

Basaveshwar Engineering College, Bagalkote

Department of Biotechnology

Scheme and Syllabus

2023-24

Basaveshwar Engineering College, Bagalkote

Department of Biotechnology

Scheme and Syllabus

2023-24

Vision

- To be an internationally reputed center of education and research in the field of Biotechnology

Mission

- To produce technically sound and ethically oriented students by imparting quality education through improved teaching-learning process
- To take up activities in the area of applied research to meet the needs of the community and industry in the field of Biotechnology
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PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse

teams, and in multidisciplinary settings.

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

11. **Project management and finance:** Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and Leader in a team, to manage projects and in multidisciplinary environments.

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

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. To provide solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering studies.
2. To provide technical education necessary for students to acquire sound knowledge of Biotechnology.
3. To prepare students to excel and succeed in industry/research/technical profession through global and rigorous
4. To train students with good scientific and engineering logics to comprehend, analyze, design and create novel products problems.
5. To encourage student's lifelong learning skills, entrepreneurship abilities, ethical values for a successful professional carrier.

Programme Specific Outcomes (PSOs)

1. Graduates will be able to develop competency in applying engineering principles to environment, agriculture and healthcare systems.

2. Graduates will be able to design, optimize, and manage bioprocesses for the development of bio-based products, ensuring quality, safety, and regulatory compliance in the industries.

3. Graduates will be able to integrate bioethics, entrepreneurship, and environmental awareness to enhance technical skills in biotechnology applications.

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOTE
DEPARTMENT OF BIOTECHNOLOGY
SCHEME OF TEACHING AND EXAMINATION
Academic Year 2023-24

I –Semester (Computer Science Engineering Stream)

S l. N o. .	Course			TD	Teaching (Hours/Week)		Examination				Credits
	Category	Code	Title		Theory	Practical/ Drawing	Duration	CIE Marks	SEE Marks	Total Marks	
					L	P					
1.	BSC(IC)	22UMA103C	Mathematics for Computer Sciences-I	Mathematics	3	2	3	50	50	100	4
2.	BSC(IC)	22UCH111C	Chemistry for Computer Sciences	Chemistry	3	2	3	50	50	100	4
3.	ESC	22UCS119C	Principles of Programming using ‘C’	Computer Science	2	2	3	50	50	100	3
4.	ESC-I	22UXXXXXN	Engineering Science Course -I	Respective Engg. Dept	2	2	3	50	50	100	3
					3	0					
5.	ETC - I	22UXXXXXB	Emerging Technology Course - I	Any Engg. Dept.	3	0	3	50	50	100	3
	OR										
	PLC-I	22UCSXXXB	Programming Language Course-I	Any Engg. Dept.	2	2	3	50	50	100	3
6.	HSSC	22UHS124C	Communicative English	Humanities	1	0	1	50	50	100	1
7.	HSSC	22UHS126C 22UHS127C	Samskruthika Kanna da* Balake Kanna da**	Humanities	1	0	1	50	50	100	1
8.	AEC	22UHS129C	Innovation and Design Thinking	Any Dept	1	0	1	50	50	100	1
Total					16/16	8/8		400	400	800	20

II -Semester (Computer Science Engineering Stream)

Sl · No ·	Course			TD	Teachin g (Hours/We ek)		Examinat ion				Credits
	Category	Code			Theory Lecture	Practical/ Drawing	Duration	CIE Marks	SEE Marks	Total Marks	
					L	P					
1.	BSC (IC)	22UMA203 C	Mathematics for Computer Sciences -II	Mathematics	3	2	3	50	50	100	4
2.	ASC (IC)	22UPH207 C	Physics for Computer Sciences	Physics	3	2	3	50	50	100	4
3.	ESC	22UME223 C	CAED	Civil/Mechanica l/IP	2	2	3	50	50	100	3
4.	ESC- I	22UXXXX XN	Engineering Science Course-I	Respective Engg. Dept	2	2	3	50	50	100	3
					3	0					
5.	ETC - I	22UXXXX XB	Emerging Technology Course - I	Any Engg. Dept.	3	0	3	50	50	100	3
	OR										
	PLC-I	22UCSXX XB	Programming Language Course-I	Any Engg. Dept.	2	2	3	50	50	100	3
6.	HSSC	22UHS224 C	Professional writing skills in English	Humanities	1	0	1	50	50	100	1
7.	HSSC	22UHS225 C	Constitution of India	Humanities	1	0	1	50	50	100	1
8.	AEC	22UHS228 C	Scientific Foundations of Health	Any Dept	1	0	1	50	50	100	1
Total					16/16	8/8		400	400	800	20

B. E. III SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UMA301C	Partial differential equations and integral transforms	03	3	0	0	50	50	100
2.	IPCC	22UBT302C	Microbiology + Lab	04	3	0	2	50	50	100
3.	IPCC	22UBT303C	Unit Operations + Lab	04	3	0	2	50	50	100
4.	PCC	22UBT304C	Biochemistry	03	3	0	0	50	50	100
5.	PCC	22UBT305C	Bioprocess Principles and Calculations	03	2	2	0	50	50	100
6.	BSC	22UBT340C	Biology for Engineers	02	2	0	0	50	50	100
7.	PCCL	22UBT306L	Biochemistry Lab	01	0	0	2	50	50	100
8.	MC	22UHS001M 22UHS002M 22UHS003M	Yoga NSS PE	00	0	0	2	25	-	-
Total				20	16	2	8	375	350	700

B. E. IV SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UBT401C	Biostatistics & Biomodeling	03	2	2	0	50	50	100
2.	IPCC	22UBT402C	Immunotechnology + Lab	04	3	0	2	50	50	100
3.	IPCC	22UBT403C	Heat & Mass Transfer + Lab	04	3	0	2	50	50	100
4.	PCC	22UBT404C	Molecular Biology	03	3	0	0	50	50	100
5.	PCC	22UBT405C	Cell culture techniques	02	2	0	0	50	50	100
6.	PCCL	22UBT406L	Cell culture & Molecular Biology Lab	01	0	0	2	50	50	100
7.	HSMC	22UHS424C	UHV-II	01	1	0	0	50	50	100
8.	PCCL	22UBT407L	Biostatistics lab	01	0	0	2	50	50	100
9.	MC	22UHS001M 22UHS002M 22UHS003M	Yoga NSS PE	00	0	0	2	25	-	-
Total				19	14	2	10	425	400	800

B. E. V SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	PCC	21UBT501C	Bioinformatics	03	3	0	0	50	50	100
2.	IPCC	21UBT502C	Genetic Engineering & Applications + lab	04	3	0	2	50	50	100
3.	PEC	21UBT5XXE	Elective –I	03	3	0	0	50	50	100
4.	OEC	21UXX5XXN	Open Elective-I	03	3	0	0	50	50	100
5.	PCCL	21UBT503L	Bioinformatics Lab	01	0	0	2	50	50	100
6.	AEC	21UHS521C	Quantitative Aptitude and Professional Skills	02	2	0	0	50	50	100
7.	INT	21UBT504I	Summer Internship – II	03	0	0	4	100	-	100
8.	HSMC	21UBT523C	Environmental Studies	01	1	0	0	50	50	100
9.	MC	21UHS001M 21UHS002M 21UHS003M	Yoga NSS PE	00	0	0	2	10	-	-
Total				20	15	0	10	460	350	800

Elective-I

21UBT511E: Environmental BT

21UBT512E: Nutraceuticals

21UBT513E: Computational Biology

21UBT514E: Protein Engineering and Drug Design

Open Elective-I

21UBT532N: Biofuels Technology

B. E. VI SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	21UBT601C	Bioprocess and Bioreaction Engineering	03	3	0	0	50	50	100
2.	PCC	21UBT602C	Upstream Processing Technology	03	3	0	0	50	50	100
3.	PCC	21UBT603C	Biotransformation and Enzyme Technology	03	3	0	0	50	50	100
4.	PEC	21UBT6XXE	Elective-II	03	3	0	0	50	50	100
5.	OEC	21UXX6XXN	Open Elective –II	03	3	0	0	50	50	100
6.	OEC	21UXX6XXN	Open Elective –III	03	3	0	0	50	50	100
7.	AEC	21UHS600C	Indian Knowledge system	01	1	0	0	50	50	100
8.	PCCL	21UBT604L	Biokinetics& Enzyme Technology Lab	01	0	0	2	50	50	100
9.	MP	21UBT605P	Mini Project	02	0	0	4	50	50	100
10.	MC	21UHS001M 21UHS002M 21UHS003M	Yoga NSS PE	00	0	0	2	10	-	-
Total				22	19	0	8	460	450	900

Elective-II

21UBT621E: Biofuels Technology

21UBT622E: Food Biotechnology

21UBT623E: Biopython

21UBT624E: Genomics & Proteomics

21UBT625E: Bioreactor Design

Open Electives –II

21UBT632N: Environmental Technology

Open Electives –III

21UBT633N: Industrial Safety

B. E. VII SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	PCC	UBT704C	Economics and Plant Design	3	3	0	0	50	50	100
2.	PCC	UBT715C	Downstream Processing Technology	3	2	2	0	50	50	100
3.	PEC	UBT7XXE	Elective-4	3	3	0	0	50	50	100
4.	PEC	UBT7XXE	Elective-5	3	3	0	0	50	50	100
5.	HSMS	UBT716H	Industrial Management and Entrepreneurship	3	3	0	0	50	50	100
6.	OEC	UBT733N	Industrial Safety (Open Elective)	3	3	0	0	50	50	100
7.	INT	UBT711I	Industrial Internship	2	0	0	4	50	50	100
8.	PCCL	UBT710L	Bioseparation Techniques Lab	1	0	0	2	50	50	100
Total				21	17	02	06	400	400	800

Elective-4 & Elective-5

UBT722E: Biopython

UBT723E: Industrial BT

UBT724E: Food Processing Technology

UBT725E: Protein Engineering and Drug Design

UBT731E: Nanobiotechnology& Biomaterials

UBT732E: Computational Biology

UBT733E: Bioconjugative Technology

UBT734E: Food Biotechnology

B. E. VIII SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	PEC	UBT82XE	Elective-6	03	3	0	0	50	50	100
2.	PEC	UBT83XE	Elective-7	03	3	0	0	50	50	100
3.	PP	UBT805P	Project	15	0	0	30	50	50	100
Total				21	6	0	30	150	150	300

Elective-6

UBT823E: Biosimulations

UBT824E: Metabolic engineering

UBT825E: Bionanalytical techniques

UBT827E: Pharmaceutical BT

Elective-7

UBT830E: Clinical research

UBT832E: Health diagnostics

UBT833E: Validation & quality control

UBT834E: Product development

UBT835E: Validation & quality assurance

DEPARTMENT OF BIOTECHNOLOGY
SCHEME OF TEACHING AND EXAMINATION
2023-24

B. E. III SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UMA301C	Partial differential equations and integral transforms	03	3	0	0	50	50	100
2.	IPCC	22UBT302C	Microbiology + Lab	04	3	0	2	50	50	100
3.	IPCC	22UBT303C	Unit Operations + Lab	04	3	0	2	50	50	100
4.	PCC	22UBT304C	Biochemistry	03	3	0	0	50	50	100
5.	PCC	22UBT305C	Bioprocess Principles and Calculations	03	2	2	0	50	50	100
6.	BSC	22UBT340C	Biology for Engineers	02	2	0	0	50	50	100
7.	PCCL	22UBT306L	Biochemistry Lab	01	0	0	2	50	50	100
8.	MC	22UHS001M 22UHS002M 22UHS003M	Yoga NSS PE	00	0	0	2	25	-	-
Total				20	16	2	8	375	350	700

22UMA301C	PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORMS	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I	10 Hrs.
Partial Differential Equations I: Introduction to PDE, Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivatives with respect to one independent variable only. Solution of Lagrange's linear PDE. (RBT Levels: L1, L2 and L3)	
UNIT – II	10 Hrs.
Partial Differential Equations_II : Solutions of PDE by the method of separation of variable. Derivation of one-dimensional heat and wave equations and their solutions by explicit method, solution of Laplace equation by using five point formulas. (RBT Levels: L1, L2 and L3)	
UNIT – III	10 Hrs.
Fourier series : Periodic functions, Conditions for Fourier series expansions, Fourier series expansion of continuous and functions having finite number of discontinuities, even and odd functions. Half-range series, practical harmonic analysis. (RBT Levels: L1, L2 and L3)	
UNIT – IV	10 Hrs.
Fourier transforms and z-transforms : Infinite Fourier transforms and inverse Fourier transforms-simple properties, Fourier sine and Fourier cosine transforms, Inverse Fourier sine and cosine transforms. Z-transforms-definition, standard forms, linearity property, damping rule, shifting rule-problems. Inverse Z-transforms. (RBT Levels: L1, L2 and L3)	
REFERENCES: - Numerical Methods for Engineers by Steven C Chapra & Raymond P Canale. - Higher Engineering Mathematics by Dr. B.S. Grewal, Khanna Publishers, New Delhi. - Advanced Engineering Mathematics By H. K. Das, S. Chand & company Ltd. Ram Nagar, New Delhi - Advanced Engineering Mathematics by E Kreyszig ,John Wiley & Sons.	
COURSE OBJECTIVES: - PDE's provides a powerful tool for quantifying rates of change optimizing functions, and modeling complex systems. - To provide a way, to represent periodic functions in terms of simple trigonometric functions. - To transform a function from the time domain to the frequency domain. - Provides a powerful mathematical tool for analyzing, designing, and manipulating discrete time signals and systems.	

Course Outcomes:**After completion of the course the students shall be able to,**

1. Identify different types of PDEs including linear vs nonlinear, first order vs higher-order, and partial derivatives of different variables.
2. Learn various analytical techniques to solve to specific types of PDEs, such as variable separable and explicit method.
3. Grasp the concept of representing periodic functions as an infinite sum sinusoidal (sine and cosine) with different frequencies.
4. Grasp the concept of the Fourier transform as a mathematical tool that converts a function from the time domain into the frequency domain.

Evaluation Scheme:

Assessment	Marks	Weightage
CIE-I	40	20
CIE-II	40	20
Assignments/ Quizzes/Case Study/ Course Project/Term Paper/Field Work	10	10
SEE	100	50
Total	190	100

Question paper pattern for CIE-I and CIE-II:

Question paper consists Part-A and Part-B. Part A is compulsory, it consists of short answer questions of 1 or 2 marks, covering Unit-I and Unit-II (no multiple choice questions and No true or false questions).

1. In Part-B, four questions are to be set as per the following table.

CIE	Number of questions / Maximum marks	Sub divisions	Covering entire unit
I	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-I
	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-II
II	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-III
	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-IV

Question paper pattern for SEE:

1. Question paper consists Part-A and Part-B. Question number 1 is compulsory, it consists of short answer questions of 1 or 2 marks, covering entire syllabus (no multiple choice questions and No true or false questions, 50% of questions must be L3 and L4 level).
2. In Part-B total of eight questions with two from each unit; with internal choice to be set uniformly covering the entire syllabus.
3. Each question carries 20 marks and should not have more than four subdivisions.

4. In Part-B, any FOUR full questions are to be answered choosing at least one from each unit.
5. Sketches, figures and tables if any should be clearly drawn, as the same is scanned for printing.
6. The question paper should contain all the data / figures / marks allocated, with clarity.

22UBT302C	MICROBIOLOGY	Credits: 04
L: T: P - 3: 0: 2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction: Scope of microbiology, History of microbiology-Evolution of microbes. Contributions of Scientist for the development of microbiology. Microbial diversity & taxonomy, Prokaryotes & Eukaryotes. Microscopy: Principles and applications of Bright field microscopy, Dark-Field Microscopy, Phase contrast microscopy, Fluorescence Microscopy and Electron microscopy (SEM & TEM).		
UNIT-II		10Hrs.
Microorganisms: Bacteria- Morphology and ultra structure of Bacteria, Culturing of bacteria, reproduction and growth pattern (continuous and batch). Viruses, fungi, algae, protozoa, actinomycetes- structure and modes of reproduction. Fastidious microorganisms. Microbial toxins. Microbial Techniques: Pure culture techniques- Aerobic and Anaerobic culture techniques. Fermentation (acid & alcohol).		
UNIT-III		10 Hrs.
Control of Microorganisms: Control of microorganisms by Physical methods and chemical methods, antibiotics, chemotherapeutic agents and Phage biotics. Medical Microbiology: Normal microflora, common diseases caused by microbes-pathogenesis, symptoms, diagnosis, treatment, prevention.		
UNIT-IV		10 Hrs.
Agricultural and Environmental Microbiology: Microbiology of soil, Air and Aquatic Microbiology, Bio-fertilizer, Plant endophytes, Microbes in bioremediation and bio-control agents. Industrial Microbiology: Microbial processes using yeasts and bacteria (production of alcohol, vinegar, cheese), Microbes as source of protein (SCP), gelatin agents (alginate, xanthin, agar agar) Microbial insecticides, Enzymes from Microbes (amylase, protease), Useful products from microorganisms using recombinant DNA technology (vaccines and antibiotics).		
REFERENCE BOOKS *		
1. Pelczar, Chan and Noel Kreig, "Microbiology"- 5 th Edition Tata Macgraw Hill, 2010. 2. Tortora, Funke and Case, "Microbiology an Introduction" -8 th Edition, Pearson Education, 2006. 3. Stainer R.Y., Ingraham J.L., "General Microbiology"- 5 th Edition Mc.Millan Press, 2010. 4. Madigan, Martinko, Parker, Brock's, "Biology of Microorganisms" - 10 th Edition, Prentice Hall, Pearson Education, 2003. 5. Prescott and Dunn, "Industrial Microbiology"-Agribios India, 2002. 6. J. Salle, "Fundamental Principles of Bacteriology" – 7 th Edition, Tata Macgraw Hill, 2007. 7. E Alcamo I "Fundamentals of Microbiology"6 th Ed, Jones &Bartlet, Pub. 2001. 8. Prescott, Harley & Klein, "Microbiology" -7 th Edition, WCB/McGraw Hill, Int. Edition, 2008.		
COURSE OUTCOMES**		
• Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy • Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes • Ability to discuss the causative organisms of the disease and their effect on society • Ability to analyse the applied techniques in the environment and create awareness to society		
LIST OF EXPERIMENTS		

1. Study of microscopes: Types, working principle, parts of the microscope, handling (operating) & caring.
2. Media preparation: NA, Peptone broth, PDA, Macconkeys agar.
3. Isolation of bacteria by serial dilution, pour plate ,spread plate and streak plate techniques
4. Isolation and identification of bacteria and fungi from different sources.
5. Study of colony characteristics and Morphology of bacteria, yeasts and fungi.
6. Study of different staining techniques. (Simple staining differential staining)
7. Enumeration of microorganisms using colony counter
8. Fermentation of Carbohydrates (gas production)
9. Growth curve of bacteria and yeast.
10. Antibiotic susceptibility testing of bacteria & Observation of motility by hanging drop technique.

