B.Tech. (Biotechnology)

2022 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

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

SATHYAMANGALAM - 638401 ERODE DISTRICT TAMILNADU INDIA

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CONTENTS

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)

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

PROGRAM SPECIFIC OUTCOME (PSOs)

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

2. Design and synthesis of novel biomolecules for the agricultural, environmental and healthcare sectors

3. Conceive Plan and Deploy bio-resources for the benefit of society and environment.

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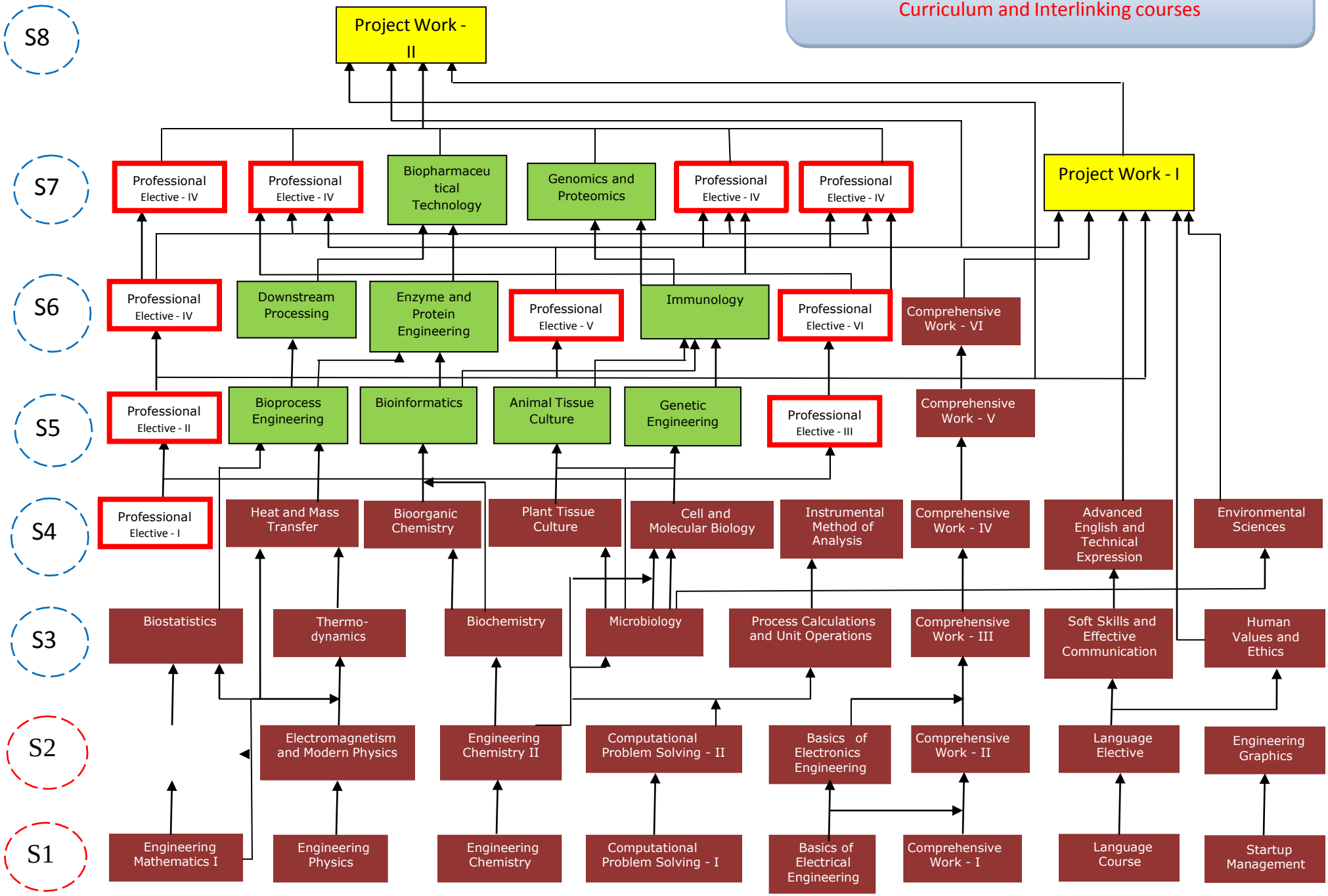
MAPPING OF PEOs AND POs

PEO(s)	Programme Outcomes(s)											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
I	x	x	X		x		x			x	x	
II		x	X	x	x			x		x	x	x
III			X			x			x		x	x

Department of Biotechnology – R (2022)

Curriculum and Interlinking courses



DEPARTMENT OF BIOTECHNOLOGY
Minimum Credits to be Earned : 165

I SEMESTER

Code No.	Course	L	T	P	C	Hours/Week	Maximum Marks			Category
							CA	ES	Total	
22MA101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
22PH102	ENGINEERING PHYSICS	2	0	2	3	4	50	50	100	BS
22CH103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
22GE001	FUNDAMENTALS OF COMPUTING	3	0	0	3	3	40	60	100	ES
22HS001	FOUNDATIONAL ENGLISH	1	0	2	2	3	100	0	100	HSS
22GE003	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
22HS002	STARTUP MANAGEMENT	1	0	2	2	3	100	0	100	EEC
22BT108	COMPREHENSIVE WORK	0	0	2	1	2	100	0	100	EEC
Total		**14**	**1**	**12**	**21**	**27**				-

II SEMESTER

Code No.	Course	L	T	P	C	Hours/Week	Maximum Marks			Category
							CA	ES	Total	
22MA201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
22PH202	ELECTROMAGNETISM AND MODERN PHYSICS	2	0	2	3	4	50	50	100	BS
22CH203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
22GE002	COMPUTATIONAL PROBLEM SOLVING	3	0	0	3	3	40	60	100	ES
22GE004	BASICS OF ELECTRONICS ENGINEERING	2	0	2	3	4	50	50	100	ES
22GE005	ENGINEERING DRAWING	1	0	2	2	3	100	0	100	ES
	LANGUAGE ELECTIVE	1	0	2	2	3	100	0	100	HSS
*22HS003	தமிழர் மரபு / HERITAGE OF TAMILS	1	0	0	1	2	100	0	100	HSS
Total		**14**	**1**	**14**	**21**	**27**				-

* The lateral entry students have to complete this course during IV semester.

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
22BT301	FOURIER SERIES, TRANSFORMS AND BIOSTATISTICS	3	1	0	4	4	40	60	100	BS
22BT302	BIOCHEMISTRY	3	0	2	4	5	50	50	100	ES
22BT303	ENGINEERING THERMODYNAMICS	3	1	0	4	4	40	60	100	PC
22BT304	MICROBIOLOGY	3	0	2	4	5	50	50	100	PC
22BT305	PROCESS CALCULATIONS AND UNIT OPERATIONS	3	1	0	4	4	40	60	100	BS
22HS004	HUMAN VALUES AND ETHICS	2	0	0	2	2	100	0	100	HSS
22HS005	SOFT SKILLS AND EFFECTIVE COMMUNICATION	0	0	2	1	2	100	0	100	EEC
22HS006	தமிழரும் தொழில்நுட்பமும் / TAMILS AND TECHNOLOGY	1	0	0	1	2	100	0	100	HSS
Total		**17**	**3**	**8**	**24**	**28**				**-**
IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/We5ek**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
22BT401	BIOORGANIC CHEMISTRY	3	0	2	4	5	50	50	100	ES
22BT402	HEAT AND MASS TRANSFER	3	0	2	4	5	50	50	100	ES
22BT403	CELL AND MOLECULAR BIOLOGY	3	0	2	4	5	50	50	100	PC
22BT404	INSTRUMENTAL METHODS OF ANALYSIS	3	0	2	4	5	50	50	100	PC
22BT405	PLANT TISSUE CULTURE	2	0	2	3	4	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
22HS007	ENVIRONMENTAL SCIENCE	2	0	0	-	2	100	0	100	HSS
22HS008	ADVANCED ENGLISH AND TECHNICAL EXPRESSION	0	0	2	1	2	100	0	100	EEC
Total		**19**	**0**	**12**	**23**	**31**				**-**

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
22BT501	GENETIC ENGINEERING	3	0	2	4	5	50	50	100	PC
22BT502	BIOPROCESS ENGINEERING	3	0	2	4	5	50	50	100	PC
22BT503	ANIMAL TISSUE CULTURE	3	0	2	4	5	50	50	100	PC
22BT504	BIOINFORMATICS	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
	OPEN ELECTIVE	3	0	0	3	3	40	60	100	PE
22BT507	MINI PROJECT I	0	0	2	1	2	100	0	100	EEC
Total		**18**	**0**	**10**	**23**	**28**				-
VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
22BT601	DOWNSTREAM PROCESSING	3	0	2	4	5	50	50	100	PC
22BT602	IMMUNOLOGY	3	0	2	4	5	50	50	100	PC
22BT603	ENZYME AND PROTEIN ENGINEERING	3	0	2	4	5	50	50	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
22BT607	MINI PROJECT II	0	0	2	1	2	100	0	100	EEC
Total		**18**	**0**	**8**	**22**	**26**				-

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
22BT701	GENOMICS AND PROTEOMICS	3	0	2	4	5	50	50	100	PC
22BT702	BIOPHARMACEUTICAL TECHNOLOGY	2	0	2	3	4	50	50	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
22BT707	PROJECT WORK I	0	0	4	2	4	60	40	100	EEC
Total		**17**	**0**	**8**	**21**	**25**				**-**
VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
22BT801	PROJECT WORK II	0	0	20	10	20	60	40	100	EEC
Total					**10**	**20**				**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
22HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
22HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
22HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
22HSC01	CHINESE	1	0	2	2	3	100	0	100	HSS
22HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS

DISCIPLINE ELECTIVES										
VERTICAL 1 - BIOPROCESS ENGINEERING										
22BT001	FERMENTATION TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT002	INDUSTRIAL MICROBIOLOGY	3	0	0	3	3	40	60	100	PE
22BT003	ENVIRONMENTAL BIOTECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT004	BIOENERGY AND BIOFUELS	3	0	0	3	3	40	60	100	PE
22BT005	BIOREACTOR DESIGN MODELING AND SIMULATION	3	0	0	3	3	40	60	100	PE
22BT006	BIOPROCESS CONTROL AND INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
22BT007	TRANSPORT PHENOMENON IN BIOLOGICAL SYSTEMS	3	0	0	3	3	40	60	100	PE
VERTICAL 2 – APPLIED BIOTECHNOLOGY										
22BT008	ASTROBIOLOGY AND ASTROCHEMISTRY	3	0	0	3	3	40	60	100	PE
22BT009	BIOPROSPECTING AND QUALITY ANALYSIS	3	0	0	3	3	40	60	100	PE
22BT010	FOOD PROCESS AND TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT011	MARINE BIOTECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT012	BIODIVERSITY	3	0	0	3	3	40	60	100	PE
22BT013	BIOSENSORS	3	0	0	3	3	40	60	100	PE
22BT014	BIOMATERIALS	3	0	0	3	3	40	60	100	PE
VERTICAL 3 - COMPUTATIONAL BIOTECHNOLOGY										
22BT015	PROGRAMS FOR BIOINFORMATICS	3	0	0	3	3	40	60	100	PE
22BT016	FUNDAMENTALS OF ALGORITHMS FOR BIOINFORMATICS	3	0	0	3	3	40	60	100	PE
22BT017	MOLECULAR MODELING	3	0	0	3	3	40	60	100	PE
22BT018	COMPUTER AIDED DRUG DESIGN	3	0	0	3	3	40	60	100	PE
22BT019	METABOLOMICS AND GENOMICS-BIG DATA ANALYTICS	3	0	0	3	3	40	60	100	PE
22BT020	DATA MINING AND MACHINE LEARNING TECHNIQUES FOR INFORMATICS	3	0	0	3	3	40	60	100	PE
22BT021	SYSTEMS AND SYNTHETIC BIOLOGY	3	0	0	3	3	40	60	100	PE
VERTICAL 4 - AGRO BIOTECHNOLOGY										
22BT022	PLANT TISSUE CULTURE AND TRANSFORMATION TECHNIQUE	3	0	0	3	3	40	60	100	PE
22BT023	TRANSGENIC TECHNOLOGY IN AGRICULTURE	3	0	0	3	3	40	60	100	PE

22BT024	BIOFERTILIZERS AND BIOPESTICIDES PRODUCTION	3	0	0	3	3	40	60	100	PE
22BT025	MUSHROOM CULTIVATION AND VERMICOMPOSTING	3	0	0	3	3	40	60	100	PE
22BT026	FUNGAL AND ALGAL TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT027	PHYTOTHERAPEAUTICS	3	0	0	3	3	40	60	100	PE
VERTICAL 5 - ANIMAL BIOTECHNOLOGY										
22BT028	ANIMAL PHYSILOGY AND METABOLISM	3	0	0	3	3	40	60	100	PE
22BT029	ANIMAL HEALTH AND NUTRITION	3	0	0	3	3	40	60	100	PE
22BT030	ANIMAL CELL CULTURE TECHNIQUE	3	0	0	3	3	40	60	100	PE
22BT031	BIOTECHNIQUES IN ANIMAL BREEDING	3	0	0	3	3	40	60	100	PE
22BT032	FUNDAMENTALS OF ANIMAL TRANSGENICS	3	0	0	3	3	40	60	100	PE
22BT033	STEM CELL TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT034	TISSUE ENGINEERING	3	0	0	3	3	40	60	100	PE
VERTICAL 6 - MEDICAL BIOTECHNOLOGY										
22BT035	BASIC PRODUCTION ON MEDICAL BIOTECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT036	MOLECULAR THERAPEAUTICS AND DIAGNOSTICS	3	0	0	3	3	40	60	100	PE
22BT037	BIONANOTECHNIQUES	3	0	0	3	3	40	60	100	PE
22BT038	CANCER AND NEURO BIOLOGY	3	0	0	3	3	40	60	100	PE
22BT039	HUMAN GENETICS	3	0	0	3	3	40	60	100	PE
22BT040	VACCINE TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT041	BIOPHARMACEUTICS AND ITS BIOSIMILARS	3	0	0	3	3	40	60	100	PE
VERTICAL 7 - QUALITY AND REGULATORY AFFAIRS										
22BT042	CLINICAL TRIALS AND HEALTHCARE POLICIES IN BIOTECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT043	BIOTECH PRODUCTS AND ITS VALIDATION	3	0	0	3	3	40	60	100	PE
22BT044	QA AND QC IN BIOTECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BT045	PATENT DESIGN , IPR IN BIOTECHNOLOGY AND BIOENTREPRENEURSHIP	3	0	0	3	3	40	60	100	PE
22BT046	BIOSAFETY AND HAZARD MANAGEMENT	3	0	0	3	3	40	60	100	PE
22BT047	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**	
22BTH28	ANIMAL PHYSIOLOGY AND METABOLISM	3	0	0	**3**	3	40	60	100	PE
22BTH29	ANIMAL HEALTH AND NUTRITION	3	0	0	**3**	3	40	60	100	PE
22BTH30	ANIMAL CELL CULTURE TECHNIQUE	3	0	0	**3**	3	40	60	100	PE
22BTH31	BIOTECHNIQUES IN ANIMAL BREEDING	3	0	0	**3**	3	40	60	100	PE
22BTH32	FUNDAMENTALS OF ANIMAL TRANSGENICS	3	0	0	**3**	3	40	60	100	PE
22BTH33	STEM CELL TECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
22BTH34	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**	
22BTM01	PLANT TISSUE CULTURE AND TRANSFORMATION TECHNIQUE	3	0	0	**3**	3	40	60	100	PE
22BTM02	TRANSGENIC TECHNOLOGY IN AGRICULTURE	3	0	0	**3**	3	40	60	100	PE
22BTM03	BIOFERTILIZERS AND BIOPESTICIDES PRODUCTION	3	0	0	**3**	3	40	60	100	PE
22BTM04	MUSHROOM CULTIVATION AND VERMICOMPOSTING	3	0	0	**3**	3	40	60	100	PE
22BTM05	FUNGAL AND ALGAL TECHNOLOGY	3	0	0	**3**	3	40	60	100	PE
22BTM06	PHYTOTHERAPEAUTICS	3	0	0	**3**	3	40	60	100	PE
22BTM07	BIOFERTILIZERS AND BIOPESTICIDES PRODUCTION	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**	
22BT0XA	DRUG DESIGN AND COMPUTATIONAL METHODS	1	0	0	1	1	50	50	100	EEC
22BT0XB	BIOANALYTICAL TECHNIQUES FOR PHARMACEUTICAL PRODUCTS	1	0	0	1	1	50	50	100	EEC
22BT0XC	MACHINE LEARNING FOR BIOLOGICAL DATA ANALYSIS	1	0	0	1	1	50	50	100	EEC

22BT0XD	BIOSTIMULANTS FOR ENHANCED CROP PRODUCTION	1	0	0	1	1	50	50	100	EEC
22BT0XE	MICROPROPOGATION FOR VIRAL FREE PLANT PRODUCTION	1	0	0	1	1	50	50	100	EEC
22BT0XF	CLINICAL RESEARCH AND DATA MANAGEMENT	1	0	0	1	1	50	50	100	EEC

OPEN ELECTIVES

Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
22BT0YA	BIOFUELS	3	0	0	**3**	3	50	50	100	PE
22OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	50	50	100	PE
22OFD01	TRADITIONAL FOODS	3	0	0	3	3	50	50	100	PE
22OEI02	SENSOR TECHNOLOGY	3	0	0	3	3	50	50	100	PE
22OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	50	50	100	PE
22OGE02	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	50	50	100	PE
22OGE03	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	50	50	100	PE

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**	10	10	8	-	-	-	-	-	28	17%	15%	20%
2	**ES**	6	8	4	8	-	-	-	-	26	16%	15%	20%
3	**HSS**	2	3	3	-	-	-	-	-	8	5%	5%	10%
4	**PC**	-	-	8	11	16	12	7	-	54	33%	30%	40%
5	**PE**	-	-	-	3	6	9	12	-	30	18%	10%	15%
6	**EEC**	3	-	1	1	1	1	2	10	19	11%	7%	10%
Total		21	21	24	23	23	22	21	10	**165**	100%	-	-

BS - Basic Sciences
ES - Engineering Sciences
HSS - Humanities and Social Sciences
PC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement Course
CA - Continuous Assessment
ES - End Semester Examination

22MA101 **ENGINEERING MATHEMATICS I** **3 1 0 4**

Course Objectives

- To impart mathematical modeling to describe and explore real-world phenomena and data.
- To provide basic understanding on Linear, quadratic, power and polynomial, exponential, and multi variable models.
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of polynomial equations.

