18GE0XJ INTERPERSONAL SKILLS 1 0 0 1

Course Objectives

- To communicate and work effectively, both individually and in groups
- To be able to understand and manage ones own and others emotions
- To define and solve problems by making decisions about the best course of action

Course Outcomes (COs)

1. Express themselves clearly and confidently
2. Listen to others completely and with empathy
3. Assert an opinion without diminishing others opinion
4. Be responsible and timely with a willingness to collaborate
5. Develop innate personality traits to handle certain social situations

UNIT I **7 Hours**

INTRODUCTION

Conversational Skills - Active Listening - Team working Empathy - Emotional Intelligence

UNIT II **8 Hours**

SKILLS

Conflict Resolution and Mediation skills - Decision making and Problem Solving - Negotiation and Persuasion skills

Total: 15 Hours

Reference(s)

1. Stephen P. Robbins, Phillip L. Hunsaker, Training in Interpersonal Skills, Pearson, 2015
2. Robert B. Cialdini, Influence: The Psychology of Persuasion, Harper Business; Revised Edition, 2006
3. Suzanne C De Janasz, Karen O Dowo & Beth Z Schneder, Interpersonal Skills in Organisations, McGraw-Hill Education; 5th Edition, 2014

18GE0XK NEW AGE INNOVATION AND ENTREPRENEURSHIP **1 0 0 1**

Course Objectives

- To make the participants understand as to how to get along with the task of setting independent business units and on the various facets of running a business
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing a business opportunity

Course Outcomes (COs)

1. Understanding entrepreneurship as an important career option
2. Concept and methodology of idea translation to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women
4. Overview of Indian trends in the start-up scene

UNIT I **15 Hours**

NEW AGE INNOVATION AND ENTREPRENEURSHIP

Introduction to Entrepreneurship - Opportunity Identification ideation -MVPPositioning as an Entrepreneur Starting own Business - Developing Effective Business Model - Industry and Competitor Analysis - Building Business PlanMentoring Session with Investors- Legal and Ethical Foundation for Startup. Types of startups and licensing systems - MSME -Evaluating the Financial Strength of a New Venture/Project - Getting Funding - Types of Sources VCs, Angel funding, PE etc. -Marketing Strategies for New Ventures - IT Systems - IPR - Strategies for New Venture Growth - Talent Acquisition and Management for New Ventures - Valuation Challenge in Entrepreneurship - Intrapreneurship Sustainability - Exit strategies and Start-up trends in India.

Total: 15 Hours

Reference(s)

1. Kathleen R. Allen, Launching New Ventures, South-WesternCengage Learning, 6th Edition, 2012
2. Alex Osterwalder and Yves Pigneur, Business Model Generation, publishedby the authors, 2010
3. Branson. R. Ãƒ?Ã‚¢??Business stripped bareÃƒ?Ã‚¢??, New York, Penguin books, 2011
4. Moris MH, Kuratko DF and Covin JG, Corporate entrepreneurship and innovation, 3 edition, Mason, Oh; CENGAGE/SOUTH WESTERN publisher, 2011

18GE0XL NATIONAL CADET CORPS **1 0 0 1**

Course Objectives

- To understand the importance of NCC and its organization.
- To realize the skills in the applications of drill and weapon training.
- To analyze the factors in National unity
- To identify the utility of smart materials in engineering applications.

Course Outcomes (COs)

1. Recall the motto and aim of NCC.
2. Implement synergy in disaster management.
3. Execute an example patriotic leader to serve nation

UNIT I **12 Hours**

NCC STRUCTURE AND TRAINING

NCC ORGANIZATION National Cadet Corps: Aim and Objectives - Administrative and Organizational pattern - NCC flag and NCC song - Duties, Responsibilities and Conduct by NCC Cadets - Badges of ranks in NCC and Armed forces- Types of NCC camps - Eligibility conditions for writing B and C certificate examinations. Cadet welfare society and Career opportunities for NCC cadets.DRILL AND WEAPON TRAINING: Drill: Aims of drill - Types of drill - Foot drill, Arms drill and Ceremonial drill. Word of commands, Guard of honour. Weapon training - Rifles used in NCC: Parts and Characteristics of 0.22 and INSAS - Stripping, Assembling and Cleaning of weapons. NATIONAL INTEGRATION AND SOCIAL AWARENESS:]National Integration: Introduction - Constitution of India- Importance and Necessity - Factors affecting National integration - Role of NCC in National integration. Social service and its need - Rural development programs - NGOs role and Contribution - Social Security schemes.

UNIT II **8 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

PERSONALITY DEVELOPMENT AND LEADERSHIP: Personality Development: Introduction - Factor influences in personality development. Leadership: Leadership traits and Skills - Indicator of good leader - Honour code concept - Type of leaders - Case studies of effective leader. DISASTER MANAGEMENT AND FIRST AID:Disaster types - Natural and Manmade disasters. Role of NCC cadets in disaster management. Civil defence: Civil defence measures - Civil defence services. First aid: First aid kits and Equipments - First aid for snake bite, Sun stroke and Drowning - Respiration -Types of respiration.