COURSE OUTCOMES**

1. Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
2. Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
3. Ability to discuss the causative organisms of the disease and their effect on society
4. Ability to analyze the applied techniques in the environment and create awareness to society

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2			2		2					1	1	1
CO 2	2	2	2		2	3		1					2	1	2
CO 3	3	3	2		2	2		1				1	1	1	2
CO 4	3	3	3		2	3		2				1	2	1	3

22UBT303C	UNIT OPERATIONS	Credits: 04
L:T:P – 3:0:2		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10 Hrs.
Fundamentals of Fluid Mechanics: Units and Dimensions- Basic and Derived units, Dimensional homogeneity, Dimensional Analysis, Fluid definition and classification of fluids, Properties and Rheological behaviour of fluids, Newton's Law of viscosity, Newtonian and Non-Newtonian types of Fluids, Hydrostatic equilibrium, Barometric equation and Pressure measurement using manometers, Conceptual numericals, Types of Fluid flow- Laminar and Turbulent, Reynolds number and its Importance.	
UNIT-II	10 Hrs.
Fluid Flow and Measurement: Basic equations of fluid flow - Continuity equation and Bernoulli theorem and equation; Derivation of Bernoulli's equation, Correction for Bernoulli's equation, Flow through circular and non-circular conduits, Flow Measurement, Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter), Pumps- Classification of Pumps (Centrifugal & Reciprocating pumps), Construction and working of Centrifugal pump, characteristics of pumps and Characteristic Curves.	
UNIT-III	10 Hrs.
Filtration and Sedimentation: Theory of Filtration, Types of Filtration, Distribution of overall pressure drop (Resistances), Filter medium, Characteristics of filter medium, Filter aids, Factors Affecting Rate of Filtration, Filtration equipment's - Plate and Frame Filter Press, Rotary Drum Filter. Theory of Settling and Sedimentation, Types of Settling - Free and Hindered, Stoke's law, Newton's law, Terminal settling velocity, Batch sedimentation, Equipment (cyclones, thickeners), Conceptual numericals	
UNIT-IV	10 Hrs.
Size Separation and Mixing: Size Separation: Concept and Importance of screening operation, Type of Screen Analysis, Effectiveness of a Screen, Factors affecting performance of screens. Concept Of Mixing, Homogeneous and Heterogeneous Mixtures, Importance of Mixing and Agitation, Mixing liquids with liquids, Construction and Flow Patterns of Impellers, Mixing Of Gases With Liquids	
LIST OF EXPERIMENTS	
1. Verification of Bernoulli's theorem 2. Study of packed bed characteristics 3. Orifice meter 4. Venturimeter 5. Rotameter 6. Batch sedimentation test 7. Screen effectiveness and Sieve analysis 8. Filtration 9. Settling 10. Mixing	

TEXT BOOKS AND REFERENCE BOOKS *

1. McCabe W. L, Smith J. C and Harriott (2005) Unit operations of Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Gavhane K. A (2014) Unit Operations I, Fluid Flow and Mechanical operations, 24nd Edition. Nirali Prakashan, India.
3. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008) Principles of Unit Operations. 3rd Edn. John Wiley & Sons, USA.
4. Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA. Edited by R. P. Chhabra V. Shankar (2017)
Coulson and Richardson's Chemical Engineering Volume 2A: Particulate Systems and Particle Technology. 6th Edition, Elsevier, USA. Edited by R. P. Chhabra and Basavaraj Gurappa (2019)

COURSE OUTCOMES**	
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After completion of the course student will be able to

1. Understand the application of dimensional analysis and can state and describe the nature and properties of the fluids.
2. Apply the knowledge of fluid mechanics and determine the flow rate, discharge of transportation fluids
3. Apply the knowledge of filtration and sedimentation in Engineering applications
4. Apply the knowledge of Size Separation and Agitation techniques in Engineering applications.

[illegible]

22UBT304C	BIOCHEMISTRY	Credits: 03
L: T: P - 3: 0: 0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT – I	12 Hrs.
Carbohydrate Metabolism: Glycolysis, TCA cycle, Glyoxylate cycle, Gluconeogenesis and regulation of gluconeogenesis, pentose phosphate pathway and Electron transport chain, oxidative phosphorylation, bioenergetics, Structure and properties of ATP. Disorders of carbohydrate metabolism.	
UNIT – II	10 Hrs.
Lipid Metabolism: Biosynthesis of fatty acids. cholesterol, phospholipids and glycolipids. Regulation of fatty acid biosynthesis, biodegradation of fatty acid. Ketone bodies production during starving and diabetes. Disorders of lipid metabolism.	
UNIT – III	10 Hrs.
Nucleic acid Metabolism: Biosynthesis of purines - origin of ring atoms, formation of IMP, conversion of IMP to AMP and GMP. De novo synthesis of pyrimidine nucleotides - biosynthesis of UTP & CTP. Biodegradation of purines & pyrimidines. Recycling of Purine and Pyrimidine nucleotides by salvage pathways. Disorders of nucleic acid metabolism.	
UNIT – IV	10 Hrs.
Amino Acid Metabolism: Biosynthesis of amino acids starting from acetyl CoA (with reference to oxaloacetate family) - Aspartate, Asparagine, Methionine, Lysine, Threonine. Biodegradation of amino acids- deamination, transamination and urea cycle. Disorders of amino acid metabolism.	

REFERENCES*

- David L. Nelson and Michael Cox (2017). "Lehninger Principles of Biochemistry" 7th edition W.H Freeman & Co., Pub.
- Lubert Stryer (2010)., "Biochemistry" -5th edition Freeman & Co., Pub.
- Voet&Voet (2011). "Biochemistry"- 4th edition, John Wiley, New York Pub.
- Thomas M. Davlins (2010). "Biochemistry with clinical correlations" 7th edition Wiley-Liss;
- Mathews, Vanholde & Arhen (2010). "Biochemistry" -3rd edition, Pearson Education Pub
- Elliot & William H (2011). "Biochemistry & Molecular Biology" 3rd edition, John Wiley.
- U. Sathyanarayana (2022). "Biochemistry" -5th edition, Books and Allied Pub.

COURSE OUTCOMES**

After completion of the course student will have the ability

- To understand the metabolic pathways in the carbohydrates along with its energetic and interpret the metabolic disorders.
- To understand lipid metabolism and comprehend the regulation of along with the in born errors of metabolism.
- To understand the origin of atoms in purine and pyrimidine & also interpret the pathways in the nucleic acid metabolism and also its disorders
- To understand pathways involved in amino acid metabolism and its disorders.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				3	2	3	

CO 2	2	3	3	3		3	2	3				3	2	1	2
CO 3	2	2	3	3		3	2	2				3	3	2	
CO 4	2	2	2	2		2	2	2				2	2	2	

22UBT305C	BIOPROCESS PRINCIPLES AND CALCULATIONS	03 - Credits (2 : 2 : 0)
Hours / Week : 04		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I		7 + 3 Hrs.
Introduction to Engineering Calculations Dimensions and System of Units: Introduction, Fundamental and Derived Units, Fundamental and Derived Quantities; System of Units (FPS, CGS, MKS, SI); Conversion of Units, Inter-conversion; Conceptual Numericals Basic Chemical Engineering Calculations: Atomic, Molecular and Equivalent weights, molar concept, Gram atom, Gram mole; Equivalent Weight; Concept of Normality, Molarity and Molality. Method of Expressing the Composition of Mixtures and solutions, weight fraction, mole fraction, Percentage by weight, mole percent and volume percent; Concept of PPM (Parts Per Million); Conceptual Numericals; Gases, Ideal Gas Law, Dalton's Law, Partial Pressure, Amagat's Law, Gaseous Mixtures, Relationship between Partial Pressure and Mole Fraction of Component Gas; Average Molecular Weight of Gas Mixture; Density of Gas Mixture; Conceptual Numericals		
UNIT – II		7 + 3 Hrs.
Introduction to Bioprocesses: Bioprocess Engineering, Role of a bioprocess engineer in the biotechnology industry, unit operations involved in bioprocesses Material Balance without Chemical Reactions General material balance equation for steady and unsteady states. Generalized Block Diagram of process showing input and output; Material balance equations for Unit Operations like Distillation, Evaporation, Crystallization, Mixing, Drying, Extraction; Material balances and calculations on Distillation, Evaporation, Crystallization and Mixing Unit Operations- Conceptual Numericals		
UNIT – III		7 + 3 Hrs.
Material Balance Involving Chemical Reactions Generalized material balance equations, stoichiometry, Principles of stoichiometry, stoichiometric ratio, proportion, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, selectivity, Material Balance and Conceptual Numericals on different Unit processes		
UNIT – IV		7 + 3 Hrs.
Stoichiometry of Microbial growth and Product formation 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		
REFERENCES		
Chemical Process Calculations by D. C. Sikdar, PHI Learning Private Limited, Delhi, 2013 Introduction to Process Calculation by K A Gavane, Nirali Publications, 2016 Stoichiometry by B. I. Bhatt and S. M. Vora, Tata McGraw Hill Publishing, 4 th Edition, 2004 Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI Learning Private Limited, 2005 Bioprocess Engineering Principles by Pauline M. Doran, Academic Press, 2012 Biochemical Engineering Fundamentals: by J. E. Bailey & D. F. Ollis, McGraw Hill, 2005 Bioprocess Engineering by Shule and Kargi, Prentice Hall, 2010		
COURSE OUTCOMES		

After completion of the course student will be able to

1. Describe and Perform Basic Biochemical Calculations involving compositions of Mixtures and solutions.
2. Apply the knowledge of Material Balances and Solve the Bioprocess Engineering Problems involving Unit Operations .
3. Apply the knowledge of Material Balances and Solve the Bioprocess Engineering Problems involving Unit Processes.
4. Solve the Bioprocess Engineering problems applying Stoichiometry knowledge of Microbial cells.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3									2	2	1	
CO 2	2	3	3									2	2	1	
CO 3	3	3	3									1	2	1	
CO 4	3	3	3									1	2	1	

22UBT340C/22UBT440C	BIOLOGY FOR ENGINEERS	02 - Credits (2: 0 : 0)
Hours / Week : 02		CIE Marks : 50
Total Hours : 26		SEE Marks : 50
UNIT-I		06 Hrs.
Bio Inspiration Models Used In Engineering: Bio inspiration - Introduction, Alliance between Engineering and Biology, Biomimicry - Science mimicking nature. Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Gecko Feet, Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train), Fire fly LED.		
UNIT-II		06 Hrs.
Nature Bioinspired Materials And Mechanisms BioEcholocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf), Respiration (MFCs) Human Blood substitutes-hemoglobin based oxygen carriers (HBOCs) and perfluorocarbons (PFCs). Artificial Intelligence for disease diagnosis. Bioichips & their applications. Biosensors & their applications. Nanobiomolecules in medical science. Biofilms in dental treatment		
UNIT-III		07 Hrs.
Human Organ Systems And Bio Designs Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson’s disease). Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification system gas exchange mechanisms, spirometry, Ventilators, Heart-lung machine). Eye as a Camera system, bionic eye. Kidney as a filtration system - dialysis systems. Muscular and Skeletal Systems as scaffolds, bioengineering solutions for muscular dystrophy and osteoporosis.		
UNIT-IV		07 Hrs.
Trends In Bioengineering Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods, electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Self-healing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic). Bio-bleaching.		
REFERENCE BOOKS *		
1. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022 2. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012 3. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011 4. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011 5. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2020. 6. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, CRC Press, 2012 7. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C.		

Mattiussi, MIT Press, 2008

8. Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N GeethaA C Udayashankar Lambert Academic Publishing, 2019
9. 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016
10. Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

Web links and Video Lectures (e-Resources)

- VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource
- <https://nptel.ac.in/courses/121106008>
- <https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists>
- <https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009>
- <https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006>
- <https://www.coursera.org/courses?query=biology>
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- <https://www.classcentral.com/subject/biology>
- <https://www.futurelearn.com/courses/biology-basic-concepts>

COURSE OUTCOMES**

After completion of the course student will be able to

1. Corroborate the concepts of biomimetics for specific requirements.
2. Understand the concept of bioinspired materials and mechanisms.
3. Evaluate the principles of design and development of biodesigns based on human organ systems.
4. Explore innovative biobased solutions for ecofriendly and socially relevant problems.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3		1									1			
CO 2	3		1									1			
CO 3	3		1									1			
CO 4	3		1		3	1	1					1			

22UBT306L	BIOCHEMISTRY LAB	Credits: 01
L: T: P - 0: 0:2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS

1. pH measurements, concentration of solutions and units, conversion factors, accuracy.
2. Preparation of buffers of constant strength.
3. Qualitative tests for carbohydrate and lipids.
4. Qualitative tests for amino acids and proteins.
5. Estimation of sugar by Folin Wu and O-toluene method.
6. Estimation of amino acid by ninhydrin method
7. Estimation of protein by Lowry's method.
8. Estimation of nitrogen by Kjeldahl method.
9. Estimation of urea by diacetylmonooxime method.
10. Determination of Saponification value of lipids.
11. Determination of Iodine value of lipid.
12. Determination of acid value of a lipid.

REFERENCE BOOKS*

1. Plummer D. T (2017) "Practical Biochemistry" – 3rd edition McGraw Hill Education pub.
2. T N. Pattabhiraman, (2017) "Laboratory Manual & Practical Biochemistry" 4th Edition, All India Publishers & Distributors
3. Sadasivam, S. and Manickam (2017) A Biochemical Method. 3rd Edition, New Age International Publishers, New Delhi.
4. Rodney Boyer, "Modern Experimental Biochemistry" 3rd edition, Pearson Education Pub, (2000).
5. Keith Wilson (2003). "Practical Biochemistry" 3rd edition Cambridge University Pub.
6. Beedu Sashidhar Rao and Vijay Deshpande (2005) "Experimental Biochemistry" I.K International Pvt. Ltd.

COURSE OUTCOMES**

After completion of the course student will have the ability

1. To understand the importance of pH & learn the different strength of solution & buffer preparations.
2. To identify various biomolecules by means of qualitative analysis.
3. To quantify the concentrations of the biomolecules in the given sample.
4. To apply knowledge of acid & iodine value to determine the quality of lipids.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				1	2	3	
CO 2	2	3	2	2			2	3					1	3	
CO 3	2	3	3	3		3	2	2					2	1	
CO 4	2	3	3	2		2	2	2					3	1	

B. E. IV SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UBT401C	Biostatistics & Biomodeling	03	2	2	0	50	50	100
2.	IPCC	22UBT402C	Immunotechnology + Lab	04	3	0	2	50	50	100
3.	IPCC	22UBT403C	Heat & Mass Transfer + Lab	04	3	0	2	50	50	100
4.	PCC	22UBT404C	Molecular Biology	03	3	0	0	50	50	100
5.	PCC	22UBT405C	Cell culture techniques	02	2	0	0	50	50	100
6.	PCCL	22UBT406L	Cell culture & Molecular Biology Lab	01	0	0	2	50	50	100
7.	HSMC	22UHS424C	UHV-II	01	1	0	0	50	50	100
8.	PCCL	22UBT407L	Biostatistics lab	01	0	0	2	50	50	100
9.	MC	22UHS001M 22UHS002M 22UHS003M	Yoga NSS PE	00	0	0	2	25	-	-
Total				19	14	2	10	425	400	800

22UBT401C	BIostatISTICS & BIO-MODELING	Credits: 03
L: T: P - 2: 2: 0		CIE Marks: 50
Total Hours/Week: 4		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction and Descriptive Statistics: Scope of biostatistics, presentation of data, Diagrammatic and graphical represent,(simple, multiple, component bar diagrams, pie chart, histogram, frequency polygon, frequency curve, ogive curve). Measure of central tendency (meaning of central tendency, arithmetic mean, median, Quartiles, mode, geometric mean, harmonic mean their merits and demerits). Measure of dispersion: meaning, range, quartile deviation, mean deviation and standard deviation, coefficient of variation, skewness and kurtosis. Correlation and linear regression analysis, curve fitting straight line).		
UNIT-II		10Hrs.
Probability and Probability Distributions: Definition of probability, Event, Mutual Exclusive, Independent, Complimentary Events Addition and Multiplication theorem of probability and examples. Discrete probability distributions: Bernoulli's , Binomial and Poisson distribution. Continuous probability distribution – normal, Standard normal variate, properties of normal curve, T, F and χ^2 (Chi square -goodness of fit test) distributions and their applications in Biology.		
UNIT-III		10 Hrs.
Statistical Inference , ANOVA and Design of Experiments: Estimation theory and testing of hypothesis point estimation, interval estimation. Sample, population, sample size determination. Methods of Sampling techniques- random (simple, stratified and systematic) non random sampling - (Judgement and convenience). Definition of analysis of variance(one way and two way classifications), Basic principles of experimental design and limitations-randomization, replication, local control, Types of statistical designs of biological experiments and limitations-CRD, RCBD, LSD, Plackett-Burmann design, Response surface methodology(RSM).		
UNIT-IV		10 Hrs.
Bio-modeling: Microbial Growth in a Chemo-stat, Growth Equations of Microbial Populations, product formation models, Models of Commensalisms, Batch culture model, Mutualism, Predation and Mutation. Simple Prey predator model, Volterra's Model for n Interacting Species. Basic Models for Inheritance, Applications of probability in genetics, Hardy - Weinberg law. Selection and Mutation Models, Genetic Inbreeding Models. Dose response studies.		
REFERENCE BOOKS *		
1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3 rd edition), Ukaaz Publication 2. Kapur J.N. (2001),Mathematical Models in Biology and Medicine(1 st edition), New age international Pvt. Ltd. 3. Agarwal B.L. (2009), Basic statistics(5 th edition), New age international Publishers 4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books		
COURSE OUTCOMES**		
After completion of the course student will be able to 1. Interpretation of the data using different statistical methods. 2. Investigate the probability distributions of the data.		

3. Design and analyze the experimentation using statistical tools.
4. Apply the biomodelling concepts in various biological studies.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	-	3	2	-	-	-	-	3	-	2	3	2	-
CO2	2	2	-	3	1	-	-	-	-	2	-	-	3	1	-
CO3	1	3	3		3	-	-	-	-	2	-	2	3	-	-
CO4	3	2	-	2	2	-	-	-	-	1	-	2	2	2	-

22UBT402C	IMMUNOTECHNOLOGY	Credits: 04
L: T: P - 3 : 0: 2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

UNIT-I	10Hrs.
The immune system: Introduction, Cells and Organs of the immune system: Lymphoid cells and myeloid cells. Primary (thymus, bone marrow and lymphatic system) and secondary Lymphoid organs (lymph nodes, spleen, MALT). Innate and adaptive immunity. Antigens: Chemical and biological Factors affecting antigenicity/Immunogenicity and molecular nature, Haptens, adjuvants. Antibodies: their structure and function, Immunoglobulin classes (IgG, IgA, IgE, IgD and IgM) and subclasses (isotypic, allotypes, idiotypes and anti-idiotypic antibodies). Cytokines and their role in immune response.	
UNIT-II	10 Hrs.
Humoral and cell mediated immunity: Introduction to humoral and cell mediated immunity. B-lymphocytes maturation and mechanism of activation. Thymus derived lymphocytes (T cells) and types, T-cell maturation and mechanism of activation. Major Histocompatibility Complex: MHC I and MHC II structure and functions. Antigen processing and presentation process. Complement system and its pathways (classical, alternative and lectin pathway) regulation and biological consequences of complement activation.	
UNIT-III	10 Hrs.
Immunological disorders: Hypersensitivity reactions and its types. Autoimmune disorders- Organ specific, Systemic Autoimmune disorders, types and treatment of autoimmune disease. Primary and secondary immunodeficiency disorders (AIDS). Transplantation Immunology: immunological basis of graft rejection, Types of transplantations. Vaccines: Active and Passive immunization. Designing vaccines for active immunization: Live, attenuated vaccines. Inactive vaccines, subunit vaccines, recombinant vector vaccines and DNA vaccines.	
UNIT-IV	10Hrs.
Immunodiagnosis: Antigen-antibody reactions- Precipitation reactions, agglutination reactions, Blood typing A, B, ABO & Rh. Principal and applications of ELISA, Radio immuno assay (RIA), western blot analysis, Immuno-electrophoresis, Immunofluorescence, chemiluminescence assay, flow cytometry, fluorescence activated cell sorting (FACS) analysis. Production of monoclonal antibodies. Laboratories: 1. Agglutination Technique: Blood group identification and Rh factor 2. Laboratory diagnosis of diseases-Widal test (Tube agglutination) and VDRL 3. Ouchterlony Double Diffusion (ODD)	

- ## REFERENCE BOOKS *

- ## COURSE OUTCOMES**

1. Interpret the properties and functions of immune system.
2. Asses the functions of humoral and cell mediated immune system.
3. Develop the vaccines by analyzing the immunological disorders
4. Identify the diseases using different immunodiagnostic tools.