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the concepts of mathematical modeling based on linear functions in Engineering.
2. Apply the real world problems as a quadratic function model.
3. Analyze the real-world phenomena and data into Power and Polynomial functions.
4. Analyze the concept of mathematical modeling of exponential functions in Engineering through regression equations.
5. Evaluate the identification of multivariable functions in the physical dynamical problems.

Articulation matrix

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

UNIT I **9 Hours**

MATHEMATICAL MODELING OF LINEAR FUNCTIONS

The geometry of linear equations - Formation of linear equations: Method of least squares and method of regression - Vector spaces: Basic concepts with examples - Linear combination - Eigen values and vectors.

UNIT II **9 Hours**

MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS

General form of a quadratic function - Basic relationships between the equation and graph of a quadratic function - Sum of squares error and the quadratic function of best fit - Quadratic forms: Matrix form - Orhtogonality - Canonical form and its nature

UNIT III **9 Hours**

MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS

Characteristics of the graphs of power and polynomial functions - Fitting of power and polynomial functions using the method of least squares - Local maxima and local minima of power and polynomial functions - Power series of functions with real variables, Taylors series, radius and interval of convergence - Tests of convergence for series of positive terms - comparison test, ratio test.

UNIT IV **9 Hours**

MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS

Concept of exponential growth - Graphs of exponential functions - Relationship between the growth factor and exponential growth or decline - Exponential equations have a variable as an exponent and take the form y = abx through least square approximation - Calculus of exponential functions - Exponential series – Characteristics.

UNIT V **9 Hours**

MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS

Graphing of functions of two variables –Partial derivatives - Total derivatives – Jacobians - Optimization of multivariable functions with constraints - Optimization of multivariable functions without constraints.

Total : 60 hours

References

1. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley IndiaPrivateLimited, New Delhi 2016.
2. B. S. Grewal, Numerical Methods in Engineering & Science: With Programs in C, C++&MATLAB, Khanna, 2014
3. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics ,Sultan Chand & Sons2020
4. Thomas and Finney, Calculus and analytic Geometry, Fourteenth Edition, By Pearson Paperback, 2018

22PH102 **ENGINEERING PHYSICS** **2 0 2 3**

Course Objectives

- Understand the concept and principle of energy possessed by mechanical system
- Exemplify the propagation and exchange of energy
- Identify the properties of materials based on the energy possession

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

Course Outcomes (COs)

1. Apply the concept and principles of energy to understand mechanical systems
2. Apply the types of mechanical oscillations based on vibrational energy
3. Analyze the concept of propagation of energy as transverse and longitudinal waves
4. Analyze the exchange of energy and work between the systems using thermodynamic principles
5. Evaluate the concept of energy and entropy to understand the mechanical properties of materials

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	1							2						

UNIT I **6 Hours**

CONSERVATION OF ENERGY

Concept of energy-types of energy-conservation of energy. Mechanical energy: -translation-rotation- vibration-Kinetic and potential energies-conservation-work and energy- laws of motion - minimization of potential energy-equilibrium-dissipative systems-friction.

UNIT II **5 Hours**

VIBRATIONAL ENERGY

Periodic Motion - Simple Harmonic Motion - Energy of the SHM - Pendulum types-Damped oscillations- forced oscillations-natural frequency-resonance

UNIT III **6 Hours**

PROPAGATION OF ENERGY

Transfer of energy-material medium- Transverse wave - Longitudinal wave - standing wave-interference-Doppler effect, Sound waves and its types - characteristics-human voice-reflection- refraction-beats

UNIT IV **7 Hours**

EXCHANGE OF ENERGY

Energy in transit-heat-Temperature - measurement - specific heat capacity and water - thermal expansion- Heat transfer processes. Thermodynamics: Thermodynamic systems and processes-Laws of thermodynamics- Entropy -entropy on a microscopic scale -maximization of entropy

UNIT V **6 Hours**

MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS

Elastic energy-Structure and bonding-Stress - strain - Tension and compression - elastic limit – Elastic Modulus - Stress-strain diagram –ductility-brittleness-rubber elasticity and entropy

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

4 **4 Hours**

EXPERIMENT 4

Determination of frequency of a tuning fork-Melde’s apparatus

5 **3 Hours**

EXPERIMENT 5

Determination of thermal conductivity of a bad conductor using Lee’s disc method

6 **4 Hours**

EXPERIMENT 6

Determine the

(i) wavelength of ultrasonics in a liquid medium,
(ii) velocity of ultrasonic waves in the given liquid
(iii) compressibility of the given liquid using ultrasonic interferometer

7 **4 Hours**

EXPERIMENT 7

Determination of Young's modulus of a given material – Non uniform bending method

Total: 60 Hours

Reference(s)

1. C J Fischer, The energy of Physics Part I: Classical Mechanics and Thermodynamics, Cognella Academic Publishing, 2019
2. P G Hewitt, Conceptual Physics, Pearson education, 2017
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole,2019
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers &Distributors, New Delhi, 2017

22CH103 **ENGINEERING CHEMISTRY I** **2 0 2 3**

Course Objectives

- Understand the origin of elements from the universe
- Outline the properties of elements in the periodic table
- Analyse the different types of bond formed during chemical reactions and its reaction thermodynamics
- Summarize different states of matter based on atomic arrangement

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the nuclear transmutation reactions that lead to the formation of elements in the universe
2. Apply the atomic structure of elements in the periodic table and interpret the periodic trends in properties of elements with its anomaly
3. Analyze the conditions for the formation of different types of chemical bonds and predict the minimum energy required for a reaction to occur
4. Analyze endothermic and exothermic processes and exchange of energy during chemical reactions
5. Evaluate whether the given matter is a solid, liquid, gas, or plasma and interpret the arrangement of atoms

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	1													
4	2	1													
5	2	1													

UNIT I **5 Hours**

ORIGIN OF ELEMENTS

Hydrogen - Elements and Sun - fusion - hypernova - supernova - dying stars - man-made elements

UNIT II **7 Hours**

ATOMIC STRUCTURE AND PERIODICITY

Atomic Structure - Electronic configuration - Periodic Table - Periodic trends in properties of elements - Anomalous behaviour in periodicity

UNIT III **6 Hours**

CHEMICAL BONDING

Octet rule & its limitations - types of chemical bonds - bond energy - bond cleavage - activation energy of reactions

UNIT IV **6 Hours**

REACTION THERMODYNAMICS

Conservation of energy - Endothermic reactions & exothermic reactions - Exchange of energy involved in chemical reactions

UNIT V **6 Hours**

STATES OF MATTER

Solid - liquid - gas - plasma - quantum dots - arrangement of atoms/ions/molecules in different phases

1 **2 Hours**

EXPERIMENT 1

Lab safety rules and guidelines for students - OSHA Guidelines

2 **3 Hours**

EXPERIMENT 2

Estimation of dissolved oxygen content in water sample(s) by Winkler's method

3 **4 Hours**

EXPERIMENT 3

Determination of Fe(II) in a sample using spectrophotometer

4 **3 Hours**

EXPERIMENT 4

Estimation of chromium content in water sample by volumetric analysis

5 **3 Hours**

EXPERIMENT 5

Estimation of chloride present in the given water sample by argentometric method

6 **3 Hours**

EXPERIMENT 6

Conductometric titration of mixture of acids

7 **4 Hours**

EXPERIMENT 7

Estimation of magnesium ions in given solution by EDTA method

8 **4 Hours**

EXPERIMENT 8

Preparation of salt of fatty acid by saponification process

9 **4 Hours**

EXPERIMENT 9

Recrystallization of aspirin from water/ethanol

Total: 60 Hours

Reference(s)

1. Peter Atkins, Physical Chemistry, Oxford university press, 2019
2. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, Oxford university press, 2020
3. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017
4. J.D. Lee, Concise inorganic chemistry, Blackman Science Ltd, France, Wiley-India, 5th edition (Reprint), 2016
5. Gareth Price, Thermodynamics of chemical processes, Oxford university press, 2019
6. D Tabor, Gases, liquids and solids and other states of matter, Oxford University press, 2018

22GE001 **FUNDAMENTALS OF COMPUTING** **3 0 0 3**

Course Objectives

- Understand the fundamental digital logics behind computations of computer systems.
- Develop simple assembly language programs with respect to arithmetic operations.
- Understand the program execution process and basics of software development methodologies.

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specializationto the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design 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. Apply the hidden languages and inner structures of computer hardware and software through codesand combinations.
2. Apply the organizational and architectural issues of a digital computer with concepts of various data transfer techniques in digital computers and the I/O interfaces.
3. Analyze programming problems and apply assembly instructions to solve simple problems.
4. Evaluate the fundamentals of operating system and System programs basics.
5. Create the software development methodologies to various real life scenarios.

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	1													
4	2	1													
5	2	1													

UNIT I **8 Hours**

CODES AND COMBINATIONS

Communication using Mores and Braille binary codes - Digitizing letters, numbers and objects using binary codes - Performing simple operations: addition through binary codes.

UNIT II **9 Hours**

COMPUTATION USING COMPUTER

Communication to computing devices through various input sources - Computational operation - itsflow, functions and control - communication to output devices - Basic communication protocol

UNIT III **11 Hours**

ASSEMBLY LANGUAGE PROGRAMMING

Little Man Computing (LMC) Model - Instruction Set - Labels - Calculation -Branching - Input- Output-Loops - Simple programs.

UNIT IV **9 Hours**

OPERATING SYSTEM AND APPLICATION GENERATION

BIOS - Device Drivers - Resources - Scheduler - Applications Generation and Creation - Stages of Compilation - Linkers, Loaders and Libraries.

UNIT V **8 Hours**

SOFTWARE DEVELOPMENT

Phases of application life cycle management - Software Development Methodologies - Web Page development .

Total: 45 Hours

Reference(s)

1. Charles Petzold, "Code: The Hidden Language of Computer Hardware and Software", Microsoft Pressbooks, 2009.
2. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
3. Andrew Eliaz, "Little Man Computer Programming: For the Perplexed from the Ground Up", The Internet Technical Bookshop; 1st edition, 2016.
4. Abraham Silberschatz, "Peter Baer Galvin and Greg Gagne, Operating System Concepts", 9th Edition,John Wiley & Sons Pvt. Ltd, 2015.
5. Roger S.Pressman, "Software Engineering: A Practitioner"s Approach", McGraw Hill International edition, Seventh edition, 2010

22HS001 **FOUNDATIONAL ENGLISH** **1 0 2 2**

Course Objectives

- Heighten awareness of grammar in oral and written expression.
- Improve speaking potential in formal and informal contexts.
- Improve reading fluency and increased vocabulary.
- Prowess in interpreting complex texts.
- Fluency and comprehensibility in self-expression.
- Develop abilities as critical readers and writers.
- Improve ability to summarize information from longer text, and distinguish between primary and supporting ideas.

Programme Outcomes (POs)

9.Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
12.Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Express themselves in a professional manner using error-free language.
2. Express in both descriptive and narrative formats.
3. Understand and make effective use of the English Language in Business contexts.
4. Actively read and comprehend authentic text.
5. Express opinions and communicate experiences.

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	3		2			
4									2	3		2			
5									2	3		2			

UNIT I **15 Hours**

SELF-EXPRESSION

Self-Introduction-Recreating Interview Scenarios (with a focus on verbal communication)-Subject Verb Concord - Tenses - Common Errors in verbal communication Be-verbs Self-Introduction- Recreating interview scenarios-Haptics-Gestures-Proxemics-Facial expressions- Paralinguistic / Vocalic- Body Language- Appearance-Eye Contact-Artefacts Self-Introduction-Powerful openings and closings at the interview-Effective stock phrases - Modified for spontaneity and individuality-Question tags, framing questions including WH- questions- Prepositions-Listening to Ted talks-

Listening for specific information

UNIT II **15 Hours**

CREATIVE EXPRESSION

Descriptive Expression-Picture Description and Blog Writing -Vocabulary-One-word substitution- Adjectives-Similes, Metaphors, Imagery & Idioms -Link words - Inclusive language Narrative Expression- Travelogue and Minutes of Meeting -Verbal Analogy-Sequence & Time order words - Jumbled paragraph, sentences, Sequencing-Text & Paragraph Completion-Past tense -Using quotation marks

UNIT III **15 Hours**

FORMAL EXPRESSION

Formal Letters and Emails-Writing: E-mails and Letters of apology, Requisition and Explanation, and Letters to newspapers-Speaking: Tendering verbal apologies, and explanations, persuading a listener/ audience-Hierarchy in Business correspondence- Subject of a mail, Header, Body (Salutation) and Footer of a mail- Conjunctional clause Punctuation-Formal Idioms-Phrases-Articles - Definite & Indefinite-Types of sentences-Modal verbs Precision in comprehension, Summary writing, Selective summary-Reading: Active reading- short paragraphs, excerpts, articles and editorials-Skimming and Scanning Reading comprehension & analysis- Tenses, QP/ PQ approach. Identifying the central themes/ crux-Interpreting tone - formal/informal/semi-formal-Note-taking-Listening: Listening for data, for specific information, for opinion-Active and passive Listening-Transcription-Paraphrasing and summarizing information-Agreeing & disagreeing-Note-taking-Writing: Summary writing, selective summary, paraphrasing, note-making, opinion pieces-Finding synonyms in the context Paraphrasing- Sentence Transformation - simple, compound, complex. Sentence Substitution-Sentence completion- Interpreting paragraphs

Total: 45 Hours

Reference(s)

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010
4. Reynolds, John. Cambridge IGCSEÃ‚Â® First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

22GE003 **BASICS OF ELECTRICAL ENGINEERING** **2 0 2 3**

Course Objectives

- To understand the basic concepts of electrical charge and its properties
- To interpret the formation of electric field due to electric charges.
- To illustrate the concept of magnetic fields due to revolving electron.
- To illustrate the force on moving charges in electric and magnetic field.
- To understand the energy transfer in electro mechanical conversion.

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. 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 basic concepts and properties of electric charge.
2. Apply the significance of electric field and electric dipole formation.
3. Analyze the formation of magnetic field and magnetic dipole.
4. Analyze the force on the moving charges.
5. Evaluate the concept of energy conversion principle in electromagnetics

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	1	1	3												
4	2	1		3											
5	3	2		1											

UNIT I **5 Hours**

ELECTRIC CHARGE

Properties of charge – additivity of charges, quantization of charge, conservation of charge - Forces between multiples of charges – Electric charge in conductors- Drift of Electrons– Charges in Clouds.

UNIT II **7 Hours**

ELECTRIC FIELD

Electric field due to system of charges – Significance- Electric field line – Electric Dipole and its significance – Continuous charge distribution. Field in infinite long uniform straight conductors – field in uniform charged uniform infinite plane sheet – field due to uniform thin spherical sheet.

UNIT III **7 Hours**

MAGNETIC FIELD

Concept of magnetic field –magnetic fields in infinitely long straight wire, straight and toroidal solenoids. Magnetic dipole moment of a revolving electron - Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to axis - Induced Electric field due to changing Magnetic Field.