Total: 20 Hours

Reference(s)

1. Cadets Hand book Common subject, DG NCC, New Delhi.
2. Cadets Hand book Special subject, DG NCC, New Delhi
3. Misra R.C and Sanjaykumar Mishra, A HAND BOOK OF NCC(English), Kanti Prakashan, 2016
4. Gupta R. K, NCC: Handbook of NCC Cadets for A, B and C Certificate Examinations (English) RPH Editorial Board, 2018.

18GE0XM COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT **1 0 0 1**

Course Objectives

- understand the role of National Service Scheme in community
- identify the needs and problems of the community and involve in problem solving
- develop competence required for group living and acquire leadership qualities

Course Outcomes (COs)

1. Compare themselves in relation to their community and develop among themselves a sense of social and civic responsibility
2. Utilize their knowledge in finding practical solution to individual and community problems
3. Develop leadership qualities in working environment and during the time of emergency

COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT **15 Hours**

Introduction and Basic Concepts of NSS: History-philosophy-aims & objectives of NSSEmblem, flag, motto, song, badge- Organizational structure roles and responsibilities functionaries. NSS Programmes and Activities: Concept of regular activities, special camping, DayCamps-Basisofadoption of village/slums-Methodology of conducting Survey -Financial pattern ofthescheme -Coordination withdifferent agencies-Maintenance oftheDiary. Community Mobilization: Mapping of community stakeholders-Designing the message in the context of the problem and the culture of the community-Identifying methods of mobilizationYouth-adult partnership. Health, Hygiene & Sanitation: Definition, needs and scope of health education Food and Nutrition - Safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) . Entrepreneurship Development: Definition & Meaning - Qualities of good entrepreneur - Steps/ways in opening an enterprise -Role of financial and support service Institutions.

Total: 15 Hours

Reference(s)

1. A Hand book on National Service Scheme, Anna University, Chennai, 2012
2. http://nss.nic.in/intro.asp
3. Delgado-Gaitn and Concha, The Power of Community: Mobilizing for Family and SchoolingNew York: Rowman & Littlefield Publishing, Inc. 2001
4. James Bailey,Guide to Hygiene and Sanitation in Aviation, World health organization, 2nd edition. 1980
5. AnuradhaBasu, Mark Casson, Nigel wadeson and Bernard Yeung, The oxford hand book of entrepreneurship, Oxford Press. 2009

18GE0XN DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES **1 0 0 1**

Course Objectives

- To make the participants understand as to how to get along with the task disruption led innovations.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing creativity based disruption strategy

Course Outcomes (COs)

1. Understanding contemporary entrepreneurship as an important career option
2. Concept and methodology of creative disruption to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women with disruptive technology option
4. Overview of Indian trends with reference to disruptive innovation based start -ups

UNIT I **15 hours**

Creativity linked innovation Differences between Disruptive & incremental Innovations Historical, theoretical, and practical evolution of disruptive innovation (DI) . - Idea generation & communication of creativity leading to DI. Innovation management concepts in DI based entrepreneur generation - How do firms bring in new business models and get new product s and services to the market? Investor preferences in core versus new or disruptive business models disruptors and the disrupted frameworks for assessing company's capabilities and rethinking product, market and strategy - Right customers for DI: strategy in a world that is changing so rapidly Application of disruptive theories to complex problems and opportunities.

Total: 15 Hours

References

1. https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-5885.2005.00177.x
2. http://www.brinq.com/workshop/archives/2005/01/08/what -is-disruptive-innovation
3. https://hbr.org/2006/12/disruptive-innovation-for-social-change

18GE0XO SOCIAL PSYCHOLOGY 1 0 0 1

Course Objectives

- To provide a basic understanding of social psychology.
- Defining psychological & physical changes during puberty age.
- To provide an awareness of various psychological problems and social problems.
- To explain social and work psychology of people and the need for mental health.

Course Outcomes (COs)

1. Understand the basics of human behavior in the workplace and society at large
2. Understand the various psychological, physical, social problems and management skills.
3. Deal people effectively in their personal and social life.

UNIT I **7 Hours**

INTRODUCTION

Introduction - Ice breaker - Time Line - Tasks and Challenges of the age(Erik Erikson)Physical changes - Introduction to Reproductive Health - Reproductive Organs - Menstruation - Changes during Puberty - Abortions - Contraception - Difference between Sex and Gender - Introduction to the origins of Patriarchy - Gender.

UNIT II **8 Hours**

PSYCHOLOGY

Developmental changes - Attraction - Friendship - Differences and Similarities - Images of Beauty and Body Image -Introduction to Media-Feedback - Sexuality - Boundaries Relationships - Marriage - Love - Emotional Health - Sexual Abuse and Safety - Role of Media.

Total: 15 Hours

Reference(s)

1. Baron, R. A.,Branscombe.N.R.(2016).Social Psychology,14th Ed. New Delhi;Pearson Education
2. Morgan,C.T., King,R.A.,Weisz,J.R.,&Schopler,J.(1993). Introduction to Psychology,7th Ed.New Dehi:Tata McGraw Hill.