[illegible]

22UBT403C	HEAT AND MASS TRANSFER	04- Credits (3 : 0 : 2)
Hours / Week : 05		CIE Marks : 50
Total Hours : 40		SEE Marks : 50
UNIT-I		10 Hrs.
Fundamentals of Heat Transfer: Modes of heat transfer; Conduction – steady state heat conduction through uni-layer and multilayer plane wall, sphere and cylinder, Conceptual numericals on conduction; Forced and Natural convection, Conceptual Numericals on convection; Significance of Dimensionless numbers (Nu, Gr, Pr, Re, Pe numbers only); Heat transfer to fluids without phase change; heat transfer in laminar and turbulent flow inside closed conducts.		
UNIT-II		10 Hrs.
Heat Transfer concept in Heat Exchangers: Heat transfer with phase change - Condensation – film wise and drop wise; Boiling – types of boiling; Flow arrangements in Heat transfer equipment's - co current and counter current flow; LMTD, Elementary design of double pipe heat exchanger and shell and tube heat exchanger; Concepts of Heat transfer coefficients- Individual and overall; Fouling factor and Resistance for heat transfer; Conceptual numericals		
UNIT-III		10 Hrs.
Mass transfer concepts Diffusion - Fick's law of diffusion; Measurement of diffusivity, Two film theory of mass transfer, Mass transfer coefficients and their correlations. Liquid-Liquid, Solid-Liquid, Liquid-Gas, Solid-Liquid-Gas mass transfer. Principles, mass transfer considerations in unit operations like Extraction, Absorption, Adsorption, Crystallization and Evaporation		
UNIT-IV		10 Hrs.
Mass transfer Operations Methods of distillation –Simple, Flash, and Fractional distillation of binary mixtures, Continuous Distillation with reflux, relative volatility, fractionation of binary mixtures -McCabe Thiele method, Extractive and Azeotropic distillation, Drying, Principle of Drying, Drying rate, drying curve.		
LIST OF EXPERIMENTS 1. Thermal conductivity of material (solid or liquid) 2. Heat transfer in a composite wall by conduction 3. Heat transfer by Natural Convection 4. Heat transfer by Forced convection 5. LMTD and Effectiveness in Heat Exchanger – Co-current 6. LMTD and Effectiveness in Heat Exchanger – Counter-current 7. Distillation 8. Extraction 9. Drying 10. Leaching		
REFERENCE BOOKS * 1. McCabe WL, Smith JC and Harriott (2005) Unit operations in Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA 2. Treybal RE (2012) Mass Transfer Operations, 3rd Edition, McGraw-Hill Publications, USA. 3. R. P. Chhabra V. Shankar (2017) Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA.		

4. Heat and Mass Transfer: Fundamentals and Applications, 7th Edition, Butterworth-Heinemann
5. Pauline Doran (2012) Bioprocess Engineering Principles, 2nd Edition, Academic Press
6. Alan S Foust, Wenzel LA, Clump CW, Maus L and Anderson LB (2008). Principles of Unit Operations, 2nd Edn. John Wiley & Sons, USA.
7. Kern (2001). Process Heat Transfer, 2nd Edn. McGraw-Hill Publications, USA.
8. Perry RH and Green DW (2008). Perry's Chemical Engineering Hand Book, 8th Edn. McGraw- Hill Publications.

COURSE OUTCOMES**

After completion of the course student will be able to

1. State the different modes of heat transfer and solve basic heat transfer problems
2. Apply the knowledge of Heat Exchangers in Biochemical Engineering applications
3. Apply the knowledge of Mass Transfer in Unit Operations to solve Biochemical Engineering problems
4. Apply the knowledge of Distillation and Drying Unit Operations in Bioprocess Industries

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2	2	1							1	2		
CO 2	3	2	3	3	2							2	2		
CO 3	2	3	2	2	1							1	2		
CO 4	3	2	1	1	1							1	2		

22UBT404C	MOLECULAR BIOLOGY	Credits-3
L: T: P - 3 : 0: 0		CIE Marks : 50
Total Hours/week : 03		SEE Marks : 50

UNIT – I		12 Hrs.
Introduction Genes and their location. Information flow in biological systems: central dogma, updated central dogma. Signalling (signal transduction)-molecular mechanism. Reverse genetics, Genetic code-its features, codon and anticodon.		
Replication: Replication-basic concepts, structure and function of DNA polymerases, ligases, helicase. mechanism of DNA replication in prokaryotes and eukaryotes, End replication problem in eukaryotes, telomerase and its role, DNA damage & Repair (Photo reactivation, excision repair, recombinational repair, SOS repair).		
UNIT – II		10 Hrs.
Transcription Mechanism of transcription in prokaryotes and eukaryotes, Bacterial RNA polymerase, structure and function of RNA polymerases (prokaryotes & eukaryotes), general transcription factors, post transcriptional processing, Si RNA, Antisense RNA technology.		
Translation: Protein synthesis: Initiators, Elongation factors, termination codons, Mechanism of translation, Structure and function of prokaryotic and eukaryotic ribosomes, Post translational modification. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation.		
UNIT –III		10 Hrs.
Gene Expression in Prokaryotes Regulation of gene expression in prokaryotes: Operon model-structure and function, galactose and lactose operon, tryptophan Operon-regulation by attenuation mechanism; positive versus negative regulation, cyclic AMP effect/catabolite repression.		
Gene Expression in Eukaryotes: Regulation of eukaryotic gene expression, hormonal regulation- peptide and steroid hormones, transcriptional control, super secondary structures-Helix turns Helix. Zinc fingers and Leucine Zippers. Gene silencing- methylation, chromatin modification.		
UNIT – IV		10 Hrs.
Transposons and Oncogenes Transposons-replicative and non replicative mechanisms, Insertion sequences, AC/DS elements, transposition in maize (Mc Clintock's work), Cut and paste transposition, Oncogenes and Protooncogenes, Tumour suppressor genes, retroviruses and its life cycle.		
Genetic Recombination and Molecular markers: Genetic recombination in bacteria- transformation, transduction and recombination, Mechanism of recombination-homologous (Holliday model), site specific recombination.		

REFERENCES*

1. David Nelson and Michael Cox, (2017), Lehninger Principles of Biochemistry (6th Edition), W.H. Freeman
2. James Watson (2008), Molecular Biology of the Gene (5th Edition) Pearson Education
3. David Freifelder, (2008), Essentials of Molecular Biology (2nd Edition), Narosa Publishing House

COURSE OUTCOMES**

1. Apply the knowledge of the basic aspects of molecular biology and classify the mechanism of DNA repair processes along with replication.
2. Acquire working knowledge on the mechanism of transcription, translation and post translational processes along with their applications in research.
3. Use research-based knowledge of gene regulation mechanism in prokaryotes and eukaryotes in the field of Biotechnology.
4. Select and apply the steps of transposition, Proto-oncogenes conversion and molecular mechanism of genetic recombination in treating diseases.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	1	3	2	1	-	-	-	-	-	2	1	1
CO2	1	-	1	3	3	2	2	-	-	-	-	-	2	2	1
CO3	1	-	1	3	2s	1	1	-	-	-	-	-	1	1	1
CO4	1	-	3	3	3	2	3	-	-	-	-	-	2	2	1

22UHS424C	UNIVERSAL HUMAN VALUES-II	Credit: 01
L:T:P - 1 : 0: 0		CIE Marks: 50
Total Hours/Week:01		SEE Marks: 50

UNIT-I	04 Hrs.
Introduction to Value Education: Right Understanding; Relationship and Physical Facility; Understanding Value Education; Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity -the Basic Human Aspiration-Current Scenario and Method to Fulfill the Basic Human Aspirations.	

UNIT-II	04 Hrs.
Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.	

UNIT-III	04Hrs.
Harmony in the Family and Society and Nature: Harmony in the Family – the Basic Unit of Human Interaction; 'Trust' – the Foundational Value in Relationship; 'Respect' – as the Right Evaluation: Other Feelings, Justice in Human-to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order; Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature.	

UNIT-IV	03 Hrs.
Implications of the Holistic Understanding – a Look at Professional Ethics Definitiveness of (Ethical) Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Competence in Professional Ethics; Holistic Technologies, Production Systems and Management Models; Strategies for Transition towards Value-based Life and Profession	

REFERENCE BOOKS

1. R R Gaur, R Sangal, G P Bagaria, 'Human Values and Professional Ethics', , Excel Books, New Delhi, 2010
2. A. Nagaraj, Jeevan VidyaEkParichaya, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.
4. Annie Leonard,The Story of Stuff (Book), Simon & Schuster, 2011.
5. Mohandas Karamchand Gandhi,The Story of My Experiments with Truth, Public Affairs Press of Washington, DC. 1948
6. E. F Schumacher, Small is Beautiful,. Blond & Briggs, 1973
7. Cecile Andrews, Slow is Beautiful, New Society Publishers, 2006.
8. J C Kumarappa, Economy of Permanence, Akhil Bharat Sarva-Seva-Sangh, Rajghat, Kashi, 1958.
9. Pandit Sunderlal, Bharat Mein Angreji Raj,Publications Division, M/O Information & Broadcasting, Govt. of India, 2016
10. Dharampal,Rediscovering India, Society for Integrated Development of Himalayas, 2003
11. Gandhi, Mohandas K. Hind Swaraj or Indian Home Rule Ahmedabad, Nava jivan Pub. House, 1946.
12. India Wins Freedom, Maulana Abdul Kalam Azad, Orient Black Swan, 1988.
13. Romain Rolland, Gandhi, Romain Rolland (English), Srishti, 2000.

Course Outcomes

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

CO1: Explore holistic vision of life - themselves and their surroundings.
 CO2: Develop competence and capabilities for maintaining Health and Hygiene.
 CO3: Analyse various problems in life, family, Society and in handling problems with Sustainable Solutions.
 CO4: Apply values to their own self in different day-to-day settings in real life and in handling problems with sustainable solutions.
 CO5: Adopt the value of appreciation and aspiration for excellence and gratitude for all.

No	Programme Outcomes Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Upon successful completion of course the Students will be able to:																
1	Explore holistic vision of life - themselves and their surroundings.							3	2	3			1			
2	Develop competence and capabilities for maintaining Health and Hygiene.						3	3	1	1			1			
3	Analyse various problems in life, family, Society and in handling problems with Sustainable Solutions.						3	3	2	1			1			
4	Apply values to their own self in different day-to-day settings in real life and in handling problems with sustainable solutions.						2	2	3	2			1			
5	Adopt the value of appreciation and aspiration for excellence and gratitude for all.								3				1			

22UBT406L	CELL CULTURE AND MOLECULAR BIOLOGY LAB	Credits: 01
0:0:2 - N _L : N _T : N _P		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS

1. Callus Induction Technique- Stock preparation, Media preparation.
2. Explants preparation and inoculation technique.
3. Development of suspension culture from callus
4. Animal cell culture techniques
5. Study of absorption spectra of nucleic acids.
6. UV Vis survival curve of bacteria.
7. Agarose gel electrophoresis.
8. Isolation of genomic DNA from plant sources.
9. Isolation of plasmid DNA from E. coli.
10. Estimation of DNA by diphenyl method.
11. Estimation of RNA by orcinol method.
12. Purity of nucleic acids by UV-Vis Spectrophotometer.
13. Standard Operating Procedure for Centrifuge and Gel Documentation Unit.

REFERENCE BOOKS *

1. Sadashiva and Manickam, (2017), Biochemical Methods, (2nd Edition), W.H. Freeman
2. R.A. Dixon & Gonzales, (1995), Plant Cell Culture: A Practical Approach by IRL Press. (2nd Edition),
3. Sambrook& Russell, (2002), Molecular Cloning, (3rd Edition), Cold Spring Harbor Lab.

COURSE OUTCOMES**

After completion of the course student will be able to

1. Conduct and analyze the growth of plant and animal cells by plant and animal tissue culture techniques.
2. Apply absorption spectra and analyze SOP for various lab equipments.
3. Conduct and analyze the concentration and purity of DNA.
4. Conduct observations and experiments including Genomic DNA/plasmid DNA /RNA/protein.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	1	3	1	-	-	-	-	-	1	1	3	1
CO2	1	2	2	1	3	2	-	-	-	-	-	1	1	3	1
CO3	1	2	2	1	3	1	-	-	-	-	-	1	1	3	1
CO4	2	2	3	2	3	2	-	-	-	-	-	1	1	3	1

22UBT407L	BIOSTATISTICS LAB	Credits: 1
L: T: P - 0:0:2		CIEMarks:50
Total Hours/Week: 02		SEEMarks:50
LIST OF EXPERIMENTS		
1. Procedure for creating Data file, Diagram and Graphs. 2. Procedure and calculation of Mean, Median, Mode, Standard Deviation and Variance. 3. Procedure and calculation of t test. 4. Calculation of Chi-square test. 5. ANOVA- one-way analysis 6. ANOVA- two-way analysis. 7. Experimental Research Design – CRD- Analysis. 8. Experimental Research design – RBD- Analysis. 9. Experimental Research design – Latin square Design- Analysis. 10. Placket-Burman Design for media optimization. 11. Response Surface Methodology for media optimization.		
REFERENCE BOOKS *		
1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3rd edition), Ukaaz Publication 2. Kapur J.N.(2001),Mathematical Models in Biology and Medicine(1st edition), New age international Pvt. Ltd. 3. Agarwal B.L. (2009), Basic statistics(5th edition), New age international Publishers 4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books		
COURSE OUTCOMES**		
After completion of the course student will be able to 1. Create data file, draw graphs, charts using statistical software tools. 2. Calculate measures of dispersion and central tendency. 3. Analyse the data using ANOVA. 4. Design experimental set up using statistical software tools.		

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	1	3	-	-	-	-	-	-	1	2	2	1	1
CO 2	3	3	2	3	3	-	-	-	-	-	2	2	2	1	-
CO 3	2	3	3	2	2	2	-	-	-	-	-	3	2	1	-
CO 4	3	3	1	3	3	2	-	-	-	-	-	3	2	1	2

B. E. V SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	PCC	21UBT501C	Bioinformatics	03	3	0	0	50	50	100
2.	IPCC	21UBT502C	Genetic Engineering & Applications + lab	04	3	0	2	50	50	100
3.	PEC	21UBT5XXE	Elective –I	03	3	0	0	50	50	100
4.	OEC	21UXX5XXN	Open Elective-I	03	3	0	0	50	50	100
5.	PCCL	21UBT503L	Bioinformatics Lab	01	0	0	2	50	50	100
6.	AEC	21UHS521C	Quantitative Aptitude and Professional Skills	02	2	0	0	50	50	100
7.	INT	21UBT504I	Summer Internship – II	03	0	0	4	100	-	100
8.	HSMC	21UBT523C	Environmental Studies	01	1	0	0	50	50	100
9.	MC	21UHS001M 21UHS002M 21UHS003M	Yoga NSS PE	00	0	0	2	10	-	-
Total				20	15	0	10	460	350	800

Elective-I

21UBT511E: Environmental BT

21UBT512E: Nutraceuticals

21UBT513E: Computational Biology

21UBT514E: Protein Engineering and Drug Design

Open Elective-I

21UBT532N: Biofuels Technology

21UBT501C	BIOINFORMATICS	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		12 Hrs.
Introduction to Bioinformatics and Biological Database		
Introduction to bioinformatics, Components of bioinformatics and interdisciplinary nature of bioinformatics, Classification of biological databases; Primary database: NCBI, GenBank, DDBJ and EMBL, PIR, Uniprot; Secondary databases: PROSITE, PRINTS, BLOCKS and Pfam; Structure databases: Protein Data Bank (PDB), MMDB, CATH, SCOP; Specialized databases: PubMed, OMIM, Metabolic Pathway-KEGG; ExPasy and PubChem databases, File format: GenBank flat file, PDB flat file. Tutorials: Practices on other primary and secondary databases		
UNIT-II		10 Hrs.
Sequence alignment and database searches:		
Introduction, Types of sequence alignment, Comparison between global and local alignment, Pairwise sequence alignment: Dot matrix analysis, Dynamic programming, Global alignment-Needleman-Wunch algorithm, Local Alignment-Smith & Waterman algorithm, Substitution matrix- BLOSUM and PAM; GAP Penalty; Low complexity regions; Word/k-tuple method- BLAST, FASTA. Multiple Sequence Alignment: Introduction, applications of MSA; Types of MSA: Progressive method of MSA-Clustal W; Iterative method of MSA; Motifs and Patterns; Statistical models of MSA-Position Specific Scoring Matrix (PSSM) and Profiles. Tutorials: Solving problems on pairwise sequence alignment		
UNIT-III		10 Hrs.
Phylogenetic analysis and predictive methods using sequences		
Introduction, concepts of trees, types of evolutionary trees, Rooted and unrooted trees, Steps in constructing phylogenetic trees, Tree building methods - Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method; Character based method: Maximum parsimony; Tree Evaluation methods, Phylogenetic Softwares. Predictive Methods using sequences: Structure of Prokaryote and Eukaryote genes; Algorithms for Prokaryotic and Eukaryotic gene prediction, Web based tools for gene prediction (ORF finder, GenScan). Protein Secondary Structure Prediction, Tertiary Structure Predictions: Homology modelling. Tutorials: Practices on prediction of phylogenetic trees		
UNIT-IV		10 Hrs.
Plasmid mapping and primer designing & molecular modelling techniques		
Restriction mapping, Web based tools: Restriction Mapper and REBASE. Utilities of Mac Vector and Vector NTI; Basics of Primer designing, Primer design softwares (PRIME3). Rational Approaches in Drug Design, molecular docking, deriving the Pharmacophoric Pattern, quantitative structure-activity relationship (QSAR), deriving bioactive conformations, Calculation of Molecular Properties, Docking softwares (AUTODOCK, HEX) Tutorials: Solving problems related to Restriction mapping and Primer designing		
REFERENCE BOOKS *		
1. Introduction to Bioinformatics – Arthur Lesk, Oxford, 2nd Edition, 2006. 2. Bioinformatics – Stuart M Brown, NYU Medical Center, NY USA. 2000. 3. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006. 4. Computational methods for macromolecular sequence analysis – R F Doolittle. Academic Press, 1996.		