UNIT IV **6 Hours**

FORCE ON CHARGES

Force on a moving charge in uniform magnetic and electric fields- Force on a current-carrying conductor in a uniform magnetic field. Force between two parallel current-carrying conductors.

UNIT V **5 Hours**

ELECTRO – MECHANICAL ENERGY CONVERSION

Energy transfer in electromagnetic fields – Energy storage in magnetic field - Electromagnetic induction - induced emf - Eddy currents. Self and mutual inductance Linear Momentum and Angular Momentum carried by Electromagnetic Fields.

1 **15 Hours**

EXPERIMENT 1

Analyze and design of Electromechanical energy conversion system.

2 **15 Hours**

EXPERIMENT 2

Develop an electrical machine and analyze its performance with supplied input of AC from 0 V to 230 V.

Total: 60 Hours

Reference(s)

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University,2015
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special,2020
3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, FifthEdition, 2017.
4. S.P.Ghosh, Lipika Datta, 'Electromagnetic Field Theory', First Edition, McGraw Hill Education (India) Private Limited, 2012.

22HS002 **STARTUP MANAGEMENT** **1 0 2 2**

Course Objectives

- Promote entrepreneurial spirit and motivate to build startups
- Provide insights on markets and the dynamics of buyer behavior
- Train to develop prototypes and refine them to a viable market offering
- Support in developing marketing strategies and financial outlay
- Enable to scale up the prototypes to commercial market offering

Programme Outcomes (POs)

7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. 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, andgive and receive clear instructions.
11. Demonstrate knowledge and understanding of the engineering and management principles and apply the set one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Apply the valid and feasible business ideas
2. Analyze Business Model Canvas and formulate positioning statement
3. Analyze prototypes that fulfills an unmet market need
4. Evaluate the business strategies and create pitch decks
5. Create appropriate strategies for commercialization

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	1	1	2				
3							3	3	1	2	2				
4							1	3	1	2	2				
5							2	3	2	2	2				

UNIT I **3 Hours**

BUSINESS MODELS AND IDEATION

Startups: Introduction, Types of Business Modes for Startups. Ideation: Sources of Ideas, Assessing Ideas, Validating Ideas, Tools for validating ideas, Role of Innovation and Design Thinking

UNIT I **3 Hours**

UNDERSTANDING CUSTOMERS

Buyer Decision Process, Buyer Behaviour, Building Buyer Personas, Segmenting, Targeting and Positioning, Value Proposition (Business Model Canvas), Information Sourcing on Markets, Customer Validation.

UNIT III **3 Hours**

DEVELOPING PROTOTYPES

Prototyping: Methods-Paper and Digital, Customer Involvement in Prototyping, Product Design Sprints, Refining Prototypes

UNIT IV **3 Hours**

BUSINESS STRATEGIES AND PITCHING

Design of Marketing Strategies and Campaigns, Go-To-Market Strategy, Financial KPIs Financial Planning and Budgeting, Assessing Funding Alternatives, Pitching, Preparing Pitch Decks

UNIT V **3 Hours**

COMMERCIALIZATION

Implementation: Prototype to Commercialization, Test Markets, Institutional Support, Registration Process, IP Laws and Protection, Legal Requirements, Type of Ownership, Building and Managing Teams, Defining role of investors

1 **1 Hour**

EXPERIMENT 1

Analysis of various business sectors

2 **2 Hours**

EXPERIMENT 2

Developing a Design Thinking Output Chart

3 **1 Hour**

EXPERIMENT 3

Creating Buyer Personas

4 **3 Hours**

EXPERIMENT 4

Undertake Market Study to understand market needs and assess market potential.

5 **3 Hours**

EXPERIMENT 5

Preparation of Business Model Canvas

6 **15 Hours**

EXPERIMENT 6

Developing Prototypes

7 **2 Hours**

EXPERIMENT 7

Organizing Product Design Sprints

8 **2 Hours**

EXPERIMENT 8

Preparation of Business Plans

9 **2 Hours**

EXPERIMENT 9

Preparation of Pitch Decks

Total: 45 Hours

References

1. Rashmi Bansal, Connect the Dots, Westland and Tranquebar Press, 2012
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Penguin Random House India, 2020
3. Ronnie Screwvala, Dream with Your Eyes Open: An Entrepreneurial Journey, Rupa Publications,2015
4. Stephen Carter, The Seed Tree: Money Management and Wealth Building Lessons for Teens,Seed Tree Group, 2021
5. Kotler Philip, Marketing Management, Pearson Education India, 15th Edition
6. Elizabeth Verkey and Jithin Saji Isaac, Intellectual Property, Eastern Book Company, 2ndEdition,2021

22MA201 **ENGINEERING MATHEMATICS II** **3 1 0 4**

Course Objectives

- To impart and analyze the concepts of differential equations to describe in real-world phenomena.
- To provide basic understanding on differential equation models and vector field models.
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of complex functions.

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the concept of differential equations through mathematical modeling and analyze its applications in engineering.
2. Apply the real world problems as second order linear differential equations.
3. Analyze the real-world phenomena with magnitude and direction in the form of vector functions.
4. Analyze the concept of vector fields and line integrals through mathematical modeling inengineering.
5. Evaluate the complex functions and apply them to formulate problems arising in engineering.

Articulation matrix

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

UNIT I **9 Hours**

FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS

Formation of differential equations- Solutions of first order linear ODE: Leibnitzs and method of separation of variables - Cooling/Heating of an object - A falling object - Modeling of electric circuits: RL and RC circuits - Modeling of population dynamics: Exponential growth and decay - Logistic growth model

UNIT II **9 Hours**

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS

Methods of solving second order linear ordinary differential equations - Models for linear oscillators: Simple harmonic motion - Mechanical vibrations with and without damping - Electric circuit system: RLC circuits.

UNIT III **9 Hours**

VECTOR DIFFERENTIAL CALCULUS

Vector and scalar functions - Fields - Derivative of a vector function and geometrical interpretation - Velocity and acceleration - Gradient and its properties - Tangent and normal vectors - Directional derivative - Divergence of a vector field - Curl of a vector field - Projectile motion

UNIT IV **9 Hours**

VECTOR INTEGRAL CALCULUS

Line integrals of vector point functions - Surface integral of vector point functions - Applications of line and surface integrals - Greens theorem in a plane - Stokes theorem - Gauss divergence theorem

UNIT V **9 Hours**

COMPLEX FUNCTIONS

Basic concepts of Complex numbers Geometrical representation of complex number - Analytic functions and its properties - Construction of Analytic functions: Fluid flow Electric flow - Mapping of complex functions

Total: 60 Hours

Reference(s)

1. Richard E. Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies. Inc, 1997
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B. Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013
4. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th editi5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017on ,2015
5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017

22PH202 **ELECTROMAGNETISM AND MODERN PHYSICS** **2 0 2 3**

Course Objectives

- Understand the principles and mechanisms of electricity and magnetism
- Infer the classification of electromagnetic waves
- Analyze the theory of relativity and energy bands

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

Course Outcomes (COs)

1. Apply the principles and mechanism of electrostatics and current
2. Apply the principles and mechanism of magneto statics
3. Analyze the electromagnetic waves and infer the characteristics of visible light
4. Analyze the importance of theory of relativity and analyze the wave nature of particles
5. Evaluate the electrical properties of semiconductor based on the band theory

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													
5	2	1							2						

UNIT I **6 Hours**

ELECTRICITY

Electric monopoles - Electric field- Electric flux - Electric potential - Electrical energy- Capacitor-Conductors and Insulators-Electric dipole and polarization - Electric current -Voltage sources- Resistance.

UNIT II **6 Hours**

MAGNETISM

Sources of magnetism- Monopoles-Magnetic field and force-magnetic field and current distribution-Magnetic dipole-Magnetic potential energy-Inductor- Electric and magnetic field comparison.

UNIT III **6 Hours**

ELECTROMAGNETIC WAVES AND LIGHT

Electromagnetism: Basic laws-Electromagnetic energy-radiation. Electromagnetic waves: origin, nature andspectrum-visible light, Principle of least time- geometrical optics-Human eye - Diffraction - Interference – polarization-LASER.

UNIT IV **6 Hours**

MODERN PHYSICS

Special theory of relativity - simultaneity and time dilation - length contraction - relativistic mas variation. Matterwaves - de-Broglie hypothesis - Wave nature of particles.

UNIT V **6 Hours**

ENERGY BANDS IN SOLIDS

Band theory of solids - Classification of materials - Semiconductors - Direct and indirect semiconductor –Fermi energy - Intrinsic and extrinsic semiconductor - Carrier concentration - Electrical conductivity

1 **5 Hours**

EXPERIMENT I

Determination of V-I characteristics of a solar cell

2 **5 Hours**

EXPERIMENT 2

Determination of Hall voltage of a given specimen by Hall Effect method

3 **5 Hours**

EXPERIMENT 3

Determination of wavelength of a given laser source - Grating method

4 **4 Hours**

EXPERIMENT 4

Determination of particle size using diode laser

5 **3 Hours**

EXPERIMENT 5

Determination of refractive index of a given solid medium and liquid medium

6 **4 Hours**

EXPERIMENT 6

Determination of energy loss per cycle of a ferromagnetic material using hysteresis curve

7 **4 Hours**

EXPERIMENT 7

Determination of band gap energy of a given semiconducting material

Total: 60 Hours

Reference(s)

1. C J Fischer, The energy of Physics Part II: Electricity and Magnetism, Cognella Academic Publishing, 2019
2. P G Hewitt, Conceptual Physics, Pearson education, 2017
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole,2019
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc,2018
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017

22CH203 **ENGINEERING CHEMISTRY II** **2 0 2 3**

Course Objectives

- Understand the concept of electrochemistry for determination of electrode potential, pH and applications as energy storage devices
- Outline the chemistry of metal corrosion and analyze the methods of corrosion control
- Understand how catalyst increases the reaction rate
- Summarize the variation in properties and reactivity of isotopes

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the electrochemical concepts to determine the electrode potential of a metal
2. Apply the working of batteries for the energy storage devices
3. Analyze the mechanism of corrosion and suggest a method to control the corrosion
4. Analyze the reaction mechanisms and assess the role of catalyst in a chemical reaction
5. Evaluate the various types of nuclear transmutation including decay reactions

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	1													
4	2	1													
5	2	1													

UNIT I **6 Hours**

ELECTROCHEMISTRY

Origin of potential - electromotive force - electrical double layer - transport of charge within the cell - cell description - prediction of cell potentials

UNIT II **6 Hours**

ENERGY STORING DEVICES

Relation between electrical energy and energy content of a cell - reversible and irreversible cell - charging and discharging reactions in a reversible cell - current challenges in energy storage technologies

UNIT III **6 Hours**

METAL CORROSION AND ITS PREVENTION

Oxidation of metals: Electrochemical origin of corrosion - electromigration - electron transfer in the presence and absence of moisture - galvanic series. Strategies for corrosion control: Galvanic anode and impressed current.

UNIT IV **6 Hours**

CATALYSIS

Energy profile diagram for a chemical reaction - activation energy - role of catalyst - homogeneous and heterogeneous catalysis - types

UNIT V **6 Hours**

NUCLEAR REACTIONS

Radioactive and stable isotopes - variation in properties between isotopes - radioactive decay (alpha, beta and gamma) - half-life period - nuclear reactions - radiocarbon dating

1 **4 Hours**

EXPERIMENT 1

Determination of strength of hydrochloric acid in a given solution using pH meter

2 **4 Hours**

EXPERIMENT 2

Application of calomel electrode to determine the redox potential of Fe(II) solution

3 **4 Hours**

EXPERIMENT 3

Construct an electrochemical cell exhibiting valid output and compare its potential with the given standard cell

4 **5 Hours**

EXPERIMENT 4

Determination of corrosion percentage of iron/steel by weight loss method

5 **4 Hours**

EXPERIMENT 5

Determination of percentage of corrosion inhibition in iron/mild steel using a natural inhibitor

6 **4 Hours**

EXPERIMENT 6

Electroplate copper on the given target object and estimate the amount of copper deposited at cathode

7 **5 Hours**

EXPERIMENT 7

Determination of rate constant of acid catalyzed hydrolysis of ester

Total: 60 Hours

Reference(s)

1. Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.
2. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012.
3. E.McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010.
4. S. Vairam, Engineering Chemistry, John Wiley &Sons, 2014.
5. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th edition, (revised) New Age International Publishers, 2011.
6. U. Hanefeld, L. Lefferts, Catalysis: An Integrated Textbook for Students, Wiley- VCH, 2017

22GE002 **COMPUTATIONAL PROBLEM SOLVING** **3 0 0 3**

Course Objectives

- Analyze the algorithm design techniques and development principles in solving the real life problems.
- Illustrate the different ways of organizing and storing the data in computing systems.
- Understand the basic network configuration and setup connections among different device systems.

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design 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. Apply and formulate algorithms, pseudo codes and flowcharts for problems.
2. Apply algorithmic solutions to simple computational problems and explore algorithmic approaches to problem solving.
3. Analyze the appropriate data structures for solving computing problems.
4. Analyze the various storage devices used in a computer system.
5. Evaluate the requirements for a given organizational structure and establish the connection between two or more computers to form a network.

Articulation matrix

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

UNIT I **6 Hours**

VISUAL PROCESS MODELING

Scenario decomposition - logical sequencing - drawing flowchart - preparing visual process model

UNIT II **12 Hours**

ALGORITHMIC DESIGN THINKING

Analysis - Verification - Brute force - Divide and conquer - Greedy - Backtracking.

UNIT III **12 Hours**

DATA ORGANIZATION

Elementary Data Organization - Abstract Data Types - Fundamentals of Linear and Non Linear Data Structures.

UNIT IV **7 Hours**

DATA STORAGE

Flat File and Relational database- Data Read & Write in Local Storage, Server Storage and Cloudstorage –Database Query Methods.

UNIT V **8 Hours**

NETWORKING ESSENTIALS

Networking Components and Services - IP Addressing - Configuring and Managing the Campus Network - NetworkSecurity - Firewalls.

Total: 45 Hours

Reference(s)

1. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor &Francis Group, 2014.
2. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education Asia,2011.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education,2016.
4. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw Hill, 2015.
5. Behrouz A.Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw-Hill, 2014.

22GE004 BASICS OF ELECTRONICS ENGINEERING 2 0 2 3

Course Objectives

- Understand the concept of energy transmission through mechanical, electrical and electromagnetic form.
- To Analyze the characteristics and electrical parameters of Diode and BJT
- To illustrate the applications of Diode and BJT for special signal conditioning.
- To apply the working principle of PN Junction Diode and BJT to design basic Digital Logic.

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyses complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. 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.

13. Able to design new concepts in the domains of Microelectronics and Communication Engineering.

Course Outcomes (COs)

1. Apply the need for electrical and electromagnetic signal transmission.
2. Analyze the working principle and characteristics of PN junction diode.
3. Analyze the working principle and characteristics of Bipolar Junction Transistor.
4. Analyze the working principle of PN Junction diode and BJT for designing basic Digital Logic functions.
5. Evaluate the energy conversion needs and working principle of Special purpose 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										2		
2	3	2	3										2		
3	2	3	3										2		
4	2	3	3										2		
5	1	2	3										2		

UNIT I 6 Hours

ENERGY TRANSFER AND SIGNALS

Energy Transmission through Mechanical, Electrical and Electromagnetic means, Signal as Energy Transmission, Complexity in signal transmission (Volume of Information, Distance and Time taken), Limitations of Mechanical Energy Transmission, Electrical and Electromagnetic Signal Transmission, Need for Conversion between Electrical and Mechanical Signals.

UNIT II 6 Hours

SIGNAL CONDITIONING USING DIODE

Need for Vacuum Tubes in the Evolution of Electronics, Overview of Vacuum Tubes, Diode and Triode, Limitations of Vacuum Tubes. Semiconductor Group in Periodic Table, Overview of Semiconductor Materials, Flow of electrical energy through PN Junction Diode, Signal Clipping, Signal Clamping and Signal Multiplication using PN Junction Diode, Limitations of PN Junction Diode

UNIT III **6 Hours**

SIGNAL CONDITIONING USING DIODE

Need for controlling electrical signals, Principle of Bipolar Junction Transistor operation, Signal Switching and Amplification using BJT, Limitations of BJT, Principle of Field Effect Transistor operation.

UNIT IV **6 Hours**

LOGIC SYNTHESIS USING DIODE AND TRANSISTORS

Overview of Logic Gates, PN Junction and BJT as electronic switches, Digital Logic Synthesis using Diode and Transistor: Diode Logic, Resistor Transistor Logic, Diode Transistor Logic, Transistor Logic.