COURSE OUTCOMES**

After completion of the course student will be able to

1. Importance of databases involved in bioinformatics along with their file formats
2. Will have idea on searching similar sequences in databases and find similarity between given set of sequences
3. Derive evolutionary relationship between genes and proteins by phylo-genetic analysis
4. Explain various statistical tools involved in predicting the structure of genes and proteins
5. The principle behind restriction mapping and primer designing
6. Different approaches involved in silico drug design

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2				3	2	2	3
CO 2	3	2	2	2	2	1	2	-				3	2	2	3
CO 3	3	2	-	1	-	-	2	-				3	2	2	3
CO 4	2	2	-	1	-	2	-	-				3	1	-	2
CO 5	2	2	2	1	-	2	-	2				1	2	-	2
CO 6	2	1	2	2	2	2	1	1				1	1	1	1

21UBT502C	GENETIC ENGINEERING & APPLICATIONS	Credits: (4: 0: 0)
L: T: P – 3-0-2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction Tools of genetic engineering- vectors in recombinant DNA technology, biology and salient features of vectors, Types of vectors - plasmids, cosmids, bacteriophage lambda vectors.		
Enzymes in genetic engineering: Introduction- Restriction Endonucleases-classification, mode of action, applications. Enzymes used in nucleic acid modification – Alkaline phosphatase, polynucleotide Kinase, Ligases, terminal deoxy nucleotidyl transferase		
UNIT-II		10Hrs.
Nucleic acid hybridization and amplification Methods of nucleic acid detection, Fluorescent In situ hybridization (FISH), colony hybridization, polymerase chain reaction (PCR), its types and applications, methods of nucleic acid hybridization, Southern, Western and Northern hybridization techniques.		
Construction of cDNA libraries: Construction of Complementary DNA (cDNA), genomic DNA libraries and cDNA libraries.		
UNIT-III		10 Hrs.
Gene transfer techniques Gene transfer techniques in plants, animals and microbes –Transformation, microinjection, electroporation, microprojectile system, and liposome mediated transfer, embryonic stem cell method. Agrobacterium-mediated gene transfer in plants – Ti & Ri Plasmid: structure and functions, Ti based vectors- Binary vectors and Cointegrate vectors.		
Transgenic science and genetic improvement: Transgenic science in plant improvement, Antisense RNA technology (Flavr savr tomatoes). Application of plant transformation for productivity and performance – Herbicide resistance - glyphosate. insect resistance - Bt genes(<i>Bacillus thuringiensis</i> and its mode of action), Cry proteins – mechanism of action.		
UNIT-IV		10 Hrs.
Gene therapy Introduction, Methods of Gene therapy-gene targeting, gene augmentation, assisted killing, prodrug therapy and gene silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy. Use of thrombolytic agents in blood clotting. Challenges in gene therapy.		
Applications: Engineering microbes for the production of Insulin, growth hormones, monoclonal antibodies.		
REFERENCE BOOKS		
1. Molecular Biotechnology, Principles and applications of Recombinant DNA by Bernard R Glick and Jack J Pasternak, second edition, CBS Publishers, 2012. 2. Recombinant DNA by Watson, et al., second edition, Freeman Publishers 2010. 3. Principles of gene manipulation, Primrose S.B., Blackwell Scientific Publications, 2010. 4. From Genetics to Gene Therapy – the molecular pathology of human disease by David S Latchman, BIOS scientific publishers, 2010. 5. Biotechnology Expanding Horizon, B.D.Singh, 3 rd revised edition, Kalyani Publishers,2010 6. https://onlinecourses.swayam2.ac.in/cec19_bt02/preview		
LIST OF EXPERIMENTS		
1. Transformation 2. Blue white colony screening 3. Thermal denaturation of DNA 4. Restriction Digestion		

5. Ligation Experiment.
6. Southern Blotting – Agarose Gel Electrophoresis
7. Electroblothing and analysis
8. Lyophilization of biologic samples (fluids, microbial samples)
9. SOP for UV-Spectrophotometer
10. SOP for PCR
PCR (Amplification with specific primers)

COURSE OUTCOMES

1. Apply the knowledge of various tools used in genetic engineering experiments.
2. Select and apply the knowledge of methods of nucleic acid detection, hybridization and amplification and library construction in research.
3. Identify different methods of various gene transfer techniques in plants, animals and microbes
4. Use knowledge of various strategies of Gene therapy in therapeutics and engineer microbes for the production of biopharmaceuticals

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	-	1	-	2	3	-	2	-	-	-	-	2	1	3	1
CO 2	-	1	-	-	3	-	1	-	-	-	-	2	2	3	1
CO 3	-	1	-	2	3	1	1	-	-	-	-	2	3	3	1
CO 4	-	1	-	2	3	2	1	-	-	-	-	2	3	3	1

22UBT511E	ENVIRONMENTAL BT	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I		10 Hrs.
Microorganisms Issues and scope of Environmental BT. Characteristics of soil, microbial flora of soil, interactions among soil microorganisms, biogeochemical role of soil microorganisms.		
Bioaccumulation of Toxicants Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation, Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation.		
UNIT-II		12Hrs.
Biological Treatment of Wastewater Waste water characteristics BOD, COD, Primary & Secondary treatment, nano-filtration, ultra-filtration and microfiltration. Microbial removal of phosphorous and Nitrogen, Nutrient removal by Biomass production Wastewater treatment of food processing industries like sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries, and distilleries.		
Solid Waste Management Basic aspects, general composition of urban solid wastes, aerobic treatment, anaerobic treatment, biogas generation; Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, MoEF rules		
UNIT-III		10 Hrs.
Bioleaching & Biomining Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of metal, phosphate, petroleum.		
Bioremediation Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications. Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation.		
UNIT-IV		10 Hrs.
Biotechnology in Biodiversity Conservation Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.		
REFERENCE BOOKS*		
1. Environmental Biotechnology by Pradipta Kumar Mahopatra. 2. Text book of microbiology by R C Dubey and D K Maheshwari 3. Environmental Biotechnology by Foster C.F., John ware D.A., Ellis Horwood Limited,1987. 4. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom (1992), RIT,. 5. Comprehensive Biotechnology Vol. 1- 4 : M.Y. Young (Eds.), Pergamon Press. 6. Industrial Microbiology : L.E. Casida, Willey Eastern Ltd., 1989. 7. Industrial Microbiology : Prescott & Dunn, CBS Publishers, 1987. 8. Biotechnology, Economic & Social Aspects : E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.		
COURSE OUTCOMES**		

1. Understand issues and scope of Environmental BT and concepts of Bioaccumulation.
2. Develop different treatment methods for waste water by using BT approach.
3. Develop different treatment methods for solid waste by using BT approach.
4. Apply the knowledge of bioleaching for metal recovery and bioremediation processes to remove environmental contaminants.
5. Understand the Value of biodiversity and threats to biodiversity.
6. Apply the knowledge of BT in biodiversity conservation.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	3	2	2				2		3		1	2	3	1
CO 2	2	3	2	1				1	2				3	3	1
CO 3	2	3	2	1				1	2				3	3	1
CO 4	1	3	2	3				2	2	3			2	3	
CO 5								2		3		3			
CO 6	1	3	2	2					2	2			1	3	

22UBT512E	NUTRACEUTICALS	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to Nutraceutical and dietetics Organizational elements, classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutraceuticals. Scope involved in the industry, Indian and global scenario. Recommended dietary intake (RDA), acceptable dietary intake, nitrogen balance, protein efficiency ratio, net protein utilisation. Basics of energy balance - Basal Metabolic Rate (BMR), Body Mass Index (BMI) and Standard Dynamic Action (SDA) with special reference to nutraceutical industry.	
UNIT-II	10Hrs.
Nutrition related diseases and disorders Carbohydrates, Protein, amino acids, Fat, vitamins and minerals - Excess and deficiency, symptoms, prevention and management. Role of nutraceuticals with special reference to diabetes mellitus, hypertension, hypercholesterolemia, cancer, glands in the prevention and treatment. Concept of antioxidants - use of antioxidants as dietary supplements in prevention and treatment of cancer, obesity and stress. Role of nutraceuticals and functional foods in pediatrics, geriatrics, sports, pregnancy and lactation.	
UNIT-III	10 Hrs.
Nutraceuticals of microbial, plant and animal origin Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources. Synbiotics for maintaining good health. Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment. Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Animal metabolites - Sources and extraction of nutraceuticals of animal origin. Examples: chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides	
UNIT-IV	10 Hrs.
Biotechnology in Phytonutraceuticals Role of medicinal and aromatic plants in nutraceutical industry – propagation - conventional and tissue culture, cultivation, post harvest technology and strategies for crop improvement, development of high yielding lines and yield enhancement, plant genomics and metabolomics. Biofortification and nutritional enhancement. GM foods with enhanced nutraceutical properties. Golden rice, GM Tomatoes	
REFERENCE BOOKS*	
1. Israel Goldberg (Ed.) (1999) Functional foods, designer foods, pharma foods, Nutraceuticals, Aspen publishers Inc., USA. 2. L. Rapport and B. Lockwood, Nutraceuticals, Pharmaceutical Press., 2 nd Edition, 2002. 3. M. Maffei, Dietary Supplements of Plant Origin, Taylor & Francis, 1 st Edition, 2003. 4. Shahidi and Weerasinghe, Nutraceutical beverages Chemistry, Nutrition and health Effects, American Chemical Society, 1 st Edition, 2004. 5. Richard Neeser & J. Bruce German (2004) Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean, Marcel Dekker, Inc. 6. Timothy S. Tracy, Richard L. Kingston, Herbal Products 2 nd Edition, 2007.	
COURSE OUTCOMES**	
1. To be aware of basic concepts of nutraceuticals and nutrition. 2. To have a general idea of scope of nutraceuticals and functional foods. 3. To have brief idea about nutrition related health disorders and the role of Nutraceuticals. 4. To classify nutraceuticals and the role of nutraceuticals among different age groups. 5. To learn about the basic aspects of nutraceuticals derived from microbial, plant and animal origin.	

6. To know about the role of biotechnology in production of plant secondary metabolites

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2				3	2	2	3
CO 2	3	2	2	2	2	1	2	-				3	2	2	3
CO 3	3	2	-	1	-	-	2	-				3	2	2	3
CO 4	2	2	-	1	-	2	-	-				3	1	-	2
CO 5	2	2	2	1	-	2	-	2				1	2	-	2
CO 6	2	1	2	2	2	2	1	1				1	1	1	1

21UBT513E	COMPUTATIONAL BIOLOGY	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I	12 Hrs
Nature and scope of Computational Biology: Basic algorithms in Computational Biology, Biological and Computer algorithm, Fibonacci problem, Dynamic Programming, Time and space complexity of algorithms, Laplace's Rule. Search Algorithms: Random walk, Hill climbing, simulated annealing. Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.	
UNIT – II	8 Hrs
Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.	
UNIT – III	10 Hrs
Hidden Markov Model: Markov processes and Markov Models, Hidden Markov Models. Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:- Baum-Welch Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.	
UNIT – IV	10 Hrs
Insilico Drug Design and Biopython applications in Computational Biology Insilico Drug Design: Basic Concepts, importance and application, Molecular force fields and energy minimization, Molecular Dynamics Simulation methods, Methods of Insilico Drug Design: structure and ligand based drug design approach, structure based drug design: Molecular docking. Biopython: Introduction, important features and application of biopython in computational biology, Create a simple sequence in Biopython for DNA, RNA and Protein Alphabets, Sequence Alignment Tools in Biopython, PDB Module of Biopython,	
REFERENCE BOOKS	
• Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith, 1999, Pearson Education. • Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003. • Higgins and W. Taylor (Eds), Bioinformatics-Sequence, Structure and databanks, Oxford University Press, New Delhi, 2000 • An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press. 2004 • Biological sequence analysis: Probabilistic models of proteins and nucleic acids by Richard Durbin, Eddy, Anders Krogh, 1998 Algorithms for Molecular Biology by Ron Shamir Lecture, Fall Semester, 20014. 1. Bioinformatics- a practical guide to the analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellette, B.F., 1998, John Wiley & Sons, UK. 2. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith, 1999, Pearson Education. 3. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003. 4. D. Higgins and W. Taylor (Eds), Bioinformatics-Sequence, Structure and databanks, Oxford University Press, New Delhi, 2000. 5. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press. 2001 6. Bioinformatics: Sequence and Genome Analysis: by David Mount, University of Arizona, Tucson	

COURSE OUTCOMES

After completion of the course student will be able to

1. Understand the nature, scope of computational biology and biological and computer algorithms.
2. Know about the Combinatorial Pattern Matching, Genetic algorithms and their applications.
3. Analyze various Markov processes and Markov Models.
4. Learn about the Insilico Drug Design and Biopython applications in Computational Biology

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3									2	2	1	
CO 2	2	3	3									2	2	1	
CO 3	3	3	3									1	2	1	
CO 4	3	3	3									1	2	1	

21UBT514E	PROTEIN ENGINEERING AND DRUG DESIGN	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hours
Structure of proteins Overview of protein structure, PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, protein-ligand interactions.		
Protein structure prediction Primary structure and its determination, secondary structure prediction and determination of motifs, profiles, patterns, fingerprints, super secondary structures, protein folding pathways, tertiary structure, quaternary structure, methods to determine tertiary and quaternary structure, post translational modification.		
Protein engineering and design Methods of protein isolation, purification and quantitation; large scale synthesis of proteins, design and synthesis of peptides, use of peptides in biology, methods of detection and analysis of proteins. Protein database analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples.		
UNIT-II		10 Hrs.
Molecular modeling Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking, Calculation of Molecular Properties, Energy Calculations (no derivation), Examples of Small Molecular Modeling Work, Nicotinic Ligands, Sigma Ligands, Antimalarial Agents.		
UNIT-III		10 Hrs.
Insilico drug design Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural Similarities and Superimposition Techniques, Rational Drug Design and Chemical Intuition, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives.		
Computer assisted new lead design Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Conformation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure.		
UNIT-IV		10 Hrs.
Docking methods Program GREEN Grid: Three -Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Scope and Limitations, Points for Consideration in Structure, Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives, Types of programs available for molecular modeling-scope and limitations-interpretation of results.		
Computer - assisted drug discovery The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD), Current Practice of CADD in the pharmaceutical Industry, Management Structures of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware		

Constraints.

REFERENCE BOOKS *

1. Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery, S C Rastogi, Mendiratta & P Rastogi, PHI, 4th Edition, 2013
2. Moody P.C.E. and A.J. Wilkinson Protein Engineering, IRL Press, Oxford, 3rd Edition, 2010.
3. Creighton T.E. Proteins, Freeman W.H. Second Edn, 1993.
4. Branden C. and Tooze R. Introduction of protein structure, Garland, 1993.
5. The molecular modeling perspective in drug design by N Claude Cohen, 2008, Academic Press.

COURSE OUTCOMES**

1. Ability to study protein structure prediction and protein engineering and design
2. Able to understand molecular modeling
3. Able to know computer assisted new lead design
4. Able to study docking methods and computer - assisted drug discovery

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	2	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	3	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	2	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	2	-	-	-	1	2	1	-

21UBT532N	BIOFUELS TECHNOLOGY	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Biochemistry of biofuels and energy resources Basic principle of light energy conversion to chemical energy & carbon fixation. Biochemistry involved in conversion of sugars to alcohols. Renewable and non-renewable resources.	
Biofuels Introduction to Biofuels - definition, advantages and disadvantages. Biofuel life cycle. Biomass as an energy core and its different mode of utilization. Conventional fuels and their environmental impacts. Modern fuels and their environmental impacts. Biofuel energy content. World scenario of biofuel production and use.	
UNIT-II	12Hrs.
Biofuel feed stocks Starch feed stocks-cereal grains, tubers & roots; Sugars feed stocks-sugarcane & sugarbeet; cellulosic feed stocks - forest residues, agricultural residues, Agricultural processing by-products, dedicated energy crops, municipal solid waste and paper waste. Lipid feed stocks :-Oilseed crops with examples, Algae, Waste oil, Animal fats. Next generation feed stocks. Environmental impacts of feed stocks.	
Types of biofuels First generation biofuels-vegetable oil biodiesel, bioalcohols, bioethers, biogas syngas, solid biofuels. Second generation biofuels and third generation biofuels.	
UNIT-III	10 Hrs.
Technologies for biofuels Historical background. Biochemical platform – bioethanol production, standardization, emissions and properties of bioethanol. Thermochemical platforms - biodiesel production, standardization, properties and emissions of biodiesel. BtL fuels -production, properties and emissions. Biohydrogen processing and uses. Converting solid wastes to pipeline gas. Biomethanation, Microbial fuel cells. Blending of biofuels	
UNIT-IV	10 Hrs.
Biofuels in perspective Integrated refining concepts with reference to ethanol production. Economic feasibility of producing biodiesel, Issues with biofuel production & use. Impact of biofuel in global climate change & food production. 1st versus 2nd generation biofuels.. Strategies for new vehicle technologies. Current research on biofuel production. Market barriers of biofuels.	
REFERENCE BOOKS*	
1. Foster C. F., John ware D.A.Environmental Biotechnology by, Ellis Horwood Limited, 1987. 2. Larry Anderson and David A Fuels from Waste by Tillman. Academic Press, 1977. 3. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge, 2000 4. Environmental Biotechnology by Pradipta Kumar Mahopatra, 2007.	
COURSE OUTCOMES**	
After completion of the course student will be able to	
1. Ability to understand the basic principle involved in bioconversion process in energy and to differentiate the conventional fuels with biofuels . 2. Able to diagnose the types of feed stocks used for biofuels. 3. Able to produce the biofuels (biodiesel, bioalcohol biogas and biohydrogen) using current technologies and innovations involved 4. Able to understand and recall current issues related with production and use of biofuels, Research	

opportunities, economic feasibility of the biofuels

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	2		1	-	-	-	-	1	3	2	-
CO 2	3	3	-	3			2	-	-	-	-	1	2	-	-
CO 3	3	3	-	3	3		2	-	-	-	-	3	-	2	-
CO 4	3	3	-	3			2	-	-	-	-	3	-	1	-

21UBT503L	BIOINFORMATICS LAB	Credits: 1
L: T: P – 0-0- 2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS

1. Bibliographic search from PUBMED, SCIRUS and MEDMINER
2. Sequence retrieval from Nucleic acid and Protein databases.
3. Sequence searches using BLAST – Retrieval of homologs, paralogs, orthologs, and Xenologs
4. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
5. Multiple alignments of sequences and pattern determination using PROSITE
6. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
7. Identification of functional sites in Genes / Genomes.
8. Secondary structure prediction of proteins and comparison with PDB.
9. Restriction mapping: Analysis of maps for suitable molecular biology experiment.
10. Primer Design: Factors affecting primer design.
11. PDB structure retrieval and visualization: Analysis of homologous structures.
12. Determination of ligand-protein interactions using SPDBV/ LIGPLOT
13. Superposition of structures – Calculation of RMSD.
14. Docking studies – Analysis of substrate / ligand binding using homologous structures.

REFERENCE BOOKS*

1. Bioinformatics – Andreas D Boxevanis. Wiley Interscience, 1998.
2. Bioinformatics – David W Mount, cold spring harbor, 2001.
3. Bioinformatics – A biologist's guide to biocomputing and the internet. Stuart M brown,
4. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
5. Computational methods in Molecular Biology – S.L.Salzberg, D B Searls, S Kasif, Elsevier, 1998.
6. Bioinformatics – methods and applications: Genomics, proteomics and drug Discovery – s c Rastogi, N. mendiratta & prastogi, phi, 2006.

COURSE OUTCOMES**

1. Ability to Search literature and sequence databases
2. Ability to retrieve and search sequences from databases
3. Ability to align pair wise and multiple sequences
4. Ability to identify evolutionary and relationships and functional sites in genomes
5. Ability to evaluate primer designing and restriction mapping
6. Ability to docking and superimpose the structures

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3	-	3	1	-	3				3	3	3	1
CO 2	3	3	3	-	3	1	-	-				3	2	3	1
CO 3	3	3	2	2	3	1	1	-				3	3	3	1
CO 4	3	3	2	-	3	-	1	-				3	2	3	2
CO 5	3	3	2	1	3	1	-	2				3	3	3	2
CO 6	3	3	3	2	3	1	-	1				3	2	3	1

21UBT523C/21UBT623C	ENVIRONMENTAL STUDIES	01 - Credits (1: 0 : 0)
Hours / Week : 01		CIE Marks : 50
Total Hours : 15		SEE Marks : 50

UNIT – I	04 Hrs.
Natural Resources: Human activities and their impacts. EIA, Renewable Energy: Solar energy, Wind energy, Hydropower, Tidal energy, Ocean thermal energy, Geo thermal energy, Biomass energy, Biogas, Biodiesel, Bioethanol, Hydrogen as fuel. Non renewable Energy: Coal, Petroleum, Natural gas, Nuclear energy.	
UNIT – II	04 Hrs.
Environmental Pollution: Water pollution, water quality standards, water borne diseases, Fluoride problem, Air pollution, Noise pollution. Effect of electromagnetic waves. Sustainable future: Concept of sustainable development, threats to sustainability, strategies for sustainable development. Environment economics – concept of green building, Circular Economy.	
UNIT – III	03 Hrs.
Current Environmental Issues of concern: Greenhouse Effect- Greenhouse gases and Global Warming, Climate change, ozone layer depletion, Acid rain, Eutrophication Environmental policy legislation rules & regulations	
UNIT – IV	04Hrs.
Fundamentals of Waste management: Solid waste management: Sources, classification, characteristics, collection & transportation, disposal, and processing methods. Hazardous waste management and handling. Concept of waste water treatment, Bioremediation. Industrial waste management (Case studies: Cement, plastic, chemical, E–waste, food & construction industry waste management).	
REFERENCES	
1. Benny Joseph “Environmental Studies” Tata McGraw Hill, 2005 2. Dr. D. L. Manjunath, “Environmental Studies” Pearson Education, 2006 3. Koushik and Koushik “Environmental Science & Engineering” New Age International Publishers, New Delhi, 2006 4. Meenakshi “Environmental Science & Engineering” Pranticce Hall of India, 2006	
COURSE OUTCOMES	
After completion of the course the students shall be able to, 1. Ability to recognize natural resources and its uses. 2. Able to understand pollution and its effects on environment and to implement sustainable future in the work place. 3. Ability to understand current environmental issues. 4. Able to apply the waste management techniques in various fields	

Course Outcomes	Program Outcomes												Program Specified Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	-	1	-	-	-	2	3	-	-	-	-	3	1	-	-
CO 2	2	-	-	-	-	-	3	-	-	-	-	3	1	-	-
CO 3	-	2	-	-	-	2	2	-	-	-	-	3	1	-	-
CO 4	-	-	-	1	-	2	2	1	-		-	3	1	-	1

Question Paper Pattern for SEE:

Question is of Objective type

Duration of exam is 1 hour 30 mins

50 questions covering all the four units. Each question carries one mark

B. E. VI SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	21UBT601C	Bioprocess and Bioreaction Engineering	03	3	0	0	50	50	100
2.	PCC	21UBT602C	Upstream Processing Technology	03	3	0	0	50	50	100
3.	PCC	21UBT603C	Biotransformation and Enzyme Technology	03	3	0	0	50	50	100
4.	PEC	21UBT6XXE	Elective-II	03	3	0	0	50	50	100
5.	OEC	21UXX6XXN	Open Elective –II	03	3	0	0	50	50	100
6.	OEC	21UXX6XXN	Open Elective –III	03	3	0	0	50	50	100
7.	AEC	21UHS600C	Indian Knowledge system	01	1	0	0	50	50	100
8.	PCCL	21UBT604L	Biokinetics& Enzyme Technology Lab	01	0	0	2	50	50	100
9.	MP	21UBT605P	Mini Project	02	0	0	4	50	50	100
10.	MC	21UHS001M 21UHS002M 21UHS003M	Yoga NSS PE	00	0	0	2	10	-	-
Total				22	19	0	8	460	450	900

Elective-II

21UBT621E: Biofuels Technology

21UBT622E: Food Biotechnology

21UBT623E: Biopython

21UBT624E: Genomics & Proteomics

21UBT625E: Bioreactor Design

Open Electives –II

21UBT632N: Environmental Technology

Open Electives –III

21UBT633N: Industrial Safety

21UBT601C	BIOPROCESS AND BIOREACTION ENGINEERING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
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Kinetics of Homogeneous reactions:

Basic Concepts of Bioreaction and bioprocess engineering, Concentration dependent term of a rate equation, Rate Constant. Representation of elementary reaction and non-elementary reactions, Kinetic Models of Non elementary Reactions, Testing Kinetic Models. Temperature-dependent term of a rate equation: Temperature dependency from Arrhenius law, Collision theory, Transition state theory, Thermodynamic approach, Activation Energy.