UNIT V **6 Hours**

DEVICES FOR SPECIAL REQUIREMENTS

Voltage Regulation using Zener Diode, Variable Capacitance using Varactor Diode, Electrical Energy to Light Energy conversion using Light Emitting Diode, Light to Energy to Electrical Energy conversion using Solar Cell.

1 **4 Hours**

EXPERIMENT 1

Design and Implement a simple device to communicate basic information between two different small distance points using wired and wireless methods.

2 **6 Hours**

EXPERIMENT 2

Design and Implement different wave shaping Circuits using PN Junction Diodes.

3 **4 Hours**

EXPERIMENT 3

Design and Implement Voltage Multiplier Circuit using PN Junction Diodes and Capacitors.

4 **4 Hours**

EXPERIMENT 4

Design and Implement t a three Stage Circuit to convert 220V 50Hz AC mains supply to 12V DC supply

5 **4 Hours**

EXPERIMENT 5

Design and Implement a BJT Amplifier Circuit to amplify audio input signal.

6 **4 Hours**

EXPERIMENT 6

Design and Implement Basic Logic Gates using PN Junction Diodes.

7 **4 Hours**

EXPERIMENT 7

Design and Implement Basic Logic Gates using BJTs.

Total: 60 Hours

Reference(s)

1. Thomas L. Floyd ,Electronic Devices: Electron Flow Version, Ninth Edition, Prentice Hall, 2012.
2. J Millman, C. Halkias & Satyabrata JIT, Electronic Devices and Circuits, Tata McGraw-Hill, 2007.
3. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education 2006.
4. David A. Bell, Electronic Devices and Circuits, Prentice Hall of India, 2003.
5. Adel S. Sedra & Kenneth C. Smith, Micro Electronic Circuits Theory and Applications, Sixth Edition, Oxford University Press, 2013.
6. Behzad Razavi, Microelectronics, Wiley India Pvt. Ltd.; 2nd edition (2018).

22GE005 **ENGINEERING DRAWING** **1 0 2 2**

Course Objectives

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simple solids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and vice versa.

Programme Outcomes (POs):

Course Outcomes (COs)

1. Apply the engineering drawing concepts as per industrial standards.
2. Analyze the orthographic projections of points and lines.
3. Analyze the projection of planes and simple solids.
4. Draw the section of solids and development of surfaces.
5. Draw the orthographic projection from isometric view and vice versa.

UNIT I **7 Hours**

FUNDAMENTALS OF ENGINEERING DRAWING

Definition - standards - drawing tools - drawing sheets - scales - line and its types. Practices on lettering - numbering - dimension of drawings. Construction of conic sections - ellipse - parabola and hyperbola using eccentricity method.

UNIT II **9 Hours**

PROJECTION OF POINTS AND LINES

Principles of projection - projection of points in four quadrants - first angle projection of straight lines - perpendicular to one plane - parallel and inclined to both planes.

UNIT III **9 Hours**

PROJECTION OF PLANES AND SOLIDS

Projection of simple planes and projection of simple solids - parallel - perpendicular and inclined to one plane using change of position method - inclined to both the planes

UNIT IV **9 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

Section of Solids - simple position with cutting plane parallel - perpendicular and inclined to one plane with true shape of section. Development of surfaces - simple and truncated solids.

UNIT V **11 Hours**

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

Orthographic projections and isometric view of components used in engineering applications.

Total: 45 Hours

Reference(s)

1. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2019.
2. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
3. K Venugopal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2013.
4. Basant Agarwal, Mechanical drawing, Tata McGraw-Hill Education, 2013.
5. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards-Sp46, 2013

22HS003 **HERITAGE OF TAMILS** **1 0 0 1**

Course Objectives

1. Describe the linguistic diversity in India, highlighting Dravidian languages and their features.
2. Summarize the evolution of art, highlighting key transitions from rock art to modern sculptures.
3. Examine the role of sports and games in promoting cultural values and community bonding.
4. Discuss the education and literacy systems during the Sangam Age and their impact.
5. Outline the importance of inscriptions, manuscripts, and the print history of Tamil books in preserving knowledge and culture.

Programme Outcomes (POs):

9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. 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. Understand the concept of language families in India, with a focus on Dravidian languages.
2. Trace the evolution of art from ancient rock art to modern sculptures in Tamil heritage.
3. Identify and differentiate various forms of folk and martial arts in Tamil heritage.
4. Understand the concepts of Flora and Fauna in Tamil culture and literature.
5. Evaluate the contributions of Tamils to the Indian Freedom Struggle.

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									2	3					
4									2	3					
5									2	3					

UNIT I **3 Hours**

LANGUAGE AND LITERATURE

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

UNIT II **3 Hours**

HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta

sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III **3 Hours**

FOLK AND MARTIAL ARTS

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

UNIT IV **3 Hours**

THINAI CONCEPT OF TAMILS

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

UNIT V **3 Hours**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE

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

Total: 15 Hours

Reference(s)

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

22BT301 FOURIER SERIES, TRANSFORMS AND BIOSTATISTICS 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)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyses 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 bio technology.
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 hypothesis testing

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- Dirichlets conditions - The Euler coefficients - General Fourier series. Fourier transforms- Properties of Fourier transform- Applications of Fourier series and transform analysis.

UNIT II 9 Hours

PARTIAL DIFFERENTIAL EQUATIONS

Formation of Partial Differential Equations by eliminating arbitrary constants and functions – Solutions of Standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second

order with constant coefficients of homogeneous type.

UNIT III **9 Hours**

LAPLACE TRANSFORM

Laplace Transform- Existence Condition -Transforms of Standard Functions - Unit step function, Unit impulse function- Properties- Transforms of Derivatives and Integrals - Initial and Final Value Theorems- Laplace transform of Periodic Functions - Inverse Laplace Transform- Convolution.

UNIT IV **9 Hours**

NUMERICAL SOLUTION OF SYSTEM OF LINEAR EQUATIONS

Solution of algebraic and transcendental equations: Fixed point iteration method - Newton- Raphson method - Solution of system of linear equations: Gauss elimination method – Gauss Seidel method - Inverse of a matrix: Gauss-Jordan method- Eigen values of a matrix by Power method.

UNIT V **9 Hours**

INTERPOLATION, DIFFERENTIATION AND INTEGRATION

Interpolation: Newton's forward and backward interpolation formulae – Lagrange's interpolation formula. Numerical Differentiation: Approximation of derivatives using interpolation polynomials. Numerical integration: Trapezoidal rule- Simpson's rules for single and double integrals.

Total: 45 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.

22BT302 **BIOCHEMISTRY** **3 0 2 4**

Course Objectives

- To learn the bio molecules in the biological system.
- To study the mechanism and role of enzymes in metabolic pathways
- To analyze the biomolecules qualitatively and quantitatively.

Programme Outcomes (POs)

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

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply the classification, structure, function and properties carbohydrates and lipids.
2. Analyse the structures , functions and classification of proteins and nucleic acids.
3. Analyze the concepts of buffers, and principles and energetics of chemical reactions inmetabolic 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 human body.

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**

METABOLISM INRODUCTION AND ENERGETICS

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

1 **6 Hours**

EXPERIMENT 1

Qualitative analysis of carbohydrates

2 **6 Hours**

EXPERIMENT 2

Qualitative analysis of amino acids

3 **6 Hours**

EXPERIMENT 3

Estimation of amino acids by ninhydrin method

4 **6 Hours**

EXPERIMENT 4

Determination of saponification /acid number of lipids

5 **6 Hours**

EXPERIMENT 5

Quantitative analysis of DNA and RNA by UV spectrophotometer

Total: 75 Hours

Reference(s)

1. D. L. Nelson and M. M. Cox, Lehninger's Principles of Biochemistry, 6th edition WHF reeman & 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 PrivateLtd., 2000.
5. www.ocw.mit.edu
6. A. Manickam , S. Sadasivam, Biochemical Methods, 3 rd Edition, New Age International Pvt LtdPublishers, 2009.

22BT303 **ENGINEERING THERMODYNAMICS** **3 1 0 4**

Course Objectives

- To study the fundamentals of thermodynamics and zeroth law.
- To provide the knowledge on first law of thermodynamics.
- To impart the knowledge on second law of thermodynamics and entropy.
- To study the thermodynamic properties of pure substances and its phase change processes.
- To learn about gas power cycles and properties of gas mixtures.

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. 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.
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
13. Design, analyse and evaluate the performance of mechanical systems
14. Address all the fluid flow and heat transfer related problems of mechanical systems

Course Outcomes (COs)

1. Apply the basic concepts and Zeroth law of thermodynamics.
2. Apply the first law of thermodynamics to closed and open systems
3. Analyze the problems related to cycles and cyclic devices using second law of thermodynamics.
4. Analyze the thermodynamic properties of pure substances and its phase change processes
5. Evaluate the air standard performance of heat engines and properties of gas mixtures.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION AND ZEROTH LAW OF THERMODYNAMICS

Macroscopic and Microscopic approaches, energy, heat, work. Thermodynamic system – Types, properties, functions, states, processes and cycle. Zeroth law of thermodynamics - temperature scale,perfect gas scale.

UNIT II **8 Hours**

FIRST LAW OF THERMODYNAMICS

First law of thermodynamics, Application of first law - Closed systems and Open systems, Thermodynamic processes in closed systems, Steady state flow processes in open systems.

UNIT III **9 Hours**

SECOND LAW OF THERMODYNAMICS

Limitations of first law of thermodynamics, Second law of thermodynamics - Kelvin - Planck and Clausius statements, Reversible and irreversible processes, Carnot theorem, Carnot engine, Clausius inequality, Entropy, Availability and irreversibility. Heat Engine, heat pump and refrigerator.

UNIT IV **10 Hours**

PROPERTIES OF PURE SUBSTANCES

Thermodynamic properties of fluids. Pure substance - Phases - Phase change processes, Steam tables and Property diagrams - (P-V), (P-T), (T-V), (T-S) and (h-s) diagrams. Ideal gas equation, Van der Waals equation and compressibility chart.

UNIT V **10 Hours**

GAS MIXTURES AND GAS POWER CYCLES

Thermodynamics and properties of ideal gas mixture and perfect gas mixture - Dalton's law of partial pressure, Amagat's law. Psychrometric properties and processes - Psychrometric chart. Air standard cycles Otto, Diesel and Dual cycles- mean effective pressure and air standard efficiency.

Total: 60 Hours

Reference(s)

1. Y. Cengel and Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2019.
2. P.K. Nag, Engineering Thermodynamics,Tata McGraw Hill Publishing Company Pvt. Ltd, NewDelhi,2018.
3. J.P.Holman, Thermodynamics, Tata McGraw Hill Publishing Company Pvt Ltd., NewDelhi,2016.
4. R.K. Rajput, Engineering Thermodynamics, Laxmi Publications Pvt.Ltd., New Delhi,2017.
5. Gordon J. Van Wylen, Richard E. Sonntag, Fundamentals of Classical Thermodynamics, December31st 1978, John Wiley & Sons.
6. https://onlinecourses.nptel.ac.in/ noc22-ch01

22BT304 **MICROBIOLOGY** **3 0 2 4**

Course Objectives

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

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. 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.
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
9. Function effectively as an individual, and as a member or leader in diverse teams, and inmultidisciplinary settings.
13. Use the analytical instruments and techniques to isolate, purify and characterize biological compound.
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the nomenclature, techniques and applications of microscopes and principles of staining techniques.
2. Apply the structure and multiplications of Microbes.
3. Analyze the microbial nutrition, Growth and metabolism of microbes.
4. Analyze the microbial control and host interaction.
5. Evaluate the production of Bio fertilizers and antibiotics.

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; principles of staining techniques - 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 bymicrobes; microbial treatment of wastewater - aerobic and anaerobic methods.

1 **3 Hours**

EXPERIMENT 1

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

2 **6 Hours**

EXPERIMENT 2

Bacterial growth curve

3 **3 Hours**

EXPERIMENT 3

Indole and Citrate utilization tests

4 **3 Hours**

EXPERIMENT 4

Methyl red and Voges-Proskauert test

5 **3 Hours**

EXPERIMENT 5

Lactophenol cotton blue staining

6 **4 Hours**

EXPERIMENT 6

Gram staining, Endospore staining and Flagella staining

7 **4 Hours**

EXPERIMENT 7

MPN test for identification of coliform bacteria

8 **4 Hours**

EXPERIMENT 8

Antibiotic sensitivity assay and Minimum inhibitory Concentration

Total: 75 Hours

Reference(s)

1. L. M. Prescott, J. P. Harley and D. A. Klein, *Microbiology*, Wm. C. BrownPublishers, 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.

22BT305 PROCESS CALCULATIONS AND UNITOPERATIONS 3 1 0 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

13. Able to design new concepts in the domains of Microelectronics and Communication Engineering.

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 and differentiate various size reduction equipment and measurement of the particle size.
4. Evaluate various types of mixers, flow patterns and scale up criteria for mixing and agitation.
5. Create the equipment 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												1		
2		2	3										2		
3		2	3										1		
4	3												2		
5	3		2										1		

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

Total: 60 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.

22HS004 **HUMAN VALUES AND 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)

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, makeeffective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Apply the importance of human values and ethics in life.
2. Analyze 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. Evaluate intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Create a 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

Importance of Human Values & Ethics in 21st Century - Understanding the theory of basic human values and ethics - Openness to change - Self enhancement - Conservation - Self transcendence - 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 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. The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin. 2011.
2. Gupta, N. L. Human Values for The 21St Century. India: Anmol Publications Pvt. Limited. 2002.
3. Mishra, A. Happiness Is All We Want. India: Bloomsbury Publishing.2017.
4. Universal Human Values. (n.p.): Booksclinic Publishing. 2023.
5. A Textbook on Professional Ethics and Human Values. India: New Age International (P) Limited.2007.

22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION 0 0 2 1

Course Objectives

- Communicate proficiently in formal discussions at the workplace.
- Describe experiences and events, and briefly give reasons and explanations for opinions and plans.
- Interact with a degree of fluency and spontaneity that results in efficacious communication
- Convey agreement and disagreement in a polite but firm manner
- Communicate with coherence and imagination in both written and spoken formats

Course Outcomes (COs)

1. Enhance confidence in expressing thoughts in grammatically proper language and etiquette in waiting for the opportunity to provide input
2. Effectively communicate in English on formal occasions and proficiency in the use of link words and other discourse markers
3. Provide constructive feedback and file logical complaints
4. Analyse the understanding of oral and written communication in real-world situations.
5. Apply the improved spelling and punctuation in writing and heightened understanding of tone, pitch and stress in oral formats.

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									2	3					
4									2	3					
5									2	3					

UNIT I **10 Hours**

SELF-EXPRESSION

Group discussion/ Peer discussion - Communicating decisions and opinions - Tone, Pitch, Stress - Agreeing, Disagreeing, Suggesting, Speculating - Comparing and Contrasting - Comparatives and Superlatives - Discourse markers – Interjections - Decision making - Synthesis - Higher order thinking Group discussion/Peer discussion – Effective Communication Types of communication - Written vs Spoken - Contractions Intonation Stress Active voice - Question tags - Confidence and body language Guided writing- Outlining Main Points - Group discussion/Peer discussion - Avoiding common errors Reduction of MTI - Common errors - Barriers to communication Accent

UNIT II **10 Hours**

CREATIVE EXPRESSION

JAM, Debate, Review writing, Social media posts Synonyms - Antonyms Cloze test Phrasal verbs Spotting errors Collocation - Commonly mispronounced

UNIT III **10 Hours**

FORMAL EXPRESSION

Writing: Giving written feedback, Review writing, and Letter of complaint. Speaking: Giving constructive feedback and offering suggestions, asking for inputs, commenting politely on appropriate phrases - Giving written feedback, Review writing, and Letter of complaint. Critical reasoning - Modal verbs - Polite ways to express negatives

Total: 30 Hours

Reference(s)

1. Word Power Made Easy by Norman Lewis, W. R. Goyal Pub. & Distributors, 2009.
2. Sasikumar, V, et al., A Course in Listening & Speaking Foundation Books, 2005.
3. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
4. Prasad, Hari Mohan. A Handbook of Spotting Errors, Mcgraw Hill Education, 2010.
5. Personality Development & Soft Skills, Barun K. Mitra, Oxford University Press, 2012
6. Business English by Ken Taylor, Orient Blackswan, 2011

22HS006 **TAMILS AND TECHNOLOGY** **1 0 0 1**

Course Objectives

- Analyse graffiti on potteries as a form of historical and cultural documentation during the Sangam Age.
- Investigate the building materials and the historical context of Hero stones during the Sangam Age by Analysing thedetails of stage constructions in Silappathikaram and their cultural significance.
- Examine ancient knowledge of oceans and its impact on Tamil society.

Programme Outcomes (POs)

9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, makeeffective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Understand the significance of the weaving industry during the Sangam Age and its cultural importance.
2. Understand the significance of dams, tanks, ponds, and sluices in the agricultural and irrigation practices of the CholaPeriod.
3. Explore the architectural designs and structural construction methods used in household materials during the SangamAge.
4. Explore the art of shipbuilding in ancient Tamil culture and its role in maritime trade and transportation.
5. Trace the development of scientific terminology and vocabulary in Tamil language.

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									2	3					
4									2	3					
5									2	3					

UNIT I **3 Hours**

WEAVING AND CERAMIC TECHNOLOGY

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

UNIT II **3 Hours**

DESIGN AND CONSTRUCTION TECHNOLOGY

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

UNIT III **3 Hours**

MANUFACTURING TECHNOLOGY

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

UNIT IV **3 Hours**

AGRICULTURE AND IRRIGATION TECHNOLOGY

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

UNIT V **3 Hours**

SCIENTIFIC TAMIL AND TAMIL COMPUTING

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

Total: 15 Hours

Reference(s)

1. Dr. K. K. Pillay , Social Life of Tamils, A joint publication of TNTB & ESC and RMRL
2. Dr. S. Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr. S. V. Subatamanian , Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr. M. Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies
5. Keeladi - Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr. K. K. Pillay, Studies in the History of India with Special Reference to Tamil Nadu.

22BT401 **BIOORGANIC CHEMISTRY** **3 0 2 4**

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)

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

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

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

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

14. Design and synthesis of the novel biomolecule for the agriculture and healthcare sectors

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. Evaluate 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									1	
3	2	3		1	1										

4	2	3		1	2			2						2	
5	2	3		1	3			2							

UNIT I **9 Hours**

INTRODUCTION

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 electrophilic, 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 catalyzed reaction. Significances of change in enthapy, free energy, entropy in enzyme kinetics. Kinetics ofmultisite co-operative enzymes-sequential (Koshland-Nemethy-Filmer (KNF) and Concerted (Monod - Changeux -Wyman model) models.

UNIT IV **9 Hours**

SYNTHESIS AND SEQUENCING OF 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

1 **6 Hours**

EXPERIMENT 1

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

2 **6 Hours**

EXPERIMENT 2

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

3 **6 Hours**

EXPERIMENT 3

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

4 **6 Hours**

EXPERIMENT 4

Extraction of lycopene from tomato

5 **6 Hours**

EXPERIMENT 5

Preparation of oleic acid from olive oil

Total: 75 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.

22BT402 **HEAT AND MASS TRANSFER** **3 0 2 4**

Course Objectives

- To familiarize conduction heat transfer mechanisms.
- To expose the mechanisms of free and forced convection.
- To develop the shape factor algebra for black body radiation and grey body radiation.
- To demonstrate the phase change heat transfer and determine the performance of heat exchanging devices.
- To infer diffusion and convective mass transfer.

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysisand interpretation of data, and synthesis of the information to provide valid conclusions.
5. 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.
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, anddemonstrate the knowledge of, and need for sustainable development
14. Address all the fluid flow and heat transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the heat conduction equation to compute the rate of heat transfer in one and two - dimensional systems and composite systems
2. Assess the convection phenomena and determine the heat transfer rate in free and forced convection
3. Determine the heat transfer rate in radiation and Compare the thermal performance of heat exchangers using LMTD or NTU approach
4. Execute mass transfer rate in diffusion mass transfer applications
5. Evaluate convective mass transfer process and apply mass transfer principles in food and bioprocessing

Articulation Matrix

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

UNIT I **8 Hours**

CONDUCTION

Introduction – Steady State Conduction in one and two – dimensional systems. Composite systems.Extended surfaces.

UNIT II **8 Hours**

CONVECTION

Basic concepts - Heat transfer coefficients, Boundary layers. Forced convection - External and Internal flows, correlations, Natural convection- Logarithmic Mean Temperature Difference.

UNIT III **11 Hours**

RADIATION AND HEAT EXCHANGERS

Radiation heat transfer – concept of black and grey body - monochromatic Total emissive power– Kirchhoff's law – Planck's law - Stefan-Boltzmann's law –Heat exchangers – parallel, counter and cross flow- Heat transfer efficiency using LMTD and NTU – overall coefficient of heat transfer in shell and tube heat exchanger for food products

UNIT IV **10 Hours**

INTRODUCTION TO MASS TRANSFER

Basics of mass transfer- Fick's laws of diffusion- mechanisms of mass transfer-Molecular diffusion, Fick's first and second laws, steady-state and non-steady-state diffusion, diffusion in solids and liquids, diffusion coefficients..

UNIT V **8 Hours**

MASS TRANSFER

Fundamentals of convective mass transfer, boundary layer theory, mass transfer coefficients in laminar and turbulent flow, Knudsen diffusion, dimensionless numbers, applications of mass transfer in bio and food industries.

1 **3 Hours**

EXPERIMENT 1

Determination of thermal conductivity for one dimensional steady state conduction.

2 **3 Hours**

EXPERIMENT 2

Determination of heat transfer co-efficient by unsteady heat transfer

3 **3 Hours**

EXPERIMENT 3

Determination of heat transfer co-efficient by natural convection

4 **3 Hours**

EXPERIMENT 4

Determination of heat transfer co-efficient by forced convection

5 **3 Hours**

EXPERIMENT 5

Determination of Stefan-Boltzmann constant

6 **3 Hours**

EXPERIMENT 6

Determination of emissivity using emissivity apparatus

7 **3 Hours**

EXPERIMENT 7

Determination of overall heat transfer for film wise and drop wise condensation

8 **3 Hours**

EXPERIMENT 8

Determination of overall heat transfer co-efficient for a parallel and counter flow heat exchanger

9 **3 Hours**

EXPERIMENT 9

Experimentation on mass transfer

10 **3 Hours**

EXPERIMENT 10

Determination of overall heat transfer co-efficient for a fluidized bed heat transfer

Total: 75 Hours

Reference(s)

1. Yunus A.Cengel, Heat and Mass Transfer: Fundamentals and Application, Tata McGrawHill publishing Company private limited, New Delhi, 6th edition, 2020.
2. J. P. Holman, Heat Transfer, Tata McGraw Hill publishing Company private limited, NewDelhi, 10th edition, 2010.
3. C. P. Kothandaraman and S. Subramanyan, Fundamentals of Heat and Mass Transfer,New Age International private limited, New Delhi, Rev.3rd edition, 2006.
4. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, Principles of Heat and Mass Transfer, ISBN: 978-1-119-38291-1 October 2017.
5. R. K. Rajput, Heat and Mass Transfer, S Chand and Company, New Delhi, 2018.
6. Robert E. Treybal, Mass-transfer operations. McGraw-Hill Book Company, Inc.,, 3rd edition, 2017
7. Dutta, B.K., Heat transfer: principles and applications. 2nd Edition, PHI Learning Pvt. Ltd.. 2023

22BT403 **CELL AND MOLECULAR BIOLOGY** **3 0 2 4**

Course Objectives

- To understand the concept of the cell division and signalling pathway.
- To expose students to various molecular events in prokaryotes.
- To create deeper understanding on regulation of genes activities.

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
13. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

Course Outcomes (COs)

1. Apply the concepts of cell structure, and functions of organelles and the cell cycle.
2. Apply the mechanisms of transport, receptors and cell signaling.
3. Analyze the mechanism of DNA replication &transcription 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	2	3		2									1	1	
2	3	3		2									1	1	
3	3			1								1	1	2	
4	3			1			1						1	2	
5	3			1									1	1	

UNIT I **9 Hours**

MEMEBRANE ORGANIZATION AND CELL CYCLE

Biological membrane organization- membrane proteins &cytoskeletal proteins, Types of cell division – mitosis, meiosis and asynthetic fission, cell cycle and molecules that control cell cycle; cell cycle and cancer. Receptors: Cytosolic, Nuclear and membrane bound receptors; Receptor Mechanism; Autocrine, paracrine and endocrine models of action; Receptor components: Neurotransmitters, agonists and antagonists

UNIT II **9 Hours**

TRANSPORT ACROSS CELL MEMBRANES AND SIGNAL TRANSDUCTION

Ligand-gated and Voltage-gated ion channels; Channel components (permeases, proton pumps & ATPase); Channels examples (sodium potassium pump, Ca2+ ATPase pumps); Channel mechanism: endocytosis, exocytosis & receptor-mediated endocytosis; co-transport (symport, antiport); Signal amplifications; different models of signal amplification; Second messengers - cAMP, Inositol phosphates,DAG, cGMP, G proteins, Ca; Protein kinases, serine threonine kinases

UNIT III **9 Hours**

DNA REPLICATION & TRANSCRIPTION

Physical and chemical structure of DNA &RNA; Properties of genetic material; Prokaryotic DNA polymerases; DNA replication in prokaryotes; Prokaryotic RNA polymerase & Transcription

UNIT IV **9 Hours**

GENETIC CODE & TRANSLATION

The genetic code- salient features; Wobble base pair & Aminoacyl-tRNAsynthetases; Posttranscriptional modification - mRNA processing; Translation in prokaryotes; DNA damage & DNA repair; Inhibitors of translation.

UNIT V **9 Hours**

REGULATION OF GENE ACTIVITY

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

FOR FURTHER READING

Apoptosis and programmed cell death, Ion channel defects; TNF receptor families, DNA replication in eukaryotes-initiation, elongation and termination; DNA transcription and translation in eukaryotes

1 **5 Hours**

EXPERIMENT I

Mitosis in onion root tip

2 **5 Hours**

EXPERIMENT 2

To isolate genomic DNA from Bacteria

3 **5 Hours**

EXPERIMENT 3

To isolate genomic DNA from plant & animal tissue

4 **5 Hours**

EXPERIMENT 4

To quantify DNA using UV spectrophotometer / DNA nano drop

5 **5 Hours**

EXPERIMENT 5

To digest DNA using restriction enzymes

6 **5 Hours**

EXPERIMENT 6

To identify DNA molecule using agarose gel electrophoresis

Total: 75 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, Lewin 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 theCell, 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

22BT404 INSTRUMENTATAL METHODS OFANALYSIS 3 0 2 4

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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. 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.

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

Course Outcomes (COs)

1. Apply the function of electrical and optical component in analytical instruments and theircalibration.
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. Evaluate the different types of electrodes and electro analytical 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								2		
3	3	2	2	1	2								2		
4	3	3	3	2	2								2		
5	3	1	2	1	1								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

1 **3 Hours**

EXPERIMENT 1

Ultraviolet Absorption Spectroscopy

2 **4 Hours**

EXPERIMENT 2

Visible Absorption Spectroscopy

3 **4 Hours**

EXPERIMENT 3

Column chromatography

4 **4 Hours**

EXPERIMENT 4

Thin Layer chromatography

5 **3 Hours**

EXPERIMENT 5

Gel filtration or size exclusion chromatography

6 **4 Hours**

EXPERIMENT 6

Ion exchange chromatography

7 **4 Hours**

EXPERIMENT 7

High performance liquid chromatography

8 **4 Hours**

EXPERIMENT 8

Affinity chromatography

Total: 75 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, AdithiyaArt Printers, 1987

22BT405 **PLANT TISSUE CULTURE** **2 0 2 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)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, andsynthesis of the information to provide valid conclusions.
5. 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.
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. 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.
13. Use the analytical instruments and techniques to isolate, purify and characterize biological compounds
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resource

Course Outcomes (COs)

1. Apply the biology being plant tissue culture techniques.
2. Analyze the need of various physio chemical conditions in PTC.
3. Analyze 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		2			1				1	1			1
2	1		3	2		1	1			1	2	1			
3		2	1		2			1	1		1		1		
4	1			2		1			1			1			2
5			2		3			1				1			2

UNIT I **9 Hours**

BIOLOGY OF PLANT TISSUE CULTURE

Basics of plant cell, Cellular differentiation, dedifferentiation & redifferentiation, Totipotency, Cellular plasticity, Organogenesis and Embryogenesis, Somoclonal variation, History of plant tissue culture.

UNIT II **9 Hours**

COMPONENTS IN TISSUE CULTURE PROCEDURES

Explants: types and sterilization techniques, Equipment and accessories for Plant tissue culture, Laboratory organization, Micro and macro nutrients, Vitamins, solidifying agents, Plant growth hormones, Role of adsorbents and antioxidants in PTC, Antibiotics in Plant tissue culture.

UNIT III **9 Hours**

TISSUE CULTURE TECHNIQUES

Need for variety of techniques in PTC, *in-vitro* seed germination, Micropropagation, Suspension culture, Callus culture, Somatic embryogenesis, Protoplast cultures, Hairy root culture.

UNIT IV **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 and cosmetics, Regulations in PTC derived plantlets.

UNIT V **9 Hours**

ADVANCEMENTS IN PLANT TISSUE CULTURE

Automation in plant tissue culture, Artificial Intelligence models in optimization procedures, CRISPR mediated gene editing using PTC techniques, Molecular farming & edible vaccines.

FOR FURTHER READING

Artificial seeds synthesis, Rapid clonal propagation, Biosafety in PTC.

1 **4 Hours**

EXPERIMENT 1

Plant tissue culture laboratory organization

2 **4 Hours**

EXPERIMENT 2

Tissue culture medium stock preparation

3 **4 Hours**

EXPERIMENT 3

Explant selection and sterilization techniques

4 **4 Hours**

EXPERIMENT 4

Medium preparation, sterilization and explant inoculation

5 **4 Hours**

EXPERIMENT 5

Hardening and Acclimatization

6 **5 Hours**

EXPERIMENT 6

Protoplast preparation and isolation

7 **5 Hours**

EXPERIMENT 7

Agrobacterium infiltration: Syringe & vacuum infiltration

Total: 75 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.

22HS007 **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)

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

Course Outcomes (COs)

1. Examine 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. Impact the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Correlate 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
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). Energy resources: renewable (solar, wind, and hydro).

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: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

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) - noise pollution- thermal pollution. Disaster management: causes - effects - control measures of floods - earthquake

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development : Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water conservation- rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

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

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

22HS008 ADVANCED ENGLISH AND TECHNICAL EXPRESSION 0 0 2 1

Course Objectives

- To enable students to achieve proficiency in academic writing
- To effectively use the language to persuade others
- To appreciate the nuances of the language and engage an audience
- To use advanced tools of language to improve communicative competence
- To prepare for professional demands at the workplace
- To give concrete expression to the plans and goals

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. Understand the clarity in articulating the objectives and aims and improved proficiency in using the English language
2. Communicate effectively and with good interpersonal skills; speak in public, engage the audience, and lead a group discussion
3. Critically evaluate the ethics of persuasive appeals and confidence to influence opinion
4. Analyse a specific piece of information; take in what is read, and use good writing techniques with proper grammar and syntax in all formal situations
5. Create awareness and empathy to emotional signals in communication

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									2	3					
4									2	3					
5									2	3					

UNIT I **15 Hours**

CREATIVE EXPRESSION

Proposals & Grant applications, Argumentative essays & editorials, Sales Pitches, Campaigning, Commercials/advertisements, effectively answering the famous interview question: 'Why should we hire you?' Sentence and paragraph formation - Rhetorical questions - Emphasis & effective repetition - Empathetic expression, knowing the audience, capturing attention - Creating Memes, Comic Strips, Stand-up comedy, Caption writing, and Limericks, Vocabulary and slang words for comedy - Similes & Metaphors - Homophones, homonyms, alliteration, wordplay

UNIT II **15 Hours**

FORMAL EXPRESSION

Writing: Action plans, Cover letters, Mind-Mapping, Paragraph writing Logical reasoning - SVA - Advanced level Style: Clarity, Concision, Coherence, Evocativeness, Efficacious Vocabulary - Conditional Clause - Be verbsTenses- advanced - Opening and closing sentences - Action plans, Anecdotal references, order of communication/ narration, complete communication- Wh-questions - Effective beginning and closing - Rhetorical questions - Appraising target audience - Pronunciation, Enunciation, Tone, Pace and Volume. - Writing: SOPs, Research objectives, Thesis Statement, Indexing, Scholarly Articles, Academic Writing, Executive Summary, Survey . Questionnaires, Citations and Bibliography - Reading: Quantitative & qualitative analysis, Analysis and paraphrasing of reference materials Speaking: Commentate live events, give instructions to operate machines/ conduct experiments Listening: Informational listening, Reflective listening, - Discriminative listening - Connective words - prefixes and Suffixes - Quoting and paraphrasing Proofreading - Directed writing and writing formats - Note taking - Active verbs

Total: 30 Hours

Reference(s)

1. Sangeeta Sharma et.al. Communication Skills for Engineers and Scientists, PHI Learning Pvt. Ltd, 2011
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001
4. Personality Development, Harold R. Wallace &L.Ann Masters, Cengage Learning, New Delhi
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi
6. English Grammar, Composition and Usage by N.K.Agrawal&F.T.Wood, Macmillan India Ltd., New Delhi

22BT501 **22BT501 GENETIC ENGINEERING** **3 0 2 4**

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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problemsreaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
5. 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.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
13. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

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

Vector: Cloning and expression vectors, Vector types: Plasmids (pBR322, Puc & pET) and Plasmid Copy Number, Phage vectors (λ DNA vectors& M13 phage vector), Combinational vectors (Cosmids & Phagemids), Shuttle vectors, Artificial chromosomes (Bacterial and yeast artificial chromosomes), Viral vectors (SV 40, Adenovirus & Retrovirus).