UNIT-II	10 Hrs.
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Interpretation of Batch Bioreactor Data:

Constant volume batch reactor, Integral method of analysis of data -first order, second order, zero order reactions, fractional life, homogenous catalysed reactions, irreversible reaction in series, irreversible reactions in parallel, reactions of shifting order, autocatalytic reactions, reversible reactions, differential method of analysis of data.

UNIT-III	10 Hrs.
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Ideal Bioreactor and bioprocess models:

Ideal Batch Reactor, General features of reactors, Basic design equation, relation between Concentration and conversion, Batch cycle time, Space-Time and Space-Velocity, Mixed flow reactor, Plug flow Reactor, Holding time and space time for flow reactors

Design for Single Reactions: Size comparison of single reactors. Growth kinetics quantification Unstructured models for microbial growth- Substrate limited growth-models with growth inhibitors, product formation kinetics. Monod kinetics

UNIT-IV	10 Hrs.
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Analysis of Bioreactors:

Various types of reactors for immobilised cell and enzyme systems, Multiple reactors like CSTR in series /CSTR in Parallel; MFR in series/ MFR in Parallel, PFR in series/ PFR in parallel, Reactors of different types in series, Challenges and issues in bioprocess industries- mixing, interphase mass and heat transfer, Bioreactor instrumentation and control, bioreactor considerations for animal cell cultures and plant cell cultures.

REFERENCE BOOKS *

1. Scott Fogler, H (2016) Elements of Chemical Reaction Engineering, 6th edn., Prentice Hall India Pvt. Ltd.
2. Levenspiel O (2006) Chemical Reaction Engineering, Wiley Eastern, 3rd edn, New Delhi.
3. Kargi and Shuler (2015) Bioprocess Engineering. 3rd edn., Prentice Hall PTR.
4. Bailey J E and Ollis DF (2010) Biochemical Engineering Fundamentals, 2nd edn. Mc Graw- Hill.
5. Charles D. Holland (1990) Fundamentals of Chemical Reaction Engineering, John Wiley and Sons.
6. Pauline M Doran., Bioprocess Engineering Principles, 2nd Edition, Academic Press, USA, 2013.

7. Tapabrata Panda., Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
8. Indian Standards Institution, Code for Unfired Pressure Vessels, IS – 2825.
9. Bhattacharya, B.C, Introduction to Chemical Equipment Design, CBS Publications, 1985.
10. Perry's Chemical Engineers Handbook. 7th Edition McGraw Hill Publications

COURSE OUTCOMES**

After completion of the course student will be able to

5. Understand the basic concept of reaction engineering to solve bioprocess problems
6. Predict the order and rate of the different reactions.
7. Analyze the batch bioreactor data for different reactions.
8. Apply the suitable bioreactor for different biochemical reactions.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	3	2	2							2	2		
CO2	2	3	2	3	1							2	2		
CO3	2	3	3	2	2							2	2		
CO4	2	3	3	3	1							2	2		

21UBT602C	UPSTREAM PROCESSING TECHNOLOGY	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
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Fermentation process

Range of fermentation processes, chronological development of fermentation industry, component of the fermentation process. Basic functions of a fermenter for microbial, plant and animal cell culture. Body parts of fermentor, aseptic operation and containment. Sterilization of fermentors. Classification of Fermentation Systems: Batch, fed batch and continuous process and their applications, Types of Fermentors.

Scale Up: Process engineering concepts, engineering considerations, mechanical considerations, energy considerations. Process GMP considerations of scale up, operations and quality.

UNIT-II	10Hrs.
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Raw materials and media

Media requirement for typical fermentation process, selection of typical raw materials, types of fermentation media. Preparation and handling of fermentation media, sterilization and its practical limits, Batch sterilization, Continuous sterilization and Filter sterilization. Different methods for optimization (Plackett-Burman Design, RSM) of industrial media, microbio

UNIT-III	10 Hrs.
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Microbial system

Isolation of industrially important microorganisms, Strain development methods, Preservation of industrially important microorganisms. Development of inoculum from laboratory scale to pilot scale and large scale fermentation (for bacterial, yeast, mycelial processes). Criteria for the transfer of inoculum. Aseptic transfer of inoculum to the fermentor. Trouble shooting during fermentation process (microbial contamination).

Secondary metabolite production: secondary metabolite production in bacteria, yeast and fungi. Production of lactic acid, butanol, antibiotics and enzymes.

UNIT-IV	10 Hrs.
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Plant Cell system

Isolation and culture of single cells, Bioprocess using plant cell cultures. Bioreactors for suspension cultures, immobilized cells and organized tissues. Secondary metabolite enhancement techniques (alkaloids, steroids, phenolics).

Animal Cell system :

Scale up in suspension (stirred and static), monolayer (roller bottles, nunc cell factory microcarriers culture) and Perfusion culture (fixed and fluidized bed reactors).

Factors affecting cell culture,

Growth monitoring.

Genetically engineered cells for bioprocessing; process, selection of host vectors, process constraints-genetic instability, mass transfer and others.

Large scale production of insulin by mammalian cell culture.

Cellbank preparation & cell reviving techniques

Monoclonal antibody production: SUDBRCS (Single use disposable bioreactor configuration, types of production (perfusion culture, submerged culture, suspended adhered culture).

REFERENCE BOOKS

1. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Aditya books (P) Ltd. New Delhi 1997.
2. Bioprocess Engineering by Michael L. Shuler, 2nd Edition Shuler & Kargi, Fikret Kargi, Academic Internet Publishers, 2006
3. Introduction to plant Biotechnology by H.S. Chawla, Second edition, Oxford & IBH Publisher
4. Plant tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan (1996). Elsevier

5. Culture of animal cells by Ian Freshney IVth Edition. John Willey & Sons Publ.
6. Animal Biotechnology by Murray Moo-Young (1989), Pergamon Press, Oxford

COURSE OUTCOMES

1. Understand and identify the component parts of fermentor and fermentation system
2. Select the raw material , prepare and sterilize the media and also to optimize the industrial media using Design of experiments
3. Develop/design the industrially important microbes for industrial scale processes
4. Operate the reactors for Plant, Animal and GMOs

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	1											1	3	
CO 2	-	3												3	3
CO 3	2	2	3	1	1					2		1	3	3	
CO 4	2									3		1		3	

21UBT603C	BIOTRANSFORMATION AND ENZYME TECHNOLOGY	Credits: 3
L:T:P - 3-0-0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I		10 Hrs.
Enzyme action: Mechanism of enzyme action. Derivations of K_m value (Michaelis-Menton constant), Lineweaver-Burk plot., Enzyme inhibition and kinetics Multi-Substrate Reactions: Introduction to enzyme catalyzed reaction Ping-pong mechanism, Sequential mechanism (ordered and random), Enzyme models - Host guest complexation chemistry		
UNIT-II		10 Hrs.
Enzymatic Techniques: Strategies of purification of enzymes: choice of source, methods of homogenization, Criteria of purity: tests for purity, tests for catalytic activity, active site titrations, Molecular weight determination and characterization of enzymes. Immobilization of enzymes: Techniques of enzyme immobilization; design and configuration of immobilized enzyme reactions, Kinetics of immobilized enzymes, immobilized enzymes in bioconversion processes(uses). The design and construction of novel enzymes		
UNIT-III		10 Hrs.
Enzymes of biological importance: Enzyme pattern in diseases like in Myocardial infarctions (SGOT, SGPT, & LDH) Acetylcholinesterase, angiotensin converting enzyme (ACE), 5'- nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD). Use of isozymes as markers in cancer.		
UNIT-IV		10 Hrs.
Industrial uses of enzymes: Enzymes used in detergents, use of proteases, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes). Uses of lactase in dairy industry, glucose oxidase and catalase in food industry. Uses of proteases in food industries.		
REFERENCE BOOKS *		
1. Trevor Palmer (2008). Enzymes: Biochemistry , Biotechnology, Clinical Chemistry. Horwood Publishing Ltd, East-West Press, 5 th Edition. 2. David L. Nelson and Michael Cox (2017). "Lehninger Principles of Biochemistry" –7th Edition. 3. Nicholas C. Price and Lewis Stevens (2009). Fundamentals of Enzymology, Oxford university Press, 3 rd edition. 4. James R Hanson (2017). "An Introduction to Biotransformation in Organic Chemistry" 5 th edition , Oxford university Press, 5. Daniel L. Purich, Melvin I. Simon, John N. Abelson (2009). Contemporary Enzyme Kinetics and Mechanism" Academic press, 3 rd edition. 6. K. Faber (2018). Biotransformations in Organic: Springer- Verlag. 4 th Edition., 7. Bailey and Ollis (2017). "Biochemical Engineering Fundamentals", Mcgraw Hill 2 nd Ed.		
COURSE OUTCOMES**		
After completion of the course student will have the ability 1. To understand mechanism of enzyme and its reactions. 2. To know enzymatic techniques to characterize the enzymes and apply the techniques of immobilization of enzymes. 3. To understand the importance of enzymes in diagnostics. 4. To apply knowledge of using enzymes in detergent, wool, leather and food industries.		

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	3	1	-	2		-	-	-	-	1	3	2	-
CO2	3	3	2	2	-	3	2	-	-	-	-	-	3	1	-
CO3	3	2	-	2	-	2	-	-	-	-	-	-	3	3	-
CO4	2	3	1	1	-	2	4	-	-	-	-	-	3	1	-

21UBT621E	BIOFUELS TECHNOLOGY	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Biochemistry of biofuels and energy resources Basic principle of light energy conversion to chemical energy & carbon fixation. Biochemistry involved in conversion of sugars to alcohols. Renewable and non-renewable resources.	
Biofuels Introduction to Biofuels - definition, advantages and disadvantages. Biofuel life cycle. Biomass as an energy core and its different mode of utilization. Conventional fuels and their environmental impacts. Modern fuels and their environmental impacts. Biofuel energy content. World scenario of biofuel production and use.	
UNIT-II	12Hrs.
Biofuel feed stocks Starch feed stocks-cereal grains, tubers & roots; Sugars feed stocks-sugarcane & sugarbeet; cellulosic feed stocks - forest residues, agricultural residues, Agricultural processing by-products, dedicated energy crops, municipal solid waste and paper waste. Lipid feed stocks :-Oilseed crops with examples, Algae, Waste oil, Animal fats. Next generation feed stocks. Environmental impacts of feed stocks.	
Types of biofuels First generation biofuels-vegetable oil biodiesel, bioalcohols, bioethers, biogas syngas, solid biofuels. Second generation biofuels and third generation biofuels.	
UNIT-III	10 Hrs.
Technologies for biofuels Historical background. Biochemical platform – bioethanol production, standardization, emissions and properties of bioethanol. Thermochemical platforms - biodiesel production, standardization, properties and emissions of biodiesel. BtL fuels -production, properties and emissions. Biohydrogen processing and uses. Converting solid wastes to pipeline gas. Biomethanation, Microbial fuel cells. Blending of biofuels	
UNIT-IV	10 Hrs.
Biofuels in perspective Integrated refining concepts with reference to ethanol production. Economic feasibility of producing biodiesel, Issues with biofuel production & use. Impact of biofuel in global climate change & food production. 1st versus 2nd generation biofuels.. Strategies for new vehicle technologies. Current research on biofuel production. Market barriers of biofuels.	
REFERENCE BOOKS*	
1. Foster C. F., John ware D.A.Environmental Biotechnology by, Ellis Horwood Limited, 1987. 2. Larry Anderson and David A Fuels from Waste by Tillman. Academic Press, 1977. 3. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge, 2000 4. Environmental Biotechnology by Pradipta Kumar Mahopatra, 2007.	
COURSE OUTCOMES**	
After completion of the course student will be able to 1. Ability to understand the basic principle involved in bioconversion process in energy and to differentiate the conventional fuels with biofuels . 2. Able to diagnose the types of feed stocks used for biofuels. 3. Able to produce the biofuels (biodiesel, bioalcohol biogas and biohydrogen) using current	

technologies and innovations involved

4. Able to understand and recall current issues related with production and use of biofuels, Research opportunities, economic feasibility of the biofuels

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	2		1	-	-	-	-	1	3	2	-
CO 2	3	3	-	3			2	-	-	-	-	1	2	-	-
CO 3	3	3	-	3	3		2	-	-	-	-	3	-	2	-
CO 4	3	3	-	3			2	-	-	-	-	3	-	1	-

21UBT622E	FOOD BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hours
Introduction Hunger, Technology and World food needs-nutritional problems, approaches to combat world hunger, roles of technology. Recent Developments in food biotechnology, introduction to molecular food biotechnology.		
Novel bioprocessing Biosensors for food quality assessment, cold active enzymes in food processing, biotransformation in food industries.		
Nutrigenomics Definition of Nutriomics, Nutrigenetics, and its applications, Nutritional genomics and applications in brief. Nutrigenetics and cancer.		
UNIT-II		10 Hrs.
Microbial biotechnology of food Metabolic engineering of bacteria for food ingredients (Amino acids, organic acids, vitamins). Introduction to technologies for microbial production of food ingredients. Solid-state fermentation for food applications (enzymes, pigments). Biotechnology of microbial polysaccharides- natural occurrence of microbial polysaccharides in foods, additives (xanthan) and its future, Microbial biotechnology of food flavor, oils and fats. Food applications of algae-nutritional value, source of nutraceuticals and industrial production processes (chlorella, spirulina, Agar, alginate). Genetics of Dairy starter cultures.		
UNIT-III		10 Hrs.
Plant food applications Genomic basics for food improvement, molecular design of soybean proteins for enhanced food quality, Genetic modifications of plant starches, plant oils, for food applications. Bioprocessing of starch using enzyme technology. Molecular biotechnology for nutraceutical enrichment of food crops, Biotechnology of nonnutritive sweeteners, metabolic redesign of vitamin -E biosynthesis, production of new metabolites, Engineering of provitamin- A ,biosynthetic pathway into rice(Golden rice), Engineering of carotenoid biosynthesis for antioxidants, approaches to improve nutritional quality and shelf life of fruits and vegetables.		
UNIT-IV		10 Hrs.
Enhancement of leaf quality protein for ruminant animals. Methods of chloroplast transformation, markers for transformation, engineering chloroplast for the production of edible vaccine, Transplastomic maize- a case study. Animal food applications: Genetic modification of production traits in farm animals, Foods made from GM animals, applications of transgenic fish technology in sea food production, enzymatic synthesis of oligosaccharides-progress and recent trends. Food safety: international aspects of the quality and safety, genetically modified food controversies. Regulation of the release of genetic modified organisms, patenting inventions in food biotechnology.		
REFERENCE BOOKS *		
1. Kalidas s, Gopinadhan P, Anthony P and Robert E.Levin- “ Food Biotechnology”- second edition, CRC press, 2006 2. Gustavo F.G and Gustavo V.B,-“ Food Science and Food Biotechnology”- CRC press, 2003 3. Mahesh S.-“ Plant Molecular Biotechnology”- first edition, New age international publishers, , 2008 4. Norman N.Potter and Joseph H. Hotchkiss- Food Science- fifth edition- CBS publishers and distributors, 2007		
COURSE OUTCOMES**		

1. Students will be able to know the importance and current status of food biotechnology
2. Students will acquire the knowledge on novel food bioprocessing, nutrigenomics in brief.
3. Explore the applications of microbes in food biotechnology, new sources of food from microbes etc
4. Will be able to learn about plant food biotechnology and transplastomic technology
5. Will get the knowledge on applications of Animal food biotechnology and food safety and its regulation
6. Able to have an overview recent trends in GMOs and food biotechnology

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	2	-	2	1	-	-	-	-	-	1	2	1	1
CO2	2	-	2	-	3	2	-	-	-	-	-	1	2	1	1
CO3	1	1	1	-	2	2	-	-	-	-	-	1	2	1	2
CO4	2	-	2	-	2	1	-	-	-	-	-	1	2	1	1
CO5	2	1	1	-	3	1	-	-	-	-	-	1	2	1	2
CO6	1	-	1	-	2	2	-	-	-	-	-	2	2	1	1

21UBT623E	BIOPYTHON	Credits: 03
L:T:P - 3 : 0: 0		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

UNIT-I	16 Hrs.
Introduction and brief history of Biopython, Biopython modules, Tools and GNU/Linux, Nucleic Acid Bioinformatics, Sequences, Strings, and the Genetic Code, Sequences File Formats, Introduction to Biological Sequence Database, Sequence Motifs, Introduction to Motifs, String Matching, Consensus Sequences, Motif Finding, Promoters, De novo Motif Finding.	

UNIT-II	12 Hrs.
Sequence Alignments, Alignment Algorithms and Dynamic Programming, Alignment Software, Alignment Statistics, Short Read Mapping Multiple Sequence Alignments, Molecular Evolution, and Phylogenetics, Multiple Sequence Alignment, Phylogenetic Trees, Models of mutations,	
Practices Lab 4: Using BLAST on the command line, Lab 5: Phylogenetics	

UNIT-III	12 Hrs.
Genomics, The Three Fundamental “Gotchas” of Genomics, Genomic Data and File Formats, Genome Browsers, Transcriptomics, High-throughout Sequencing (HTS), RNA Deep Sequencing, Small RNA sequencing, Long RNA sequencing, Single-Cell Transcriptomics, Transcription Initiation, Transcription, Elongation, RNA Seq, Noncoding RNAs, Small Noncoding RNAs (srcRNAs), Long Noncoding RNAs, RNA Structure Prediction, Destabilizing energies.	
Practices: Lab 6: Genome Annotation Data, Lab 7: RNA-seq, Lab 8: RNA Structure, Lab 9: Proteins.	

UNIT-IV	12 Hrs.
Protein Alignment, Functional Annotation of Proteins, Secondary Structure prediction, Gene Ontology, Gene Regulation, Transcription Factors and ChIP-seq, MicroRNA regulation and Small RNA-seq, Regulatory Networks.	
Practices: Lab 8: RNA Structure, Lab 9: Proteins, Lab 10: ChIP-seq	

REFERENCE BOOKS *

- 1) Prof. David A. Hendrix
- 2) Deep Learning with Python, [Francois Chollet](#)

COURSE OUTCOMES**

After completion of the course student will be able to

1. Knowledge on the biopython-GNU/Linux, modules, tools, commands and Motifs.
2. Acquire the skills of Sequence Alignments using the Softwares, Statistics, Short Read Mapping, Multiple Sequence Alignments, Molecular Evolution,
3. Understand and Analyze the Phylogenetics, Phylogenetic Trees, and Models of mutations.
4. Utilize the biopython in analysis of the Genomic and transcriptomics data.
5. Conduct the Protein Alignment, Functional Annotation, Secondary Structure prediction, Gene Ontology, Gene Regulation.

21UBT624E	GENOMICS AND PROTEOMICS	Credits: 3
L:T:P – 3-0-0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction Genes and Proteins, Polymorphisms – types of polymorphism, commercializing the Genome - Revenue opportunities: a) genome sequences and database subscriptions, b) prediction of new genes and their function by databases. c) prediction of new genes and their function by databases, d) potential revenue in the area diagnostic and biomedical applications, e) biosimilars market and implications. Sequencing & genome projects: Early sequencing efforts. Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods, Sanger Dideoxy method, Fluorescence method, shotgun approach. Next generation sequencing Genome projects on <i>E.coli.</i> , Arabidopsis and rice; Human genome project.		
UNIT-II		10 Hrs.
Functional Genomics Gene variation and Single Nucleotide Polymorphisms (SNPs) genotyping tools -DNA Chips, comparative genomics. Functional genomic studies with model systems such as Drosophila, Yeast or C. elegans. Applications in Functional genomics, medicine and Gene Knockdown. Metagenomics- definition & concept. C-Value and paradox of genomes, Repetitive and coding sequences, Genetic and physical maps, chromosome walking Methods of molecular mapping, Marker assisted selection, map based cloning, Bioinformatics analysis- clustering methods. Approaches to physical mapping		
UNIT -III		10 Hrs.
Structure of Proteins Conformational analysis and forces that determine protein structures, geometries, phi, psi, omega angles, Ramachandran diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, Vanderwaal's force , salt bridges hydrophobic interactions, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions (Examples of bio-molecular interactions), fibrous proteins (structure of collagen, keratin) and Quaternary structures.		
UNIT-IV		10 Hrs.
Proteomics Introduction to proteomics, Sample preparation, protein extraction Denovo protein synthesis, LCMS/MS, M/Z ratio, sequencing and identification, Predictive Methods using Protein sequences: Protein Identity based on composition, Related web based software (JPRED, PROSEC, NNPPREDICT and SOPMA) Proteome analysis "Protein Chip" - interactions and detection techniques, two dimensional PAGE for proteome analysis, Applications of proteome analysis to drug development and toxicology. Crisper-cas. Challenges in proteomics.		
REFERENCE BOOKS *		

1. Genetic Analysis – Principles, Scope and Objectives by JRS Finchman, Blackwell Science, 1st Edition, 1994.
2. A M Campbell & L J Heyer Discovering Genomics, Proteomics & Bioinformatics –, Pearson Education, 2nd Edition, 2006.
3. Albala J S & I Humprey-Smith Protein Arrays, Biochips and Proteomics, CRC Press, 1st Edition, 2003.
4. Sabesan, Genomics & Proteomics –Ane Books, 2007. 5. Pennington S. R. and M J Dunn Proteomics.

COURSE OUTCOMES**

After completion of the course student will be able to

1. To know about genes, brief history, polymorphism, prediction methods, Biosimilars, business opportunities in diagnostic and medicine
2. Understand about the Human genome project, tools in DNA sequencing methods and other advanced techniques, Comparative genomics using model organisms, functional genomics of different organisms and molecular markers, gene and physical mapping techniques
3. To know about Protein structure analysis and molecular interactions
4. Analysis of proteins, quantification, sequencing, identification, protein predictive methods and proteomics in medicine

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	2	-	-	2	2	-				1	-	2	3
CO 2	3	3	1	-	-	2		-				2	1	-	3
CO 3	3	2	2	1	2	-		-				1	1	2	2
CO 4	2	2	2	2	2	2	2	2				1	1	2	2

21UBT625E	BIOREACTOR DESIGN	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50
UNIT-I		10 Hrs.
BASICS OF BIOREACTORS		
Overview of bioreactions, Elements in bioreactor design, Rate expression in biological systems, Basic concept of material and energy balances, Development and significance of bioreactors, Bioreactor configurations, Classification of bioreactors, Bioreactors for solid-state fermentation, plant and animal cell cultures		
UNIT-II		10 Hrs.
BIOREACTOR OPERATION		
Common operations of bioreactor, Identification of common factors for smooth operation of bioreactors, Spectrum of basic bioreactor operations, Bioreactor operation for immobilized systems, plant and animal cell cultures		
UNIT-III		10 Hrs.
BATCH, SEMICONTINUOUS AND CONTINUOUS BIOREACTORS DESIGN		
Overview of bioreactor design, Batch and semi continuous bioreactors for submerged fermentation of microbes, Continuous flow stirred tank and plug flow tubular bioreactors for submerged fermentation of microbes, Recycle bioreactors, Multistage bioreactors, Bioreactors for enzyme reactions and immobilized systems		
UNIT-IV		10 Hrs.
CASE STUDIES AND SCALE-UP		
Design of packed bed, fluidized bed, airlift, hollow fibre, plant cell, mammalian cell bioreactors for various applications, Scale=up – Criteria, Similarity criteria, Methods, Generalized approaches.		
REFERENCE BOOKS *		
1. Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd. 2. Atkinson, B., Biological Reactors, pion Ltd., London,1974. 3. Coulson, Richardson, Sinnott, An introduction to chemical engineering design, Pergamon 4. Alba S., Humphrey E and Milli N.R., “Bio Chemical Engineering” Academic Press, 1973. 5. Scragg. A.H “Bioreactors in Biotechnology”- A Practical approach 6. Tapobrata Panda. “Bioreactors: Analysis and Design”, Latest Edition, New Delhi: Tata McGraw Hill Education Private Limited. 2011 7. Moser, Anton. “Bioprocess Technology: Kinetics and Reactors”, Latest Edition, New York: Springer Verlag. 1988 8. Lydersen, D’ Elia, Nelson, Bioprocess engineering: Systems and equipment. 9. Rawlings, J. B. and Ekerdt, J. G. “Chemical Reactor Analysis and Design Fundamentals”, Latest Edition, San Francisco: Nob Hill Publisher. 2002		
COURSE OUTCOMES**		
After completion of the course student will be able to		
5. State and Describe basic concepts of bioreactors 6. Apply the knowledge and Execute bioreactor operations for various applications 7. Design bioreactors for various biochemical applications		

8. Apply the knowledge of scale up process to design bioreactors from Research to Industrial level

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2	2	1							1	2		
CO 2	3	2	3	3	2							2	2		
CO 3	2	3	2	2	1							1	2		
CO 4	3	2	1	1	1							1	2		

21UBT632N	ENVIRONMENTAL TECHNOLOGY	Credits: 3
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hours
Introduction: Current Environmental Issues and scope of Environmental science and technology biogeochemical role of soil microorganisms, Bioconcrete, Environment Impact Assessment Bioaccumulation of toxicants Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation Sustainable future: Green building concept, Carbon foot print, crediting, trading and its calculation, Water foot print Rain water harvesting .		
UNIT-II		10 Hrs.
Waste water treatment: Waste water characteristics BOD, COD, Primary & Secondary treatment, nanofiltration. ultrafiltration and microfiltration Microbial removal of phosphorous and Nitrogen Wastewater treatment of industries like sugar factories, food industries, beverages industries, and distilleries. Solid waste management Basic aspects, general composition of municipal solid wastes, aerobic treatment, anaerobic treatment biogas generation Solid waste management. Hazardous wastes, Biomedical Wastes E waste management, MoEF rules.		
UNIT-III		10 Hrs.
Bioleaching & Biomining: Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of phosphate, petroleum. Bioremediation: Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation		
UNIT-IV		10Hrs.
Biofuels: Definition, Renewable and nonrenewable resources Advantages and disadvantages of biofuels Biofuel feed stocks-sugar starch, cellulose, lipid Types of biofuel- first, second and third generation Technologies for bio-fuel production-transesterification, gasification 2G technology, Biomethanation, Issues of biofuel production and its use. Microbial fuel cells. Biodiversity: Value of biodiversity, threats to biodiversity approaches of biodiversity conservation.		

REFERENCE BOOKS *

1. Pradipta Kum Mahapatra, 2006, Text Book of Environmental Biotechnology, I K Publishers.
2. R C Dubey and D K Maheshwari, 2013 Text book of Microbiology,
3. M Y Young, 2004, Comprehensive Biotechnology Vol 1-4 (Eds). Pergamon Press
4. EJ Dasilva, C Ratledge & A Sasson, 2003, Biotechnology, Economic & Social Aspects Cambridge Univ Press.
5. Indu Shekhar Thakur, 2012, Environmental Biotechnology Basic concepts and applications, Second Edition, I K international Publishing House, Pvt, Ltd.

COURSE OUTCOMES**

1. Able to analyse the current environmental issues, scope of environmental Technology and understand the various sustainable future concepts.
2. Able to analyse the methods used in treatment of waste water and solid waste.
3. Able to understand the concept of bioleaching process and biomining activity
4. Able to analyse the types and methods used in cleaning of the environment by bioremediation.
5. Able to define the sources of biofuels and produce various biofuels
6. Able to analyse the need of conservation of biodiversity

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2				2	1								1	1
CO2	2	3	1		1								2	2	2
CO3	3	2			1								2	3	2
CO4	2	2	1				1						2	3	1
CO5	2	1					3					2	2	2	2
CO6	2		1		2		1					2	2	3	2

21UBT633N	INDUSTRIAL SAFETY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Industrial safety Need for safety, importance of occupational health and safety, Health and safety programs, unsafe conditions, factors contributing to unsafe conditions, Good Lab Practices (GLP). Accidents: Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention- Engineering, Education, Enthusiasm, Enforcement and Evaluation. Hierarchy of Controls, Safety policy. Chemical Hazards- Types of hazards, Classification of chemicals based on their nature, routes to exposure of chemicals, Health effects of harmful chemicals in the work environment, Control of chemical hazards.	
UNIT-II	10Hrs.
Electrical Hazards and Control measures Electrical hazards, protection against voltage fluctuations, effects of shock on human body. Fire- Fire formation, Classification of fire, Methods of fire extinction, Fire extinguishing agents. Evacuation procedures for workers during emergency conditions. Physical Hazards and Control measures Noise in Industry, Effect of noise on humans, Noise exposure regulation, Workers exposure to electromagnetic field, effects of radiations, Conflict resolution techniques, Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines.	
UNIT-III	10 Hrs.
Biological and Construction Hazards and their control measures Biosafety levels for microorganism (BL1,BL2,BL3,BL4), Risk groups and their classification. Bioterrorism. HAACP system, Lab associated infections, Cartagena Protocol on Biosafety. Biohazard control program, Construction Hazards Hazards in construction and safety measures, site safety, scope of safety in construction, Good Manufacturing Practices (GMP).	
UNIT-IV	10 Hrs.
Occupational Health and Toxicology Classification of Occupational hazards, occupational related diseases- silicosis, asbestosis, pneumoconiosis. Industrial toxicology, local, systemic and chronic effects. Industrial Hygiene- principles of industrial hygiene, Various types of Company policies. Ergonomic hazards, work- related musculoskeletal disorders, physical workplace risk factors.	
REFERENCE BOOKS	
1. Bioethics and Biosafety by Sateesh M.K., I.K. International pub, Kindle edition, 2012 2. Biotechnology Expanding Horizon, B.D. Singh, 3 rd revised edition, Kalyani Publishers, 2015 3. Safety Management in Industry N.V Krishnan, 3 rd revised edition JAICO Publishing House 4. Fundamentals of Occupational Health and safety, Benjamin O Alli, 2 nd edition, Geneva Publications, 2008 5. Bioethics and Biosafety in Biotechnology V. Krishna, New Age International, 1 st edition, 2007 6. Handbook of Human Factors and Ergonomic Hazards, M Neville Stanton Alan Hedge, 2 nd edition, CRC Press, 2015	

COURSE OUTCOMES

1. Apply the knowledge of the basic aspects of Industrial hazards (Accidents and Chemical Hazards) and safety in Industries.
2. Identify physical hazards electrical hazards and apply control measures in workplace.
3. Identify various types of biological hazards and apply control measures.
4. Acquire the knowledge of Occupational related diseases and Identify control measures and apply industrial toxicology and hygiene the same in work place.

21UBT604L	BIOKINETICS & ENZYME TECHNOLOGY LAB	Credits: 01
L: T: P - 0: 0:2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS

1. Isolation of alpha-amylase from sweet potato or saliva
2. Maltose calibration curve by DNS method
3. Determination of activity of Salivary alpha-amylase
4. Determination of Specific activity of an enzyme
5. Effect of pH and temperature on enzyme activity
6. Determination of Kinetics constants (K_m & V_{max})
7. Urea calibration curve
8. Determine the activity of enzyme Urease
9. Effect of inhibitors on enzyme activity
10. Immobilization of enzyme and determination of immobilized enzyme activity
11. Prediction of % error, standard deviation need to be calculated from expt. no 5 and 6)

12 Hrs.

REFERENCE BOOKS*

1. Pattabiraman 2017. Laboratory manual of Biochemistry, 4th Edition, International Book Publishers, India,.
2. Sadasivam and Manickam, 2017, Biochemical methods, 2nd Edition, New age International Publishers.

COURSE OUTCOMES**

After completion of the course student will have the ability

1. To isolate enzymes and plot calibration curves for estimation the enzyme activity and specific activity.
2. To evaluate the optimum pH and temperature required for enzyme activity and analyze the effect of inhibitors for enzyme activity.
3. To apply knowledge of K_m & V_{max} for enzyme activity.
4. To immobilize enzymes and find the activity of enzymes.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				3	2	3	1
CO 2	2	3	3	2			2	3				3	2	3	1
CO 3	2	3	3	3		3	2	2				2	2	1	2
CO 4	3	3	3	2		2	2	2				2	3	1	1

B. E. VII SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	PCC	UBT704C	Economics and Plant Design	3	3	0	0	50	50	100
2.	PCC	UBT715C	Downstream Processing Technology	3	2	2	0	50	50	100
3.	PEC	UBT7XXE	Elective-4	3	3	0	0	50	50	100
4.	PEC	UBT7XXE	Elective-5	3	3	0	0	50	50	100
5.	HSMS	UBT716H	Industrial Management and Entrepreneurship	3	3	0	0	50	50	100
6.	OEC	UBT733N	Industrial Safety (Open Elective)	3	3	0	0	50	50	100
7.	INT	UBT711I	Industrial Internship	2	0	0	4	50	50	100
8.	PCCL	UBT710L	Bioseparation Techniques Lab	1	0	0	2	50	50	100
Total				21	17	02	06	400	400	800

Elective-4 & Elective-5

UBT722E: Biopython

UBT723E: Industrial BT

UBT724E: Food Processing Technology

UBT725E: Protein Engineering and Drug Design

UBT731E: Nanobiotechnology& Biomaterials

UBT732E: Computational Biology

UBT733E: Bioconjugative Technology

UBT734E: Food Biotechnology

UBT704C	ECONOMICS & PLANT DESIGN	Credits: 3:
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week:03		SEE Marks: 50

UNIT-I	10 Hrs.
Process design development Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design and equipment design and specialization, safety factors specifications, and materials of construction.	
General design considerations: Marketability of the product, availability of technology, raw materials, human resources, land and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, storage, materials handling, materials and fabrication selection,. Waste disposal community factors. Safety and hazard control measures.	
UNIT-II	12Hrs.
Capital investments Fixed capital investments including land, building, equipment and utilities, installation costs,(including equipment, instrumentation, piping, electrical installation and other utilities),working capital investments.	
Manufacturing costs and plant overheads: Manufacturing Costs: Direct Production costs (including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges Plant Overheads: Administration, safety and other auxiliary services, Conceptual numerical.	
UNIT-III	10 Hrs.
Cost analysis Cost Analysis: Factors involved in project cost estimation, methods employed for the estimation of the capital investment. Estimation of working capital Depreciation: different type of depreciation methods of and calculations, Conceptual numerical.	
UNIT-IV	10 Hrs.
Profitability analysis Methods for the evaluation of profitability. Return on original investment, interest rate of return, Cash flow diagrams. Break-even analysis. Conceptual numericals.	
REFERENCE BOOKS*	
1. Peters and Timmerhaus (1989) Plant Design and Economics for Chemical Engineers, 4th edn. McGraw Hill. 2. Rudd and Watson (1987) Strategy of Process Engineering, Wiley. 3. Poornima M C (2006) Entrepreneurship Development and Small Business Enterprises”, Pearson education. 4. Vasanth Desai (2007) Dynamics of Entrepreneurial Development & Management”,H imalaya Publishing House. 5. Khanka SS (2004) Entrepreneurship Development, S Chand & Co. 6. Thomas W. Zimmer, Norman M. Scarborough.(2007), Essentials of Entrepreneurship and small Business Management	
COURSE OUTCOMES**	
At the end of the course the student should be able to: 1. Acquire knowledge in the design of a plant. 2. Conduct preliminary feasibility study of the plant design assigned. 3. Estimate the cost analysis involved in the design of a chemical plant. 4. Analyze the project profitability and alternative investments for the selection of good	

investment projects

5. Develop entrepreneurs with substantial knowledge in engineering concepts.
6. Apply the knowledge of plant design and cost estimation in actual engineering problems.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3		2	1								3	3	3	
CO 2	3		2	1	2							3	3	3	
CO 3	3		2	2	2							3	3	2	
CO 4	3		2	2	2							3	3	2	
CO 5	3		2	1								3	2		3
CO 6	3		2	1	2							3	3	2	

UBT715C	DOWNSTREAM PROCESSING TECHNOLOGY	Credits: 3
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction Role and importance of downstream processing in biotechnological processes. Range and characteristics of bioproducts. Purification process of bio-product. Cell disruption methods for intracellular products; physical, chemical and mechanical methods. Basic principles of distillation, crystallization, centrifugation, ultracentrifugation (preparative and analytical). Types of centrifuges and rotors, centrifugation-differential, density gradient (zonal and isopycnic).		
UNIT-II		12Hrs.
Primary Recovery Operations Process involved in liquid-liquid extraction, solid-liquid extraction, ammonium sulphate precipitation, Precipitation of proteins and nucleic acids by solvents and polyethylene glycol, dialysis, electrodialysis, ultrafiltration (Removal of insolubles by filtration), reverse osmosis, drying and lyophilization. Membrane based separations theory, design and configuration of membrane separation equipment.		
UNIT-III		10 Hrs.
Chromatography Principles of chromatographic separations, Classification of chromatography- plain and column chromatography, Paper chromatography - Single dimensional (Ascending and Descending, radial and two dimensional) chromatography, partition coefficient, retention factor, Thin layer chromatography, Gas liquid Chromatography, Adsorption Chromatography: Adsorption column chromatography, Ion Exchange Chromatography: cation Exchange and anion Exchange chromatography. Gel Filtration Chromatography, Affinity Chromatography, High Performance liquid chromatography, NP-HPLC and RP-HPLC.		
UNIT-IV		10 Hrs.
Electrophoresis Electrophoresis principles, factors affecting electrophoresis mobility, Moving boundary electrophoresis, Zone Electrophoresis, Gel Electrophoresis, Continuous Gel electrophoresis, Disc Gel electrophoresis, Agarose Gel Electrophoresis, Capillary Electrophoresis, Cellulose Acetate, Starch Gel, Native and SDS-PAGE, High voltage electrophoresis, Isoelectric focusing, Immunoelectrophoresis, ELISA, Flow cytometry.		
Downstream Processes Case studies (production)-DSP flowsheets for penicillin, insulin, amino acid, monoclonal antibody.		
REFERENCE BOOKS*		
1. Bioseparations Principles and techniques, by B.Sivasankar, Kindle edition, PHI Publishers, 2010 2. Biophysical chemistry principles and Techniques by Upadhyay and Nath, Himalaya Publishing House, 3rd edition, 2010 3. NPTEL Source material. 4. Bioseparations - Downstream processing for biotechnology by Belter P.A., Cussier E. and Wei Shan Hu., Wiley Interscience Pub, 1988 5. Separation Processes in Biotechnology by Asenjo J. and Dekker M, 1993. 6. Product Recovery in Bioprocess Technology – BIOTOL Series, VCH, 1990 7. Rate controlled separations by Wankat P.c., Elsevier, 1990 8. Fermentation & Enzyme Technology by D.I.C. Wang, Wiley Eastern 1979		
COURSE OUTCOMES**		