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 labelling.

1 **2 Hours**

EXPERIMENT 1

Primer designing using online tools.

2 **5 Hours**

EXPERIMENT 2

Gene amplification by PCR and its confirmation by agarose gel electrophoresis.

3 **5 Hours**

EXPERIMENT 3

Restriction & ligation of vector and the amplified DNA

4 **4 Hours**

EXPERIMENT 4

Competent cell preparation

5 **4 Hours**

EXPERIMENT 5

Transformation of recombinant vector into *E. coli* by Heat shock / electroporation.

6 **5 Hours**

EXPERIMENT 6

Confirmation of recombinant transformed clones using Blue White screening

7 **5 Hours**

EXPERIMENT 7

Isolation of recombinant plasmid DNA using alkaline lysis method

Total: 75 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.Oldand S.B.Primrose, Principles of Gene Manipulation: An Introduction to Genetic engineering, Blackwell Science Publications, 2001
4. B.D.Singh, Biotechnology, Kalyani Publishers, 2010

22BT502 **BIOPROCESS ENGINEERING** **3 0 2 4**

Course Objectives

- To understand the fundamentals of bioreactor design for efficient production o f biomolecules and monitoring of bioprocesses in industry.
- To plan a research career or to work in the biotechnology industry with strong foundation about bioreactordesign and scale-up.
- To apply modelling and simulation of bioprocesses to reduce costs and to enhance the quality of products and systems.

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and anengineering specialization to the solution of complex engineering problems.
2. 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.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
14. Process designing and production of novel biomolecules for the agricultural, environmental and healthcaresectors
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the bioprocess and sterilization kinetics.
2. Apply stoichiometric calculations to predict bioprocess efficacy.
3. Analyze the productivity in a bioreactor for the given metabolite.
4. Evaluate the structured models and metabolic pathways in product formation.
5. Evaluate simulated bioprocesses for automatic control with reduced costs and enhanced product quality.

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													
3	3	3	3	3	2										
4			2	3	3			1			2	2		3	2
5	1	3		3	2										

UNIT I **9 Hours**

MEDIA DESIGN AND STERILIZATION

Basic configuration of bioreactor and ancillaries, Medium requirements for bioprocesses, Medium formulation of optimal growth and product formation, Medium optimization methods, Thermal death kinetics of microorganisms, Heat and filter sterilization of liquid media, Air sterilization, Design of sterilization equipment.

UNIT II **9 Hours**

METABOLIC STOICHIOMETRY AND ENERGETICS

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, Energetic analysis of microbial growth and product formation, Thermodynamic efficiency of growth.

UNIT III **9 Hours**

BIOREACTOR DESIGN AND SCALE UP

Batch, Fed batch and continuous cultivation – Feeding Strategies and Microbial Kinetics, Rheology of fermentation fluids, Transport phenomena in bioprocess systems, Oxygen mass transfer rate determination methods, Stirred tank reactor, Plug flow reactor, Fluidized bedreactor, Bubble column, Air lift reactor, Photo bioreactor, Bioreactors on a chip, Scale up criteria for bioreactors.

UNIT IV **9 Hours**

MODELLING OF BIOPROCESSES

Monod's model, Multiple substrate models, Models of growth associated product formation kinetics, Compartmental models, Models of cellular energetics and metabolism, Single cell models, Models of gene expression and regulation, Models of plasmid expression and replication.

UNIT V **9 Hours**

BIOPROCESS SIMULATION

Major subsystems of a process simulator, General architecture of on-line simulation system, Dynamic simulation of batch, fed batch, steady and transient culture metabolism, Model simulation using MATLAB-SIMULINK and ISIM software packages.

FOR FURTHER READING

On-line and off-line monitoring systems, Oxygen consumption and heat evolution in aerobic cultures, Overall mass transfer coefficient, Models of Inhibition, Control sites of major metabolic pathway, Correlation between pH, DO and Feed for the improvement of Biomass and Recombinant protein production.

1 **4 Hours**

EXPERIMENT 1

Sterilization of bioreactor

2 **4 Hours**

EXPERIMENT 2

Estimation of growth kinetic parameters of bacterial cells

3 **4 Hours**

EXPERIMENT 3

Determination of Volumetric Oxygen Transfer Coefficient (K_La) in fermentation system

4 **4 Hours**

EXPERIMENT 4

Determination of mixing time in a stirred tank reactor

5 **4 Hours**

EXPERIMENT 5

Estimation of cell maintenance coefficient and true growth yield by studying the mass and energy balance during cell growth

6 **5 Hours**

EXPERIMENT 6

Determination of Residence Time Distribution (RTD) for a CSTR

7 **5 Hours**

EXPERIMENT 7

Studies on the kinetics of immobilized enzyme and immobilized cells

Total: 75 Hours

Reference(s)

1. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering - Basic Concepts, PearsonNew International Edition, 2014.
2. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press Limited, 2013.
3. Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Principles of Fermentation Technology, ButterworthHeinemann publications, 1995.
4. Harvey W. Blanch, S. Douglas and Clark, Biochemical Engineering, New York: Marcel Dekker Inc., 1997.
5. Shijie Liu, Bioprocess Engineering - Kinetics, Sustainability, and Reactor Design,Elsevier Science, 2013.
6. Kim Gail Clarke, Bioprocess Engineering - An Introductory Engineering and LifeScience Approach, Elsevier Science, 2010

22BT503 **ANIMAL TISSUE CULTURE** **3 0 2 4**

Course Objectives

- To impart the knowledge on basic concepts of cell culture techniques
- To gain theoretical and practical knowledge on animal cell culture *in vitro*
- To have an exposure of real time applications of culturing techniques

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societaland environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
14. 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 competency in culturetechniques
2. Apply the various culture media available for different cell lines
3. Apply the knowledge of developing cell lines from primary cell culture
4. Analyze the efficiency of developed cell line cultures
5. Analyze the potential benefits of cell lines 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	2	3						2	
2	2		3			2	2	2							
3	3		2			3	2	3						1	
4	2		3			2	1	2						1	
5	2		2			3	2	3						2	

UNIT I **9 Hours**

INTRODUCTION TO TISSUE CULTURE

Introduction, history and development of tissue culture; equipment's for tissue culture; Aseptic techniques; Layout of tissue culture laboratory, Safety guidelines.

UNIT II **9 Hours**

CELL CULTURE MEDIA AND STERILIZATION

Cell culture media components; types of cell culture media; biological and defined media; serumfree media and balanced salt solution; sterilization techniques- hydrophobic, hydrophilic methodof sterilization, filter sterilization

UNIT III **9 Hours**

CELL CULTURE TECHNIQUES

Development of primary culture and passaging; development of suspension culture; cell line development, finite and continuous cell lines-Hayflick limit; cell line designations; Routine maintenance; cell line immortalization

UNIT IV **9 Hours**

CELL CULTURE CHARACTERIZATION AND MAINTENANCE

Cell line characterization methods; cryopreservation and maintenance; common cell culture contaminants; cell viability and cytotoxicity assays

UNIT V **9 Hours**

APPLICATIONS OF CELL CULTURE

Recombinant protein production; gene and stem cell therapy; gene transfer methods; viral andnon-viral methods; transgenic animal production

FOR FURTHER READING

Animal cell staining, immuno histochemical analysis, IVF technology, viral mediated gene transfer technology

1 **3 Hours**

EXPERIMENT 1

Organizing animal tissue culture laboratory

2 **3 Hours**

EXPERIMENT 2

Cell culture media preparation & sterilization

3 **3 Hours**

EXPERIMENT 3

Establishment of primary culture - Cell line

4 **3 Hours**

EXPERIMENT 4

Passaging of primary culture- Cell line

5 **6 Hours**

EXPERIMENT 5

In vitro cytotoxicity and geno toxicity assays

6 **6 Hours**

EXPERIMENT 6

Gene Expression Studies – RT PCR

.

7 **6 Hours**

EXPERIMENT 7

Protein Expression Studies- Western blot -

Total: 75 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.

22BT504 **BIOINFORMATICS** **3 0 2 4**

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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and anengineering specialization to the solution of complex engineering problems.
2. 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.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

13.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 various applications
5. Evaluate the drug designing techniques with online resources

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	1										2		
3	2	2	1										2		
4	3	2	1										2		
5	3	2	1										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, CATH, SCOP NDB, RNA Structurome DB, Database management models

.

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, T-COFFEE, 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, Basics of Machine learning, Next Generation Sequence Analysis, High Throughput databases, Computer aided drug design, Quantitative structure activity relationship (QSAR) for drug designing.

FOR FURTHER READING

Online Tools, open source databases

1 **4 Hours**

EXPERIMENT 1

Retrieving files and information from biological databases (NCBI, PDB, PubChem)

2 **3 Hours**

EXPERIMENT 2

Sequence alignment -BLAST, FASTA, Clustal Omega

3 **5 Hours**

EXPERIMENT 3

Molecular phylogenetic analysis

4 **4 Hours**

EXPERIMENT 4

Gene annotation and gene finding

5 **4 Hours**

EXPERIMENT 5

Molecular modeling of protein and its visualization

6 **5 Hours**

EXPERIMENT 6

Computer aided drug design with online tools

7 **5 Hours**

EXPERIMENT 7

Network construction and visualization

Total: 75 Hours

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

22BT507 **MINI PROJECT I** **3 0 2 4**

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
13. Use the analytical instruments and techniques to separate, purify and characterize biological compounds.
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies
3. Utilize the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare 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	1	2	1	1	2			2	2	2			1	1	
2	1	2	1	1	2			2	2	2			1	1	
3	1	2	1	1	2			2	2	2	2		1	1	
4	1	2	1	1	2			2	2	2	2		1	1	
5	1	2			2			2	2	2			1	1	

2BT601 DOWNSTREAM PROCESSING 3 0 2 4

Course Objectives

- To introduce the methods of separation technology.
- To expose students to techniques of product purification.
- To have depth knowledge and hands on experience in Downstream processes.

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
5. 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.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

Course Outcomes (COs)

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

UNIT I 9 Hours

DOWNSTREAM PROCESSING IN BIOTECHNOLOGY

Introduction to downstream processing; Principles and characteristics of bio-molecules and bioproducts, Rheology of fermentation broth; Cell disruption for product release – mechanical, enzymatic and chemical methods; Pre-treatment and stabilisation of bio-products.

UNIT II **9 Hours**

PHYSICAL METHODS OF SEPARATION

Unit operations for solid - liquid separation - Flocculation and sedimentation; Centrifugation - basket, tubular bowl, disk and ultra-centrifugation; Filtration - conventional and cross flowfiltration.

UNIT III **9 Hours**

ISOLATION OF PRODUCTS

Adsorption; liquid-liquid extraction; aqueous two-phase extraction; membrane separation –ultrafiltration, reverse osmosis, dialysis; precipitation of proteins by different methods.

UNIT IV **9 Hours**

PRODUCT RESOLUTION AND FRACTIONATION

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

UNIT V **9 Hours**

FINISHING OPERATIONS FOR FINAL PRODUCT

Principles, practices and equipments of Crystallization; Drying; Lyophilization, Pervaporation.

FOR FURTHER READING

Criteria for scale up; Vacuum extraction; Recrystallization

1 **4 Hours**

EXPERIMENT 1

Cell Disruption by Physical method

2 **4 Hours**

EXPERIMENT 2

Cell Disruption by Chemical method

3 **4 Hours**

EXPERIMENT 3

Microfiltration using tangential flow separation

4 **4 Hours**

EXPERIMENT 4

Precipitation of proteins

5 **4 Hours**

EXPERIMENT 5

Aqueous two phase extraction of biological molecules

6 **5 Hours**

EXPERIMENT 6

High resolution purification using HPLC

7 **5 Hours**

EXPERIMENT 7

Drying of bioproducts using different dryers

Total: 75 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

22BT602 **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 preventand combat infectious diseases
- To understand transplantation and autoimmunity

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Apply the structure, function and properties of different cell types and organs in the immune system andthe types of immune response.
2. Apply the structure, function and differentiation of the cells involved in humoral immune response and theproduction of monoclonal and polyclonal antibodies.
3. Analyze the development and differentiation of T-cells and the mechanism involved in cell mediatedimmune response.
4. Analyze the immune responses against microbial infections, allergy and hypersensitivity and the process ofcytokine and complement activation
5. Analyze the autoimmune disorder and graft rejection during organ transplantation and will be able to provide a possible solution

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

Organisation and classification of immune system – immune cells and organs; innate and acquired immunity; Toll receptors and responses, classification of antigens – chemical and molecular nature; haptens, adjuvants; cytokines; complement pathway, antigen presenting cells; major histocompatibility complex.

UNIT II **9 Hours**

HUMORAL AND CELLULAR IMMUNITY

Development, maturation, activation, regulation, differentiation and classification of T-cells and B cells, antigen processing and presentation, theory of clonal selection, TCR; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions

UNIT III **9 Hours**

IMMUNITY AGAINST PATHOGENS AND TUMORS

Inflammation; protective immune responses to virus, bacteria, fungi and parasites; tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy

UNIT IV **9 Hours**

IMMUNE TOLERANCE AND HYPERSENSITIVITY

Immune tolerance, Immuno deficiencies; Transplantation – genetics of transplantation; laws of transplantation; Allergy and hypersensitivity – Types of hypersensitivity, Autoimmunity, Auto immune disorders and diagnosis

UNIT V **9 Hours**

APPLIED IMMUNOLOGY

Monoclonal antibodies, engineering of antibodies; Classification of Vaccines, methods of vaccine development, immunodiagnostic methods (Immuno diffusion ELISA, FACS), immune modulatory drugs.

FOR FURTHER READING

Types of antigen antibody reactions - agglutination, precipitation, Immuno diffusion - single, double,radial, immuno - electrophoresis.

1 **4 Hours**

EXPERIMENT 1

Blood grouping and Blood Typing (ABO)

2 **4 Hours**

EXPERIMENT 2

Detection of Salmonella antibody in serum (Widal test)

3 **4 Hours**

EXPERIMENT 3

Ouchterlony double immunodiffusion (ODD)

4 **4 Hours**

EXPERIMENT 4

Radial immuno diffusion (RID)

5 **4 Hours**

EXPERIMENT 5

Rocket immuno electrophoresis (RIE)

6 **5 Hours**

EXPERIMENT 6

Enzyme-linked Immunosorbent assay (ELISA)

7 **5 Hours**

EXPERIMENT 7

SDS PAGE and Western Blotting

Total: 75 Hours

Reference(s)

1. A David Male, Jonathan Bros toff, 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. Judith A Owen, Jenni Punt, Sharon A Stranford, Patricia P Jones, Janis Kuby, Kuby Immunology 7th Edition,New York : W.H. Freeman, 2013
6. Ashim K. Chakravarty, Immunology and Immunotechnology, Oxford University Press India Publication, 2006.

22BT603 **ENZYME AND PROTEIN ENGINEERING** **3 0 2 4**

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)

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

11. 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.

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

Course Outcomes (COs)

1. Apply and gain knowledge on enzyme, coenzyme and their classification
2. Apply the different methods of Production and Purification of enzymes from various sources
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 catalyticdesign by engineering trypsin, chymotrypsin and elastase.

FOR FURTHER READING

TIM barrel structures nucleotide binding folds, prediction of substrate binding sites, current applications of enzymes in food and pharmaceutical industries.

1 **4 Hours**

EXPERIMENT 1

Identification of enzyme from different sources

2 **4 Hours**

EXPERIMENT 2

Production of crude enzyme extracts from plant, animal and microbial sources

3 **4 Hours**

EXPERIMENT 3

Purification of crude enzyme extracts

4 **4 Hours**

EXPERIMENT 4

Determination of enzyme activity

5 **4 Hours**

EXPERIMENT 5

Optimization of pH and temperature for enzyme activity

6 **5 Hours**

EXPERIMENT 6

Immobilization of enzymes

7 **5 Hours**

EXPERIMENT 7

Determination of K_m and V_{max} of enzymes

Total: 75 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 Garland Publishing, 1999.
6. Creighton T.E. Proteins, 2ndEdition. W.H. Freeman, 1993.