1. Identify the basic separation unit operation in DSP like membrane separation, enrichment operation, product recovery and various resolutions and fractionation techniques.
2. Interpret and analyze the industrial fermentation processes.
3. Apply the knowledge in identifying various pharma and R&D sections.
4. Analyse the details of experimentation pertaining to chromatography and electrophoresis.
5. Understand analyse and apply the techniques in various tests involved in finding out purity of biological components.
6. Apply the knowledge in identifying various biochemicals using advanced purifications like HPLC and to demonstrate DSP flowsheets.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3		2	2	2							3	3	3	2
CO 2	3		2	2	2							3	3	3	2
CO 3	3		2	2	2							3	3	3	2
CO 4	3		2	2	2							3	3	3	2
CO 5	3		2	2	2			2				3	3	3	2
CO 6	3		2	2	2			2				3	3	3	2

UBT716H	INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.
Development of management thoughts and its functions Concept & definition of Management, Social Responsibilities of Management, and Pioneers in Management: Contributions of Taylor, Henry Taylor, Gilberth& Mayo, Schools of Management thought: Management process school, Empirical School, Human Behavior School, Social system school, Systems approach school and decision theory school. Selection of site for the plant and plant layout, plant operation and control, utilities, structural design, storage, material handling, Sources of capital. Definition and functions of administration. Planning, organizing, staffing, directing and controlling. Concept of authority and responsibility.	
UNIT-II	10 Hrs.
Quantitative techniques in managerial decisions Concept of productivity, measuring productivity, concept of budget, effective budgetary control, ABC analysis, break even analysis, product life cycle, promotion of sales, pricing, "EOQ" model. Production costs (including raw materials, and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges (including depreciation, taxes, insurance, rental costs etc.).	
UNIT-III	10 Hrs.
Production And Material Management Types of production, types of planning, manufacturing planning, factory planning, production planning, method study, systems of wage payments, bonus, automation, organization of production, planning. Functions of purchasing & materials management, quality, quality standard & inspection, sources of supply, pricing, principles & practices, Inventory management.	
UNIT-IV	10 Hrs.
Entrepreneurship& personnel management Meaning of entrepreneur, evaluation of the concept, function of entrepreneur, evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development entrepreneurship- its barriers. Recruitment and selection. Training of personnel. Employer - Employee relationship. Settlement of disputes.	
REFERENCE BOOKS *	
1. O.P. Khanna - "Industrial Engineering & Management", Dhanpat Rai & Sons, 1992. 2. T. R. Banga & S. C. Sharma - "Industrial Engineering & Management Science", 6 th . Edn, Khanna Publications, 2003. 3. C.B.Mamoria and S.V.Gankar- Personnel Management, Himalaya Pub, 21 st edn,2010 4. Veerabhadra Havinal -Management and Entrepreneurship- New Age International, 2009 5. Ramesh Burbure – Management &Entrepreneurship- Rohan Pub. 2008 6. Poornima M. Charanthimath – Entrepreneurship Development, Pearson Education-2005	
COURSE OUTCOMES**	
After completion of the course student will be able to - Recall and recollect the history theories and definition of management and its importance in society - Analyze and apply the basic concepts of Quantitative techniques of management - Know the difference between production and productivity, measurement and cost analysis - Explore the knowledge of production costs, planning and material management - Make basic economic analysis of project - Understand the role and importance of entrepreneurship in economic development	

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C01	2		-	-	-	-		-	-	-	3	3	3	2	3
C02	3	2	2	2	2	-	-	-	-	-	3	3	3	2	3
C03	3	2	-	2	2	-	-	-	-	-	3	3	3	2	3
C04	3	2	-	2	2	-	-	-	-	-	3	3	3	2	3
C05	3	2	2	2	2	-	-	2	-	-	3	3	3	2	3
C06	2		-	-	-	-	-	2	2	1	3	3	3	2	3

UBT710L	BIOSEPARATION TECHNIQUES LAB	Credits: 1
L: T: P – 0-0-2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS

1. Cell disruption techniques.
2. Solid-liquid separation methods: Filtration (Cross flow)
3. Solid-liquid separation methods: Sedimentation.
4. Solid-liquid separation methods: Centrifugation.
5. Membrane dialysis
6. Product enrichment operations: Precipitation – (NH₄)₂ SO₄ fractionation of a protein.
7. Product enrichment operations: Two – phase aqueous extraction.
8. Product drying techniques.
9. Estimation of Amino acids / Carbohydrates by TLC.
10. Separation of ethanol from fermented broth.
11. Separation of Citric acid from fermented broth.
12. Separation of proteins by molecular sieving.
13. Analysis of biomolecules by HPLC / GC (using standard spectra).

REFERENCE BOOKS**

1. Protein Purification by Scopes R.K., IRL Press, 1993.
2. Rate controlled separations by Wankat P.C., Elsevier, 1990
3. Bioseparations by Belter P.A. and Cussier E., Wiley, 1985.
4. Bio-separations Science & Engineering By Roger G Harrison, Paul Todd, Scott R Rudge, Demetri.
5. Product Recovery in Bioprocess Technology - BIOTOL Series, VCH, 1990
6. Separation processes in Biotechnology by Asenjo J. and Dekker M. 1993

COURSE OUTCOMES**

1. Able to prepare/reproduce the protocols for the experiments.
2. Able to extract the intracellular product using different cell disruption techniques.
3. Able to concentrate, purify the desired product using different chromatography/ filtration techniques.
4. Able to analyze the product both quantitative/qualitatively.
5. Able to record/observe the experimental data and interpret them in the graph/table.
6. Able to calculate the result and to write the conclusion at the end of the experiment.

Course Outcome s	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3												3		1
CO 2		2												3	1
CO 3			3										2	2	1
CO 4				3	3								2	2	1
CO 5		3										2	2	3	1
CO 6		3										2	3	2	1

UBT722E	BIOPYTHON	Credits: 03
L:T:P - 3 : 0: 0		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

UNIT-I		16 Hrs.
Introduction and brief history of Biopython, Biopython modules, Tools and GNU/Linux, Nucleic Acid Bioinformatics, Sequences, Strings, and the Genetic Code, Sequences File Formats, Introduction to Biological Sequence Database, Sequence Motifs, Introduction to Motifs, String Matching, Consensus Sequences, Motif Finding, Promoters, De novo Motif Finding.		
UNIT-II		12 Hrs.
Sequence Alignments, Alignment Algorithms and Dynamic Programming, Alignment Software, Alignment Statistics, Short Read Mapping Multiple Sequence Alignments, Molecular Evolution, and Phylogenetics, Multiple Sequence Alignment, Phylogenetic Trees, Models of mutations, Practices Lab 4: Using BLAST on the command line, Lab 5: Phylogenetics		
UNIT-III		12 Hrs.
Genomics, The Three Fundamental “Gotchas” of Genomics, Genomic Data and File Formats, Genome Browsers, Transcriptomics, High-throughout Sequencing (HTS), RNA Deep Sequencing, Small RNA sequencing, Long RNA sequencing, Single-Cell Transcriptomics, Transcription Initiation, Transcription, Elongation, RNA Seq, Noncoding RNAs, Small Noncoding RNAs (srcRNAs), Long Noncoding RNAs, RNA Structure Prediction, Destabilizing energies. Practices: Lab 6: Genome Annotation Data, Lab 7: RNA-seq, Lab 8: RNA Structure, Lab 9: Proteins.		
UNIT-IV		12 Hrs.
Protein Alignment, Functional Annotation of Proteins, Secondary Structure prediction, Gene Ontology, Gene Regulation, Transcription Factors and ChIP-seq, MicroRNA regulation and Small RNA-seq, Regulatory Networks. Practices: Lab 8: RNA Structure, Lab 9: Proteins, Lab 10: ChIP-seq		
REFERENCE BOOKS *		
3) Prof. David A. Hendrix 4) Deep Learning with Python, <u>Francois Chollet</u>		
COURSE OUTCOMES**		
After completion of the course student will be able to		
1. Obtain knowledge on the biopython-GNU/Linux, modules, tools, commands and Motifs. 2. Acquire the skills of Sequence Alignments using the Softwares, Statistics, Short Read Mapping, Multiple Sequence Alignments, Molecular Evolution, 3. Understand and Analyze the Phylogenetics, Phylogenetic Trees, and Models of mutations. 4. Utilize the biopython in analysis of the Genomic and transcriptomics data. 5. Conduct the Protein Alignment, Functional Annotation, Secondary Structure prediction, Gene Ontology, Gene Regulation.		

Course Outcomes(CO)	Programme Outcomes (PO)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11		1	2	3
CO1	2	2	2		3						3		3	2	
CO2	2	2	2		3						3		2	2	
CO3	2	2	2		3						3		2	2	
CO4	2	2	2		3						3		2	2	
CO5	2	2	2		3						3		2	2	

UBT724E	FOOD PROCESSING TECHNOLOGY	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction Constituents of food, soluble fibres, protein rich foods, popular fats and oils in foods, Food flavours, Browning reactions and its effects . Intrinsic and extrinsic parameters of foods, effect of inhibitors, pH and temperature. Minerals in foods. Aroma compounds in foods .Food additives, Vitamins, amino acids, Sweeteners, Food colours. Toxic-trace elements in food.		
UNIT-II		12Hrs.
Detection of Microorganisms Culture, Microscopic and Sampling Methods, Conventional; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dyer reduction, Roll Tubes, Direct, Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Dairy products: Composition of milk, Sterilization of milk (Pasteurization and UHT), Cheese production, Acidophilus milk Yoghurt, Kummis and Kefir. Marketing scope of dairy & food products Fruit and vegetable processing: Jam, jelly, Juice, squash, wine, pickles and sauerkraut		
UNIT-III		10 Hrs.
Food Spoilage & Preservation The Role and Significance of Microorganisms, Primary Sources of Microorganisms found in Foods Synopsis of common borne bacteria, Molds& Yeasts. Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry, and Seafood. Spoilage of Miscellaneous Foods, Food Preservation: Principles Underlying in spoilage and preservation, Application, Effect and Legal Status of Food Irradiation, Food Preservation with Low Temperatures, High Temperatures and Drying. Food Industry: Characteristics of Food Industry., nutritional food supplements. Food packaging, New trends in packing, edible films. Factors influencing food product development, marketing, and promotional strategies, risks and benefits of food industry.		
UNIT-IV		10 Hrs.
Food Engineering Properties of fluid foods, Measurement of rheological parameters .Thermal properties of frozen foods. Food freezing equipment, storage of frozen foods. Food dehydration: Freeze Dehydration Calculation of drying times. Food waste management.		
REFERENCE BOOKS*		
1. Food Science & Nutrition, by Sunetra Roday, Oxford University Press,2007. 2. Food microbiology by William Frazier and Westhoff D.C, 4 th Edn,TATA McGraw Hill Pub(2005) 3. Modern Food Micro-Biology by James M.Jay, CBS Publishers.2005. 4. Food Microbiology by K.Vijay RameshMJP Publishers, 2007. 5. Plant biotechnology In Agriculture by K. Lindsey and M.G.K. Jones, Prentice Hall, USA. 1990. 6. Food Science By Potter N.N. and Joseph Hotchkiss, 5 th Edn, CBSPub,1996.		
COURSE OUTCOMES**		
1. Able to know about basic constituents of food 2. Able to know the techniques involved in detection of microbes in food industry 3. To have idea about Dairy , fruits and vegetable processed products and production		

4. To be aware of different food spoilage and preservation techniques
5. To know the Characteristics of food industry and scope
6. Able to understand Basic concepts in food Engineering for preservation

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3											3	3	2	
CO 2	3		2		2			2				3	3	2	2
CO 3	3		2		2							3	3	2	2
CO 4	3		2		2			2				3	3	2	2
CO 5	3		2		2							3	3	2	
CO 6	3				2							3	3	2	

UBT725E	PROTEIN ENGINEERING AND DRUG DESIGN	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hours
Structure of proteins Overview of protein structure, PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, protein-ligand interactions.		
Protein structure prediction Primary structure and its determination, secondary structure prediction and determination of motifs, profiles, patterns, fingerprints, super secondary structures, protein folding pathways, tertiary structure, quaternary structure, methods to determine tertiary and quaternary structure, post translational modification.		
Protein engineering and design Methods of protein isolation, purification and quantitation; large scale synthesis of proteins, design and synthesis of peptides, use of peptides in biology, methods of detection and analysis of proteins. Protein database analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples.		
UNIT-II		10 Hrs.
Molecular modeling Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking, Calculation of Molecular Properties, Energy Calculations (no derivation), Examples of Small Molecular Modeling Work, Nicotinic Ligands, Sigma Ligands, Antimalarial Agents.		
UNIT-III		10 Hrs.
Insilico drug design Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural Similarities and Superimposition Techniques, Rational Drug Design and Chemical Intuition, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives.		
Computer assisted new lead design Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Conformation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure.		
UNIT-IV		10 Hrs.
Docking methods Program GREEN Grid: Three -Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Scope and Limitations, Points for Consideration in Structure, Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives, Types of programs available for molecular modeling-scope and limitations-interpretation of results.		
Computer - assisted drug discovery The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD), Current Practice of CADD in the pharmaceutical Industry, Management Structures of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware		

Constraints.

REFERENCE BOOKS *

6. Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery, S C Rastogi, Mendiratta & P Rastogi, PHI, 4th Edition, 2013
7. Moody P.C.E. and A.J. Wilkinson Protein Engineering, IRL Press, Oxford, 3rd Edition, 2010.
8. Creighton T.E. Proteins, Freeman W.H. Second Edn, 1993.
9. Branden C. and Tooze R. Introduction of protein structure, Garland, 1993.
10. The molecular modeling perspective in drug design by N Claude Cohen, 2008, Academic Press.

COURSE OUTCOMES**

5. Ability to study protein structure prediction and protein engineering and design
6. Able to understand molecular modeling
7. Able to know computer assisted new lead design
8. Able to study docking methods and computer - assisted drug discovery

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	2	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	3	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	2	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	2	-	-	-	1	2	1	-

UBT731E	NANOBIOTECHNOLOGY AND BIOMATERIALS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to nanotechnology: A Brief History of the Nano particles : Bottom-Up versus Top-Down; What Is Nanobiotechnology. Discussions on nanofabrication, nanolithography, nanotubes, buckyballs, structure-property relationships in materials, materials characterization techniques, scanning electron, scanning tunneling and atomic force microscopy (SEM, STM & AFM), biomolecule-surface interactions, quantum dots, Applications of nanotechnology in the life sciences: Buckyballs and Buckytubes, Diagnostics and Sensors, Drug Delivery Revenues Health Risks and Challenge.	
UNIT-II	10 Hrs.
Biopolymers: Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli, sterilization and disinfections of polymeric materials. Biocompatibility of polymers, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins.	
UNIT-III	10 Hrs.
Synthetic polymers: Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization.	
UNIT-IV	10 Hrs.
Biocompatibility: Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials . Testing of implants: Methods of test for biological performance-In vitro implant tests, In vivo implant test methods. Medical devices: Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, Properties of implant materials, metals and alloys.	
REFERENCE BOOKS *	
1. B. Vishwanath (2011). “ Nano Materials” Published by Narosa Publishing House Pvt. Ltd., New Delh. 2. Mark Ratner and Daniel Ratner (2003). “Nanotechnology: A Gentle Introduction to Next Gig Idea” Pearson Education Ltd. 3. K Eric Drexler (1993). “Unbounding the future” Quill. 4. Stephen Lee and Lynn M Savage (2010). “Biological molecules in Nanotechnology”.	
COURSE OUTCOMES**	
After completion of the course student will have the 1. Ability to explain the characterization techniques of nanotechnology. 2. Ability to understand the importance of nano-particles in drug delivery system. 3. Ability to understand the importance of biopolymers. 4. Ability to differentiate biopolymer and synthetic polymer. 5. Ability to understand the importance of biocompatibility.	

6. Ability to apply the methods to test the implants and use in medical devices.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			-	3	1		-	-	-	-	3	3	2	2
CO2	3	2	2	-	3			-	-	-	-	3	3	2	2
CO3	3			-				-	-	-	-	3	3	2	2
CO4	3			-				-	-	-	-	3	3	2	2
CO5	3			-				-	-	-	-	3	3	2	2
CO6	3	2	2	-	2			-	-	-		3	3	2	2

UBT732E	COMPUTATIONAL BIOLOGY	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I	12 Hrs
Nature and scope of Computational Biology: Basic algorithms in Computational Biology, Biological and Computer algorithm, Fibonacci problem, Dynamic Programming, Time and space complexity of algorithms, Laplace's Rule. Search Algorithms: Random walk, Hill climbing, simulated annealing. Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.	
UNIT – II	8 Hrs
Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.	
UNIT – III	10 Hrs
Hidden Markov Model: Markov processes and Markov Models, Hidden Markov Models. Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:- Baum-Welch Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.	
UNIT – IV	10 Hrs
Insilico Drug Design and Biopython applications in Computational Biology Insilico Drug Design: Basic Concepts, importance and application, Molecular force fields and energy minimization, Molecular Dynamics Simulation methods, Methods of Insilico Drug Design: structure and ligand based drug design approach, structure based drug design: Molecular docking. Biopython: Introduction, important features and application of biopython in computational biology, Create a simple sequence in Biopython for DNA, RNA and Protein Alphabets, Sequence Alignment Tools in Biopython, PDB Module of Biopython,	
REFERENCE BOOKS	
• Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith, 1999, Pearson Education. • Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003. • Higgins and W. Taylor (Eds), Bioinformatics-Sequence, Structure and databanks, Oxford University Press, New Delhi, 2000 • An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press. 2004 • Biological sequence analysis: Probabilistic models of proteins and nucleic acids by Richard Durbin, Eddy, Anders Krogh, 1998 Algorithms for Molecular Biology by Ron Shamir Lecture, Fall Semester, 20014. 7. Bioinformatics- a practical guide to the analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellette, B.F., 1998, John Wiley & Sons, UK. 8. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith, 1999, Pearson Education. 9. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003. 10. D. Higgins and W. Taylor (Eds), Bioinformatics-Sequence, Structure and databanks, Oxford University Press, New Delhi, 2000. 11. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press. 2001 12. Bioinformatics: Sequence and Genome Analysis: by David Mount, University of Arizona, Tucson	
COURSE OUTCOMES	

After completion of the course student will be able to

5. Understand the nature, scope of computational biology and biological and computer algorithms.
6. Know about the Combinatorial Pattern Matching, Genetic algorithms and their applications.
7. Analyze various Markov processes and Markov Models.
8. Learn about the Insilico Drug Design and Biopython applications in Computational Biology

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3									2	2	1	
CO 2	2	3	3									2	2	1	
CO 3	3	3	3									1	2	1	
CO 4	3	3	3									1	2	1	

UBT733E	BIOCONJUGATIVE TECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours:40		SEE Marks: 50

UNIT-I		10 Hours
Bioconjugative technology Modification of Amino Acids, Peptides and Proteins – Modification of sugars, polysaccharides and glycoconjugates – modification of nucleic acids and oligonucleotides.		
UNIT-II		10 Hrs.
Chemistry of active groups Amine reactive chemical reactions – Thiol reactive chemical reactions – carboxylate reactive chemical reactions – hydroxyl reactive chemical reactions – aldehyde and ketone reactive chemical reactions – Photoreactive chemical reactions. Bioconjugate reagents Zero length cross linkers – Homobifunctional cross linkers – Heterobifunctional cross linkers – Trifunctional cross linkers – Cleavable reagent systems – tags and probes.		
UNIT-III		10 Hrs.
Enzyme and nucleic acid modification and conjugation Properties of common enzymes – Activated enzymes for conjugation – biotinylated enzymes – chemical modification of nucleic acids – biotin labeling of DNA- enzyme conjugation to DNA – Fluorescent of DNA.		
UNIT-IV		10 Hrs.
Bioconjugate applications Preparation of Hapten-carrier Immunogen conjugates - antibody modification and conjugation – immunotoxin conjugation techniques – liposome conjugated and derivatives- Colloidal – gold-labeled proteins – modification with synthetic polymers.		
REFERENCE BOOKS *		
1. Bioconjugate Techniques, G.T. Hermanson, Academic Press, 2 nd edition 2008 2. Bioconjugate techniques , Greg T Hermanson, academic Press ,Global store , 2016 3. A Text book of biophysics by Dr R.N. Roy,UBS publishers, 2001 4. Bioconjugative Chemistry by Vincent M Rotello, American Chemical society, 2016 5. Bioconjugate techniques , Greg T Hermanson, academic Press ,Global store , 2017		
COURSE OUTCOMES**		
1. Able to understand modification of nucleic acids and oligonucleotides. 2. Ability to know the chemistry of active groups. 3. To analyse the bioconjugate reactants. 4. To analyze bioconjugate applications . 5. Ability to know the conjugate derivatives. 6. Ability to study the conjugation process.		