22BT607 **MINI PROJECT II** **0 0 2 1**

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
13. Use the analytical instruments and techniques to separate, purify and characterize biological compounds.
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors

Course Outcomes (COs)

1. Formulate a real-world problem, identify the requirements, and develop the design solutions.
2. Identify technical ideas, strategies, and methodologies.
3. Utilize the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare 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	1	2	3	2										1	
3	3	3	1											2	
4	2	3	1	1							2			1	
5	2	3	3	-							2			1	

22BT701 GENOMICS AND PROTEOMICS 3 0 2 4

Course Objectives

- To understand the background of genomes and proteomes used in providing new insights in biotechnology tools
- To explore the genome and protein sequence analysis and determination.
- To formulate genome related hypothesis and design an experimental plan for testing and analysis.

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

Course Outcomes (COs)

- Apply the importance of genomes and proteomes
- Apply the knowledge in genomic approaches for Biotechnology applications
- Apply the knowledge in proteomic approaches for Biotechnology applications
- Analyze the advanced genome-proteome based concepts
- Evaluate genome and proteomic approaches in systems biology and other medical applications

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	2	1										2		
3	2	2	1										1		
4	3	2	1										2		
5	3	2	1												

UNIT I **9 Hours**

INTRODUCTION

Introduction to genomes, transcriptomes and proteomes; Organisation and structure of genomes; DNA sequencing methods; Recombinant DNA technology; Human genome project; Overview of Protein structure; Introduction to omics: Genomics, Proteomics, Transcriptomics, Metabolomics, Fluxomics

UNIT II **9 Hours**

GENOMICS

Introduction and scope of genomics, Next generation sequencing methods, Genetic Mapping, Physical Mapping, Integration of mapping methods, Gene variation and Single Nucleotide Polymorphisms (SNPs),Expressed sequenced tags (ESTs), Gene- disease association, Polymorphism, Social, Legal and Ethical Implications of Human Genome Research

UNIT III **9 Hours**

PROTEOMICS

Introduction and scope of proteomics, Protein separation techniques: ion-exchange, size- exclusion and affinity chromatography techniques, Polyacrylamide gel electrophoresis, Isoelectric focusing (IEF), Two dimensional PAGE for proteome analysis, Introduction to mass spectrometry, Protein sequencing, Protein modifications and proteomics

UNIT IV **9 Hours**

ADVANCEDPROTEOMICSANDGEMOMICS

Comparative genomics, Functional genomics, Structural genomics, Personal Genomics, Protein engineering, DNA and Protein chips, Functional proteomics, Quantitative proteomics, Structural proteomics, DNA Protein interactions, Protein-Proteininteractions, HTP Analysis

UNIT V **9 Hours**

APPLICATIONSOFGENOMICS ANDPROTEOMICS

Systems and Synthetic biology, Genomics based drug design, Predictive Medicine, Cytogenomics, Clinical and biomedical application of proteomics, Applications of proteome analysis to drug

FOR FURTHER READING

Protein chip technologies-drug designing

Total: 45 Hours

Reference(s)

1. T.A.Brown, Genomes3, Garl andScience, 2007.
2. D.C.Libeler, Introduction to Proteomics: Tools for the New Biology, HumanaPress,2006
3. Arthur M. Lesk, Introduction to Protein Science-Architecture, Function and Genomics, Oxford University Press, 2004.
4. Peter Sudbery, Human Molecular genetics, Benjamin-Cummings Publishing Company,2010
5. S.R. Pennington, and M.J. Dunn, Proteomics: from Protein Sequence to FunctionFirst, Viva Books Private Limited, 2002
6. S.B.Primrose and R.M.Twyman, Principles of Genome Analysis and Genomics, Blackwell Publishing Co., 2005.

22BT702 **BIOPHARMACEUTICAL TECHNOLOGY** **2 0 2 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
13. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
14. Design and synthesis of the novel bio-molecule for the agriculture 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	1	2	3											2	
3	3	1	2											3	
4	2	1	3										1	2	
5	2	1	2										1	2	

UNIT I **9 Hours**

INTRODUCTION

Pharmaceutical Drug – API, Excipient; Drug approval criteria – Physicochemical properties of a drug; Biosimilars - global and Indian scenario, advantages and issues concern with the use of biosimilars; Routes of Drug Administration

UNIT II **9 Hours**

FORMULATION OF BIOPHARMACEUTICALS

Rational for formulation of biotherapeutics (Lipinski's rule of 5), formulation of excipients – solubility enhancers (Apparent and Free), Permeability enhancer, anti-aggregating agents, buffers, cryoprotectants, antioxidants, methods to enhance shelf- life of protein based therapeutics, preservatives and packaging techniques

UNIT III **9 Hours**

CONVENTIONAL DOSAGE FORMS AND NOVEL DRUG DELIVERY SYSTEMS(NDDS)

Conventional dosage forms – Liquids, Semisolid, Solid and Gaseous. NDDS – Micellar compounds (Liposomes, Phytosomes), Solid-Lipid Nanoparticle, Antigen mediated Drug Delivery system, Retroviral delivery (CAR-T cells), and Dendrimers.

UNIT IV **9 Hours**

PHARMACOKINETIC PARAMETERS

Absorption, Distribution, Metabolism (Phase I and II), Elimination; Drug Release – Kinetics (Zero Order, First Order, Higuchi's, Korsmeyer - Peppa's Model); Significance of Elimination inTherapeutic Index; Significance of Absorption, Distribution and Metabolism in Toxicokinetics; Bioavailability and Bioequivalence

UNIT V **9 Hours**

PHARMACODYNAMIC PARAMETERS

Receptor Mediated and Non-Receptor Mediated Drug action; Agonists and Antagonists; Types of Drug Action; Site of Drug Action; Dosage; Factors affecting the efficiency of a drug

Total: 45 Hours

Reference(s)

1. Daan J A Crommelin, Pharmaceutical Biotechnology, Taylor &Francis Group, 2ndEdition, 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 andClinical Applications, John Wiley & Sons, Inc., 2nd Edition.

22BT707 **PROJECT WORK I** **0 0 4 2**

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)

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

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions
2. Improve technical presentation and communication skills
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Prepare 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

22BT801 **PROJECT WORK II** **0 0 20 10**

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)

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

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions
2. Improve technical presentation and communication skills
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Prepare 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

22BT001 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)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

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

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

Course Outcomes (COs)

1. Understand growth and metabolism of microorganisms.
2. Understand 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. Enable the students to use organisms to produce valuable pharmaceutically important bioproducts on an 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

22BT002 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)

1. An ability to independently carry out research /investigation and development work to solve practical problems
3. 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
4. Graduates will demonstrate knowledge of professional and ethical responsibilities

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

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

Course Outcomes (COs)

1. Analyze microbes and media and optimize culture conditions
2. Evaluate fermenters for maximum production of biomass and bio products
3. Create various biomolecules of microbial origin
4. Create industrially important bio products
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 of microbial strains.

UNIT II **9 Hours**

FERMENTATION TECHNOLOGY

Types of bioreactors; operation of bioreactors; media for industrial fermentation, solid substrate fermentation, 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

22BT003 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)

1. An ability to independently carry out research /investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
4. Graduates will demonstrate knowledge of professional and ethical responsibilities

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

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

Course Outcomes (COs)

1. Analyze 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										3	3
5	2	2		2										3	3

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 and 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

22BT004 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors
15. 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 bio-gas production technology with environmental sustainability
3. Analyze the technology involved in liquid bio-fuels production and analyze their properties
4. Analyze various technologies involved in biomass processing
5. Evaluate 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		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**

BIOETHANOL

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. Stout. B.A. Biomass energy - A monograph, TEES mono- fraph series - Texas University Press, College Station,1985
2. Chahal.D.S. Food, Feed and Fuel from Biomass. Oxford & IBH Publishing Co. Pvt LTD.
3. Biofuels. Wim Soetaert and Erik Vandamme (Editors) Wiley. 2009.
4. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology, McGraw HillProfessional, 2008.
5. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
6. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer, 2007

22BT005 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
5. 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 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,scope of cov

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 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 NewYork, 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, MassachusettsInstitute of Technology,Cambridge University press 2007 edition

22BT006 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
5. 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.
6. 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.
13. Use the analytical instruments and techniques to isolate, purify and characterize biologicalcompounds
14. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

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, Continuity equation, 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 Runge Kutta 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; 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

22BT007 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 timeproblems
- 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 momentumtransport to solve problems

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
15. 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 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.

NIT III **9 Hours**

INTRODUCTION TO MASS TRANSPORT

Mass flux; continuity equation; Fick's Law of binary diffusion - Temperature and pressure dependency of diffusivity. Shellmomentum 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 concentrationgradient 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).

22BT008 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
12. Recognize the need for and have preparation and ability to engage independent and lifelong learning in the broadest context of technological change.
15. 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						1					2			3
3	1						3					1			2
4	2						3					1			3
5	1						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).

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22BT009 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)

2. 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.

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

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

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

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

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

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

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

15. 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 Geneticresources. 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, Antigenotoxicityassay – 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 MarineYeast 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 andaromatic 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 HorizonsPublishers, New Delhi, India, 2002.

22BT010 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)

2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
5. 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.
6. 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.
7. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
13. Use the analytical instruments and techniques to isolate, purify and characterize biological compounds
14. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors
15. 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.

22BT011 **MARINE BIOTECHNOLOGY** **3 0 0 3**

Course Objectives

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

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineeringpractice.
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors
15. 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 can bring about solutionsfor 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: productsand 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.

22BT012 **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)

2. 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.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change
14. Design and synthesis of the novel biomolecule for the agriculture and healthcaresectors
15. Conceive, Plan and Deploy societal projects for environmental protection using

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 - Classificationof 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.

22BT013 **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)

1. An ability to independently carry out research /investigation and development work to solve practical problems
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of theprogram. The mastery should be at a level higher than the requirements in the appropriate bachelor program
5. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues

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

15.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

22BT014 **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)

1. An ability to independently carry out research /investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
4. Graduates will demonstrate knowledge of professional and ethical responsibilities
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
14. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors
15. 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 membrane

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 Hours**

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

22BT015 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including designof experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT toolsincluding prediction and modelling to complex engineering activities with an understanding of the limitations.

14. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors
15. 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 files.

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

22BT016 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

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 coordinatelyRegulated 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, 1edition, 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. JohnWiley and Sons, 2004.

22BT017 **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)

1. An ability to independently carry out research /investigation and development work to solve practical problems
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of theprogram. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4. Graduates will demonstrate knowledge of professional and ethical responsibilities
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
14. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply and develop theoretical and software skills to model biomolecules
2. Apply the concept of molecular model
3. Analyze 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 - Abinitio - Density-Functional Theory and semi empirical methods

UNIT IV **9 Hours**

MACROMOLECULAR MODELING

Identification and mapping of active sites - Design of ligands for known macro molocular 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 ChemicalSociety, 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 molecularmodeling in drug design Synergix drug design, Israel,1999

22BT018 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
14. Process designing and production of novel biomolecules for the agricultural,environmental and healthcare sectors
15. 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 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 lead development 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 actions. Antibiotics affecting bacterial cell wall formation, cytoplasmic membrane, nucleic acid synthesis, and protein synthesis. Antiviral Drugs: And HIV compounds Nucleoside reverse transcriptase inhibitors; nucleotide reverse transcriptase inhibitors; non- nucleoside reverse transcriptase inhibitors, protease inhibitors. Viral entry inhibitors. 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

22BT019 **METABOLOMICS AND GENOMICS – BIG DATA ANALYTICS** **3 0 0 3**

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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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

15.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 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	1										2	2

2	2	1	3	1				2						2	2
3	1		2	2	3		2							2	2
4		1	3	1		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 Hou**

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 construction (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

22BT020 **DATA MINING AND MACHINE LEARNING TECHNIQUES FOR INFORMATICS** **3 0 0 3**

Course Objectives:

This course will help the learner to understand the fundamental processes, concepts and techniques of data mining in biology with particular emphasis on data warehousing classification, clustering and association rule mining develop the ability to select methods and techniques appropriate for a given biological data mining problem

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data,and synthesis of the information to provide valid conclusions.
5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction andmodelling to complex engineering activities with an understanding of the limitations.
6. 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.
13. Use the analytical instruments and techniques to isolate, 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 evaluationmethods, 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

22BT021 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 syntheticbiology.
- To work in multi-disciplinary teams for both computational and wet-lab projects

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety,and the cultural, societal, and environmental considerations.
5. 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.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
13. 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 **9 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 **9 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 **9 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.

22BT022 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
5. 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.
6. 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.
7. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
11. 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.
12. 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.
14. Process designing and production of novel biomolecules fo agricultural,environmental and healthcare sectors
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the historical developments in plant cell culture and learn to handle the techniques in aseptic conditions.
2. Analyze 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. Evaluate the recent methodologies of plant tissue and cell culture to develop a whole plant.
5. Create 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
2		3	1			2						2		2	2

3		3	2			1						1		2	2
4			1			1	3	3				2		2	2
5			3					2			1	1		2	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 Hou**

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

22BT023 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data,and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

15. 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. Anlayze 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 and cosmetics, 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

Total: 45 Hours

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,

22BT024 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineeringpractice.
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors
15. 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 Bio fertilizers
4. Analyze the concept of Bio pesticides, Bio fungicides, Bio insecticide
5. Evaluate 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**

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.

FOR FURTHER READING

Biofertilizers -Storage, shelf life, quality control and marketing. Factors influencing the efficacy of bio fertilizers. Storage ofPesticides, 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.

22BT025 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)

2. 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.

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

5. 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.

6. 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.

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

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

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. Execute 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 techniquesof 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 Vermi compositing (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

22BT026 **FUNGAL AND ALGAL TECHNOLOGY** **3 0 0 3**

Course Objectives

- This course aims to develop skills of the students in the research areas o f Mycology a nd Algae
- To execute the bioprocess techniques in Mycology and algae
- To acquire prerequisite knowledge for all Bioprocess Technology processes

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Apply the General Characteristic features of Fungi
2. Analyze the fungal forms and it's associations
3. Analyze the Economic importance of fungi
4. Analyze the Algal classification, Lifecycle and reproduction
5. Determine 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, andgrowth, 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

22BT027 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data,and synthesis of the information to provide valid conclusions.
5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

Course Outcomes (COs)

1. Apply the scope and importance of medicinal plants
2. Analyze the classification of herbal drugs
3. Analyze the importance of ethanobotany
4. Analyze the Phytotherapeutic compounds
5. Evaluate 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 plants through 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

22BT028 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
14. 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. Analyze the physiology of blood and neuronal system
3. Analyze the role and interactions of hormones
4. Evaluate 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 andmedulla, 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; Regulationof 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, TheMcGraw-Hill Companies, Inc. 2006.
3. Guyton., Textbook of Medical Physiology, 11th Ed, A. C., H. Sanders Philadelphia. 2005.

22BT029 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
14. Process designing and production of novel biomolecules for theagricultural,environmental and healthcare sectors

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**

NUTRIENTS REQUIREMENTS OF ANIMAL

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 diseases. Role of OIE and laws on international trade of animals 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.

22BT030 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety,and the cultural, societal, and environmental considerations.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety,legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineeringpractice.
14. 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 ofanimal 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.

22BT031 **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)

1. Demonstrate problem analyzing ability to develop solutions for the shortcomings encountered in biological sciencesector
2. Design and perform precise investigations on complex problems and contemporary issues of life science domainusing modern technological innovations
3. Excel in research blended academic learning and exhibit a higher degree of attributes which is necessary for bothindustrial and research sector
4. Carry out research /investigations independently and develop explicit solutions for solving real-world problems
5. Apply the acquired technical knowledge and ethical principles to realize the professional and ethical responsibilities
6. Write and present an extensive technical report/document that disseminate the knowledge to the academic andresearch community.

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

15. Conceive, Plan and Deploy societal projects for environmental protection using

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 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

FURTHER READING

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.

22BT032 **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)

1. Demonstrate problem analyzing ability to develop solutions for the shortcomings encountered in biological science sector
2. Design and perform precise investigations on complex problems and contemporary issues of life science domain using modern technological innovations
3. 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

4. Apply the acquired technical knowledge and ethical principles to realize the professional and ethical responsibilities
5. Write and present an extensive technical report/document that disseminate the knowledge to the academic and research community

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 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 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.

22BT033 **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)

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

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

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

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

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

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

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

15. 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		1
2	2			2		2				1	2			2	2
3	2			2	2	2				2	2		2	2	2
4	2			1	2					1	1		1	1	2
5	1			2		1							1		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.

22BT034 **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)

1. Demonstrate problem analyzing ability to develop solutions for the shortcomings encountered in biological science sector
2. Design and perform precise investigations on complex problems and contemporary issues of life science domain using modern technological innovations
3. Excel in research blended academic learning and exhibit a higher degree of attributes which is necessary for both industrial and research sector
4. Carry out research /investigations independently and develop explicit solutions for solving real-world problems
5. Apply the acquired technical knowledge and ethical principles to realize the professional and ethical responsibilities
6. Write and present an extensive technical report/document that disseminate the knowledge to the academic and research community

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

22BT035 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

13. Use the analytical instruments and techniques to isolate, purify and characterize biological compounds
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

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, 2005.
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.

22BT036 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)

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

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

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

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

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

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

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

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

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

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

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 industry.

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 Sequencing for 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

22BT037 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
13. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
14. 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. 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	
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.

22BT038 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)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. 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.
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. 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.
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

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).

22BT039 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. 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.
15. 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 infertility, 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

22BT040 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

14. Process designing and production of novel biomolecules for the agricultural, environmental and healthcare sectors
15. Conceive, Plan and Deploy societal projects for global welfare using Bio-resources

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, linearand conformational epitopes, characterization and location of APC, MHC and immunogenicity; immunization programs androle 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

22BT041 **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)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

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

3.: 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.

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

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

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

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. Apply the knowledge of pharmacokinetic models and parameters to describe the process of drug absorption and distribution.
4. Apply the knowledge of pharmacokinetic models and parameters to describe the process of drug metabolism and elimination.
5. Analyze the dosage regimens of the drugs using pharmacodynamics parameters and evaluate the drug performance 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 **9 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 **9 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.

22BT042 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

Course Outcomes (COs)

1. Apply the clinical trails and its organizatiom.
2. Analyze the clinical research and its regulatory
3. Analyze the biotechnology national policies
4. Analyze maintain the biotechnology global practice
5. Evaluate the international policies for biotechnology

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

22BT043 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors
15.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. Apply the different aspect of validation
3. Analyze the knowledge of validation to instruments and equipments
4. Analyze 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 Instruments and 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. Cleaning Validation: 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

22BT044 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

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 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

22BT045 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
13. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
15. 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; Patent databases; 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 for patenting, 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 of relevance to Biotechnology Agreements and Treaties. History of GATT and TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty Indian Patent 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.

22BT046 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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
13. Use the analytical instruments and techniques to separate, purify and characterize biological compounds
15. Conceive, Plan and Deploy societal projects for environmental protection using Bioresources

Outcomes (COs)

1. Apply the insights into Biosafety guidelines
2. Analyze and Manage the Risks involved with GMOs
3. Analyze the International Agreements and Regulations with respect to Biosafety
4. Analyze 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	1		2							1					

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

22BT047 **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)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
14. Design and synthesis of the novel bio-molecule for the agriculture and healthcare sectors
15. 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 equipment in biopharmaceuticals industries, Microbiological test and air quality control in Aseptic production localities, 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

OPEN ELECTIVES

22BT0YA **BIOFUELS** **3 0 0 3**

Course Objectives

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more ecofriendly options.

Programme Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
15. Conceive, Plan and Deploy societal projects for environmental protection using Bio-resources.

Course Outcomes (COs)

1. Apply thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of 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				3								1
2	2						1								3
3	1						3								2
4	2						3								3
5	1						1								

UNIT I **9 Hours**

CLASSIFICATION AND RESOURCES

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feed stocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Trans esterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative andthermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, purification - wet and dry milling processes, saccharification-chemical and enzymatic .Production of bio methane and bio hydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purificationof glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

FOR FURTHER READING

Edible and non-edible oils as fuels - their extraction; Purification - washing and drying options (bubble and mist washing), storage; Comparison of biodiesel with high speed diesel

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology,McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer,2007

22OCS01 OBJECT ORIENTED PROGRAMMING 3 0 0 3

Course Objectives

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

Course Outcomes (COs)

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
5. Design applications using templates and apply exception handling mechanisms

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	1	2	3		3										1
3	1	2	2		3										1
4	1	2	3		3										1
5	1	2	3		3										1

UNIT I **8 Hours**

INTRODUCTION

Need for object oriented programming - Procedural Languages vs. Object oriented approach -Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading.(sona)

UNIT II **8 Hours**

OBJECTS AND CLASSES

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types- CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

UNIT III **9 Hours**

OPERATOR OVERLOADING AND INHERITANCE

Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV **10 Hours**

POLYMORPHISM AND FILE STREAMS

Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer- Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **10 Hours**

TEMPLATES AND EXCEPTION HANDLING

Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall,2005
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing.

22OFD01 TRADITIONAL FOODS 3 0 0 3

Course Objectives

- Understand the importance of traditional foods and food habits
- Know the traditional processing of snack, sweet and dairy food products
- Infer the wide diversity and common features of traditional Indian foods and meal patterns.

Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

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

UNIT I **9 Hours**

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:-Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods -types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

22OEI02 SENSOR TECHNOLOGY 3 0 0 3

Course Objectives

- To impart knowledge about various sensors in multidisciplinary engineering domain
- To familiarize students with different applications and its material handling technology
- To understand the concept of sensing circuits and its static and dynamic characteristics

Course Outcomes (COs)

1. Conclude the static and dynamic characteristics of measuring instruments
2. Compare the characteristics and working principles of Resistance, Inductance and Capacitance type sensors
3. Construct the interfacing and signal conditioning circuit for measurement system using different types of sensor
4. Analyze and select the suitable sensor for different industrial applications
5. Combine the modern technologies and smart materials to design various sensors

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	2	3	2	1	1										2
3	1	2	3	3	1										1
4	2	1	1	3	3										2
5	1	2	1	2	3										1

UNIT I **8 Hours**

SENSORS FUNDAMENTALS AND CHARACTERISTICS

Sensors: Principles of Sensing - Sensor Classification and terminology- Units of Measurements - Measurands- Sensor Characteristics: Static and Dynamic.

UNIT II **8 Hours**

PHYSICAL PRINCIPLES OF SENSING

Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements.

UNIT III **9 Hours**

INTERFACE ELECTRONIC CIRCUITS

Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.

UNIT IV **10 Hours**

SENSORS IN DIFFERENT APPLICATION AREA

Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors.

UNIT V **10 Hours**

SENSOR MATERIALS AND TECHNOLOGIES

Materials, Surface Processing- MEMS microsystem components- Microfluidics microsystem components - Nano Technology- Smart Materials.

Total: 45 Hours

Reference(s)

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer, 2016.
2. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, New Delhi, 2009.
3. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", 1st Edition, World Scientific Publishing Co, Singapore, 2015.
4. Horowitz, P., and W. Hill. The Art of Electronics. 2nd ed. Cambridge University Press, 1989.

22OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

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		2				
4									3		2				
5									2		2				

UNIT I **9 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II **9 Hours**

PLANNING

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

UNIT III **9 Hours**

ORGANISING

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

UNIT IV **9 Hours**

DIRECTING

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

UNIT V **9 Hours**

CONTROLLING

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

Total: 45 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

22OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

Course Objectives

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

Course Outcomes (COs)

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

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	2		2						
3						1	2		2						
4						1	2		2						
5						1	2		2						

UNIT I **9 Hours**

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act-Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow

analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance – functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

22OGE03 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

Course Objectives

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

Course Outcomes (COs)

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

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	2		2						
3						1	2		2						
4						1	2		2						
5						1	2		2						

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute - NIESBUD, IIE, EDI. State Level Institutions - TIIC,CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

LANGUAGE ELECTIVES

22HSH01 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

1 0 2 2

22HSG01 GERMAN

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 withDictionary.

UNIT II **9 Hours**

Nouns - articles - Speaking about one self - Listening to CD supplied with the books, paying specialattention 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

Total: 45 Hours

Reference(s)

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

1 0 2 2

22HSJ01 JAPANESE

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 teform 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

22HSC01 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

22HSF01 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

22BT0XB	BIOANALYTICAL TECHNIQUES FOR PHARMACEUTICAL PRODUCTS	1 0 0 1

Course Objectives:

- Familiarize with the working principles, tools and techniques of analytical methods
- Design experiment and understand instrumentation
- Understand the strengths, limitations and creative use of bioanalytical techniques for problem solving

Programme Outcome:

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 modeling to complex engineering activities with an understanding of the limitations.

Course Outcome:

1. Apply spectroscopic technique to analyze biomolecules and monitor biochemical reactions of pharmaceuticals
2. Analyze the right chromatographic/hybrid methods for purification and analysis of pharmaceuticals

Articulation Matrix:

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

Unit – I **15 Hours**

ANALYSIS OF PHARMACEUTICAL PRODUCTS

Principles, instrumentation, sampling and applications of UV-VIS, FT-IR, Fluorescence, Raman, CD and NMR spectroscopic techniques-case studies with simple biomolecules, drugs and proteins. Principles of Gas, liquid, Column, reverse phase, normal phase, ion exchange, size exclusion, hydrophobic interaction, bioaffinity, pseudo affinity, thin layer and paper chromatographic techniques. Protein Removal; Phospholipid Removal; Protein Precipitation; Liquid-Liquid Extraction; Solid Phase Extraction. FTIR, HPLC: Instrumentation, detectors, columns, pumps, solvent programming and applications with examples. Gas Chromatography- Instrumentation, Hyphenated techniques in chromatography, GC-MS and LC-MS.

Total: 15 Hours

Reference Books:

1. Williams, D. and Fleming, I. Spectroscopic Methods in Organic Chemistry, 6th edition, McGraw-Hill Higher Education, Maidenhead, UK, 2008.
2. James M. Miller, Chromatography : Concepts and contrasts , Wiley, 2019
3. Skoog, D.A., Crouch, S.R., and Holler, F.J. Principles of Instrumental Analysis, 6th edition, Brooks/Cole, USA, 200

22BT0XC	MACHINE LEARNING FOR BIOLOGICAL DATA ANALYSIS	1 0 0 1

Course objectives:

1. To apply the machine learning techniques for biological data analysis.
2. To analyse the information derived out a biological database using ML approaches.

Course Outcomes:

1. Students will be able to select the appropriate model for specific biological data analysis.
2. Students will be able to outline the relevant information derived out of the biological data analysis.

Syllabus: **15 hours**

Basics of machine learning, Supervised and unsupervised learning, Machine Learning (ML) models, Training, validation and testing a model, ML models for biological data classification (case study), ML for Regression analysis in biological data (case study), ML for biological data clustering (case study), Dimensional reduction in Genomic data analysis (case study), Artificial Neural Networks in sequence analysis (case study), Antibody Engineering using Support Vector Machines (case study).

References:

1. Mohammad Sufian Badar, *A Guide to Applied Machine Learning for Biologists* (2023), Springer, No. of pages: 262.
2. Faheem Masoodi, Mohammad Quasim, Syed Bukhari, Sarvottam Dixit, Shadab Alam, *Applications of Machine Learning and Deep Learning on Biological Data* (2023), CRC Press, No. of pages: 210.
3. Xu, C., Jackson, S.A. Machine learning and complex biological data. *Genome Biol*, 20, 76 (2019).
4. Joe G. Greener, Shaun M. Kandathil, Lewis Moffat and David T. Jones, A guide to machine learning for biologists. *Nature Reviews* (2021).

22BT0XD	**BIOSTIMULANTS FOR ENHANCED CROP PRODUCTION**	**1 0 0 1**

Course Objective:

To provide basic and applied training in the subject for development of skills for a successful career in entrepreneurship, generate technically trained human resource for Biofertilizer industries

Course Outcome:

1. Apply the techniques to focus on commercial applications of biostimulants such as crop improvement
2. Analyze the growth and other parameters like sustainability and beneficial effects for the agricultural crops

15 Hours

Categories- Humic and fulvic acids, Protein hydrolysates and other N-containing compounds, Seaweed extracts and botanicals, Chitosan and other biopolymers, Inorganic compounds, Beneficial fungi, Beneficial bacteria. Regulation of biostimulants; opportunities and challenges. Beneficial Bacteria for Agriculture - Isolation of Bacillus sp. from agricultural soil; Phosphate solubilizing bacteria as plant biostiumulants; Beneficial Fungi for Agriculture - Isolation of Arbuscule-forming mycorrhiza; In-vivo method of production of Arbuscular Mycorrhizal Fungi.

References

1. Rouphael Y., Jardin P (2020) Biostimulants for sustainable crop production, 1st Edition, Kindle Edition.
2.Calvo., Pamela., Nelson L, and Kloepper J W(2014) Agricultural uses of plant Biostimulants, Plant and soil, 383.
3. Colla., Giuseppe., Rouphael Y., Canaguier R., Svecova E and Cardarelli M (2014) Biostimulant action of a plant-derived protein hydrolysate produced through enzymatic hydrolysis, Frontiers in plant science, 448.
4.Jardin D, Patrick (2015) Plant biostimulants: Definition, concept, main categories and regulation, Scientia horticulturae 196, 3-14.
5. https://www.biostimulant.com/scientific-research/

22BT0XE	MICROPROPAGATION FOR VIRAL FREE PLANT PRODUCTION	1 0 0 1

Course Objective:

- To provide basic and applied training in the subject for development of skills for a successful career in entrepreneurship, generate technically trained human resource for tissue culture industries

Programme Outcome:

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. Lifelong 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 Outcome:

1. Apply the techniques to focus on commercial applications of plant tissue culture such as crop improvement
2. Analyze the secondary metabolite production, and various strategies for inducing genetic interference

Articulation Matrix:

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

Unit – I **15 Hours**

Micropropagation - Factors affecting morphogenesis and proliferation rate; technical problems in micropropagation. Organogenesis - formation of shoots and roots, production of virus free plants by meristem and shoot-tip culture. Omatic embryogenesis - Process of somatic embryogenesis, structure, stages of embryo development, factors affecting embryogenesis; production of artificial seeds; Cryopreservation; Preparation of mother plants for collection of explants - Demonstration of meristematic explants in different plants - Establishment of cultures for the induction of embryogenic callus.

Reference Books:

1. Cervelli R and Senaratna T (1995) Economic aspects of Somatic embryogenesis. In: J. AitkenChristie et al. (Eds.) Automation and environment control in plant tissue culture. Kluwer, Dordrest
2. Smith R.H (2000) Plant Tissue Culture: techniques and Experiments, Second edition, Academic Press, USA
3. Bhojwani S.S., Razdan M. K (2005) Plant tissue culture: Theory and practice, Studies in plant science 5, North Holland, Elsevier, New Delhi
4. Anderson S.B, Christiansen I and Faresveit B (1990) Carrot (Daucus carota L.): In vitro production of haploids and field trials. In: Y.P.S. Bajaj (Ed.) Biotechnology in Agriculture and Forestry, Vol. 12. Haploids in crop improvement I. Springer, Berlin.

22BT0XF	CLINICAL RESEARCH AND DATA MANAGEMENT	1-0-0-1

Introduction to Clinical Research (Theory): Clinical Research: An Overview, Different types of Clinical Research, Terminologies and definition in Clinical Research, Drug Development Process: Preclinical trail, Human Pharmacology (Phase-I), Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trail (Phase-III) and Post marketing surveillance (Phase-IV). Guidelines and Regulations in Clinical Research: International Conference on Harmonization (ICH), Guidelines for Good Clinical Practice, ICMR guidelines for Biomedical Research on Human Subjects, Regulation in Clinical Research: Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities. *Clinical Trial Management (Theory cum Practical):* Contract Research Organization (CRO), Site Management Organization (SMO), Central Lab, Clinical Data Management Organization (CDMO), Medical Writing Organization, Logistic Management Organization, Pharmacovigilance Organization. Clinical Research Operation, Monitoring and Clinical Evaluation: Project management, Protocol in Clinical Research, Informed Consent, Case Report Form, Investigator's Brochure (IB), Selection of an Investigator and Site, Patient screening, Inclusion and exclusion criteria, Randomization, Blinding, Recruitment Techniques (materials and methods),Retention and complaisance of study subjects, Ethics and Regulatory submission, Monitoring Visits, Investigator Meeting, Essential Document preparation (IB, ICF, PIS, TMF, ISF, CDA.CTA etc)

Clinical Data Management (Theory cum Practical): CDM Systems: Clinical data management systems, Electronic data capture systems, Choosing vendor products, Implementing new systems, System validation, Test procedures, Change control, Coding dictionaries, Migrating and archiving Legacy Data, Clinical Data Management process: Data management Plan, CRF design considerations, Database design considerations, Study setup, Entering Data, Tracking CRF pages, cleaning data, Managing Lab Data, Identifying and Managing the discrepancies, Collecting Adverse Event Data, Coding Reported terms, Creating report and Transferring data, Closing study, SAS in Clinical data analysis, Importing data from Excel to SAS, Statistical analysis of SAS datasets. Standard operating procedures and guidelines for data management.

15 hours

Reference

1. Practical Guide to Clinical Data Management, PROKSCHA, CRC Press; Third edition (1 January 2016).
2. Textbook of Clinical Research, Vikas Dhikav, AITBS Publishers & Distributors; First Edition (1 January 2016).