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	1	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	-	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	-	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	1	-	-	-	1	2	1	-
CO5	-	-	1	2	2	-	3	1	-	-	-	1	2	1	1
CO6	1	-	1	-	-	2	2	2	-	-	-	2	2	1	-

UBT734E	FOOD BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hours
Introduction Hunger, Technology and World food needs-nutritional problems, approaches to combat world hunger, roles of technology. Recent Developments in food biotechnology, introduction to molecular food biotechnology.		
Novel bioprocessing Biosensors for food quality assessment, cold active enzymes in food processing, biotransformation in food industries.		
Nutrigenomics Definition of Nutriomics, Nutrigenetics, and its applications, Nutritional genomics and applications in brief. Nutrigenetics and cancer.		
UNIT-II		10 Hrs.
Microbial biotechnology of food Metabolic engineering of bacteria for food ingredients (Amino acids, organic acids, vitamins). Introduction to technologies for microbial production of food ingredients. Solid-state fermentation for food applications (enzymes, pigments). Biotechnology of microbial polysaccharides- natural occurrence of microbial polysaccharides in foods, additives (xanthan) and its future, Microbial biotechnology of food flavor, oils and fats. Food applications of algae-nutritional value, source of nutraceuticals and industrial production processes (chlorella, spirulina, Agar, alginate). Genetics of Dairy starter cultures.		
UNIT-III		10 Hrs.
Plant food applications Genomic basics for food improvement, molecular design of soybean proteins for enhanced food quality, Genetic modifications of plant starches, plant oils, for food applications. Bioprocessing of starch using enzyme technology. Molecular biotechnology for nutraceutical enrichment of food crops, Biotechnology of nonnutritive sweeteners, metabolic redesign of vitamin -E biosynthesis, production of new metabolites, Engineering of provitamin- A ,biosynthetic pathway into rice(Golden rice), Engineering of carotenoid biosynthesis for antioxidants, approaches to improve nutritional quality and shelf life of fruits and vegetables.		
UNIT-IV		10 Hrs.
Enhancement of leaf quality protein for ruminant animals. Methods of chloroplast transformation, markers for transformation, engineering chloroplast for the production of edible vaccine, Transplastomic maize- a case study. Animal food applications: Genetic modification of production traits in farm animals, Foods made from GM animals, applications of transgenic fish technology in sea food production, enzymatic synthesis of oligosaccharides-progress and recent trends. Food safety: international aspects of the quality and safety, genetically modified food controversies. Regulation of the release of genetic modified organisms, patenting inventions in food biotechnology.		
REFERENCE BOOKS *		
5. Kalidas s, Gopinadhan P, Anthony P and Robert E.Levin- “ Food Biotechnology”- second edition, CRC press, 2006 6. Gustavo F.G and Gustavo V.B,-“ Food Science and Food Biotechnology”- CRC press, 2003 7. Mahesh S.-“ Plant Molecular Biotechnology”- first edition, New age international publishers, , 2008 8. Norman N.Potter and Joseph H. Hotchkiss- Food Science- fifth edition- CBS publishers and distributors, 2007		
COURSE OUTCOMES**		

7. Students will be able to know the importance and current status of food biotechnology
8. Students will acquire the knowledge on novel food bioprocessing, nutrigenomics in brief.
9. Explore the applications of microbes in food biotechnology, new sources of food from microbes etc
10. Will be able to learn about plant food biotechnology and transplastomic technology
11. Will get the knowledge on applications of Animal food biotechnology and food safety and its regulation
12. Able to have an overview recent trends in GMOs and food biotechnology

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	2	-	2	1	-	-	-	-	-	1	2	1	1
CO2	2	-	2	-	3	2	-	-	-	-	-	1	2	1	1
CO3	1	1	1	-	2	2	-	-	-	-	-	1	2	1	2
CO4	2	-	2	-	2	1	-	-	-	-	-	1	2	1	1
CO5	2	1	1	-	3	1	-	-	-	-	-	1	2	1	2
CO6	1	-	1	-	2	2	-	-	-	-	-	2	2	1	1

UBT733N	INDUSTRIAL SAFETY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.
Industrial safety Need for safety, importance of occupational health and safety, Health and safety programs, unsafe conditions, factors contributing to unsafe conditions, Good Lab Practices (GLP). Accidents: Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention- Engineering, Education, Enthusiasm, Enforcement and Evaluation. Hierarchy of Controls, Safety policy. Chemical Hazards: Types of hazards, Classification of chemicals based on their nature, routes to exposure of chemicals, Health effects of harmful chemicals in the work environment, Control of chemical hazards.	
UNIT-II	10 Hrs.
Electrical Hazards and Control measures Electrical hazards, protection against voltage fluctuations, effects of shock on human body. Fire- Fire formation, Fire extinguishing agents. Evacuation procedures for workers during emergency conditions. Physical Hazards and Control measures: Noise, noise exposure regulation, properties of sound, Workers exposure to electromagnetic field, Ionizing radiation and non-ionizing radiations, effects of radiations, Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines.	
UNIT-III	10 Hrs.
Biological and Construction Hazards and their control measures Classification of Bio hazardous agents –bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases –Hazardous material used in labs, Instructions followed for hazardous waste disposal, Biohazard control program, Biological safety cabinets. Construction Hazards: Hazards in construction and safety measures, Good Manufacturing Practices (GMP).	
UNIT-IV	10 Hrs.
Occupational Health and Toxicology Classification of Occupational hazards, occupational related diseases- silicosis, asbestosis, pneumoconiosis, etc. lead, nickel, chromium and manganese toxicity, effects and prevention Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects. Industrial Hygiene. Various types of Company policies.	
REFERENCE BOOKS *	
1. Mark Friend and James Kohn, (2007), Fundamentals of Occupational Safety and Health the Scarecrow Press, Inc. 2. Phil Hughes and Ed Ferret, (2011), Introduction to Health and Safety at work, (5th edition), Elsevier Ltd.	
COURSE OUTCOMES**	
After completion of the course student will be able to - Analyze the effects of hazards in workplace and select appropriate measures of safety for preventing industrial accidents and chemical hazards. - Identify physical and electrical hazards and apply control measures in work place for the prevention of fires and explosions.	

3. Identify various types of biological hazards and understand the methods of hazard identification and preventive measures.
4. Assess the risks in the occupation, identify control measures and apply hygiene in the work place.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	1	2	-	1	3	-	-	-	-	-	1	1	1	1
CO2	-	1	2	-	1	3	-	-	-	-	-	1	1	1	1
CO3	-	1	2	-	1	3	-	-	-	-	-	1	1	1	1
CO4	-	1	2	-	1	3	-	-	-	-	-	1	1	1	1

B. E. VIII SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	PEC	UBT82XE	Elective-6	03	3	0	0	50	50	100
2.	PEC	UBT83XE	Elective-7	03	3	0	0	50	50	100
3.	PP	UBT805P	Project	15	0	0	30	50	50	100
Total				21	6	0	30	150	150	300

Elective-6

UBT823E: Biosimulations

UBT824E: Metabolic engineering

UBT825E: Bionanalytical techniques

UBT827E: Pharmaceutical BT

Elective-7

UBT830E: Clinical research

UBT832E: Health diagnostics

UBT833E: Validation & quality control

UBT834E: Product development

UBT835E: Validation & quality assurance

UBT827E	PHARMACEUTICAL BT	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction: Introduction to pharmaceutical biotechnology, Pharmaceutical Industry. Drug design, development and Economics, Fundamental principles and processes involved in preclinical and clinical development of a chemical or biological entity. Orphan drugs Provisions for and use of unlicensed medicines, Drug abuse and dependence, Prescription and Non-prescription drugs. Regulations & guidelines for pharma ,CDSCO, fda, ichq7, usfdA21 cfr part11.		
Drug metabolism: Evolution of Drug Metabolism as a Science, Phase I Metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II Metabolism (Drug conjugation pathway) . Pharmacodynamics and Pharmacokinetics of drugs.		
UNIT-II		10 Hrs.
Toxicology: Basic concepts in toxicology, the mechanism of toxin action, biotransformation of toxins, their inactivation and removal from the body, Reactive intermediates.		
Manufacturing principles and formulations: Definitions, applications, composition, preparation, physicochemical considerations,. Preformulation Testing, Tablets, compressed tablets, tablet granulation, Coatings, Pills, Parental preparations, herbal extracts, Oral liquids, Ointments, short study of current biotech products, herbal medicines. Quality control, storage and stability of biotech products.		
UNIT-III		10 Hrs.
Stem cells in health care: Introduction to Stem Cell Biology, Fate Mapping of Stem Cells, Mesenchymal Stem Cells, Stem Cells and Neurogenesis and its application , Epidermal Stem Cells, Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon. Application of epidermal stem cell in Tissue engineering, Hematopoietic Stem Cells, Classification and clinical manifestations of hematopoietic stem cell disorders.		
Drug delivery system: Advanced Sustained Release Drug Delivery System, Advanced drug Delivery Systems, Liposomes and Nanoparticles Drug Delivery System, Biodegradable Drug Delivery System, Hydrogel based Drug Delivery System.		
UNIT-IV		10 Hrs.
Analysis of biologicals & pharmaceuticals: Vitamins Cold remedies Laxatives Analgesics, NSAIO, External antiseptics, Antacids, Antibiotics, Biologicals, Herbal products. Packaging techniques – Glass containers, plastic containers, film wrapper, bottle seals.		
Advanced pharmacology: Introduction to pharmaceutical chemistry, classification of drugs based on therapeutic actions using suitable examples. Antineoplastic agents, Immunomodulators, Heavy metals and heavy metal antagonists, Therapeutic gases. Free radical biology and antioxidants.		
REFERENCE BOOKS *		
4. Gary Walsh, (2013),Biopharmaceuticals Biochemistry and Biotechnology (2 nd Edition), Wiley Publishers. 5. Bartram Katzung, (2009),Basic & Clinical Pharmacology(9th Edition), McGrawHill. 6. Leon Lachman, Herbert. Lieberman & Joseph Kanig, Vergese, (1987) The Theory & Practice of Industrial Pharmacy, (3 rd Edition) Publishing House Bombay.		

COURSE OUTCOMES****After completion of the course student will be able to**

1. Apply and classify various biological sources of pharmaceutical products to retrieve the basic concept of pharmacology, drug metabolism and their importance in biotechnology
2. Select and apply the toxicological studies of pharmaceutical products and Use knowledge of the techniques used in the manufacture of pharmaceutical products and apply in the field of Biopharmaceuticals
3. Ability to discuss the concepts used in production of stem cells and analyse the applications and ethical issues of stem cells in the society and Select and apply appropriate techniques advanced techniques in drug delivery system
4. Demonstrate an ability to apply principles various other applications to protect the global community from various dreadful diseases.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3	3	3	3	2	-	-	-	-	3	3	3	3
CO2	3	3	3	3	3	2	2	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	2	3	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	2	2	-	-	-	-	3	3	3	3

UBT830E	CLINICAL RESEARCH	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Introduction The philosophy behind organization of research. Disease target identification and selection. Patenting new active substances. Receptor-based approaches, agonists, antagonists, enzyme inhibitors. Lead optimization and candidate selection of molecules for exploratory human investigation. In vitro and In vivo testing of new compounds Relationship between animal and human pharmacology.	
Clinical pharmacology Pre-clinical development to support testing in humans. Safety testing, Pharmaceutical development - formulations, manufacture and supply of materials, labeling and presentation, stability and storage, purity, compatibility, disposal; Concepts of Pharmacovigilance.	
UNIT-II	10 Hrs.
Therapeutics Clinical importance of Therapeutic Proteins, Antibodies, Enzymes; Hormones and Growth Factors, Interferon's, Interleukins and Additional Regulatory Factors.	
Management of drugs Management of common acute and chronic diseases. Major drug classes including biologicals. Measurement of drug effects Adverse drug reactions (short term & long term). Benefit and risk, Drug interactions; Prescribing for particular populations . Controlled drugs and drug dependence, Over dosage and treatment of poisoning. Patient compliance and information, Therapeutic Drug Monitoring.	
UNIT-III	10 Hrs.
Healthcare marketplace National and local formularies. Product information (Generic v/s Rx), advertising and claims Product support and promotion Product life-cycle management Product liability Codes of practice including the MHRA Blue Principles of health economics Pharmacoepidemiology Competition, in-licensing, co-marketing.	
Social, ethical issues patents and copyrights. Social-genetic discrimination: insurance and employment, human cloning, foeticide, sex determination. Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Preservation and clinical use of blood and blood components.	
UNIT-IV	10 Hrs.
Clinical research Types of Epidemiology study designs, ecological (correlation) studies, Case reports and case series, prevalence surveys or cross-sectional studies, case control studies, Clinical Trials, Small Clinical Trials, Placebo Responses in Clinical Trials, Large Clinical Trials and Registries – Clinical Research Institutes, Data Management in Clinical Research: General Principles and Guide to Sources, Clinical Research from Pharmaceutical Industry Perspective.	
REFERENCE BOOKS *	
1. Gary Walsh., Biochemistry and Biotechnology, 2002, John Wiley & Sons Ltd. 2. Gallin and . J. I. Ognibene F. P, 2007 Principles and Practice of Clinical Research by, 2nd Edition, Elsevier Publication. , 3. William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman,2005, Hematology, 4. John Wiley & Sons Ltd by Arunabha Ray & Kavitha Gulati, 2007,Current Trends in Pharmacology IK Intl.	
COURSE OUTCOMES**	
1. Exploit the knowledge to know the clinical importance of different therapeutic products 2. An integrated understanding of the formulations, manufacturing and supply of materials	

3. Ability to study the philosophy behind organization of research Ability to understand control measures used in drug and its control
4. Ability to elucidate the marketing strategies of pharma products
5. Ability to compare the social and ethical issues
6. Ability to inculcate the epidemiology study designs, case reports and case series

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	3	3	-	2	-	2	1	-	-	-	2	2	2	1
CO2	1	2	3	-	1	-	2	1	-	-	-	3	3	1	1
CO3	1	2	3	-	2	-	2		-	-	-	3	2	2	1
CO4	1	3	3	-	1	-	1	1	-	-	-	2	2	1	1
CO5	1	3	3	-	-	-	-	-	-	-	-	1	2	3	
CO6	1	3	3	-	1	-	2	-	-	-	-	3	3	3	3

UBT832E	HEALTH DIAGNOSTICS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hours
INTRODUCTION: Biochemical disorders, Immune disorders, Infectious diseases, Parasitic diseases, Genetic disorders chromosomal disorders, single cell disorders and complex traits. Chromosomal disorders : autosomal; sex chromosomal; karyotype analysis.		
DNA BASED DIAGNOSTICS G-banding, <i>in situ</i> hybridization (FISH and on-FISH), and comparative genomic, hybridization (CGH). Cancer cytogenetics: spectral karyotyping. DNA diagnostics: PCR based diagnostics; ligation chain reaction, Southern blot diagnostics, array-based diagnostics, Genome sequencing and Metagenomics, DNA sequencing, genetic profiling, single nucleotide polymorphism. Haemoglobinopathies. Neuro developmental disorders. Neuro degenerative disorders. Dynamic mutations. G-banded chromosomal preparations for detection of autosomes of autosomal/sex chromosomal disorders. (translocation, deletion, Down's syndrome, Klinefelter syndrome, Turner's syndrome, etc.) FISH for detections of: translocations, inversions (using appropriate probes) (e.g., chro 9-22 translocation; X-Y translocation).		
UNIT-II		10 Hrs.
Biochemical diagnostics Inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, lipid profiles, HDL, LDL, Glycogen storage disorders, amyloidosis Cell based diagnostics Antibody markers, CD Markers, FACS, HLA typing, Bioassays		
UNIT-III		10 Hrs.
Immunodiagnostics Introduction, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Case studies related to bacterial, viral and parasitic infections. Diagnosis of infectious diseases, respiratory diseases (influenza, etc.) Viral diseases-HIV etc., bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases. Phage display, immunoarrays, FACS.		
UNIT-IV		10 Hrs.
Imaging diagnostics Imaging Techniques (Basic Concepts), Invasive and Non-Invasive, Electrocardiography (ECG), Uses of ECG, Electroencephalography (EEG), Use of EEG, Computerized Tomography (CT), Uses of CT, Magnetic Resonance Imaging (MRI), uses of MRI, Ultrasound Imaging (US), Uses of Ultrasound, Planning and Organization of Imaging Services in Hospital, Introduction, Planning, Physical Facilities, Layout, Organization, Organization and Staffing, Records, Policies, Radiation Protection.		
REFERENCE BOOKS *		
1. Lisa Anne Shimeld.,2000 Essentials of Diagnostic Microbiology 2. Balley & Scott's. 1998 Diagnostic Microbiology, 2ND edition, 3. Burtis & Ashwood.,Tietz ,2005,Text book of Clinical Biochemistry.		
COURSE OUTCOMES**		
1. Ability to study Biochemical disorders, chromosomal disorders. 2. Able to study DNA based diagnostics. 3. Analyse Biochemical diagnostics. 4. Understand cell based diagnostics. 5. Analyse Immunodiagnostics 6. Understand imaging diagnostics		

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C01	2	2	2	-		2	-	-	-	-	-	-	1	1	1
C02	2	2	2	-	2	3	-	-	-	-	-	-	2	1	2
C03	3	3	2	-	2	2	-	-	-	-	-	1	1	1	2
C04	3	3	3	-	2	3	-	-	-	-	-	1	2	1	3
C05	1	3	3	-	-	-	-	-	-	-	-	1	2	3	
C06	1	3	3	-	1	-	2	-	-	-	-	3	3	3	3

UBT833E	VALIDATION & QUALITY CONTROL	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation . Validation of Water, Active Pharmaceutical Ingredients (APIs) & Aseptic Processes. Validation of Non-Sterile Processes (used in the manufacture of Solids, Liquids, & Semisolid Dosage Forms). FDA and ICH guidelines .		
UNIT-II		10Hrs.
Medical Device, In-Vitro Diagnostics & Packaging Validation Issues, Validation of Analytical Methods, Computerized & Automated Systems under 21 CFR Part 11. Standards Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques, ISO-9001-2000, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Measurement, Analysis and Improvement, ISO-14001 - Environmental Management Systems.		
UNIT-III		10 Hrs.
Implementation The Influence of Good Automated Manufacturing Practice (GAMP); The FDA's Approach to GMP Inspections of Pharmaceutical Companies. Quality System, Contract Review, Design Control, Document and Data Control, Purchasing, Control of Customer Supplied Product, Product Identification and Traceability, Process Control, Inspection and Testing, Final Inspection and Testing, Control of Inspection, Measuring and Test Equipment, Inspection and Test Status, Control of Nonconforming Product, Corrective and Preventive Action, Handling, Storage, Packaging, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques. Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement		
UNIT-IV		10 Hrs.
Quality Terminology Relating to Quality, Quality Requirement, Customer Satisfaction, Capability; Terms Relating to Management, Management System, Quality Management System, Quality Policy, Continual Improvement, Effectiveness, Efficiency; Relating to Process and Product, Process, Product, Procedure; Terms relating to Characteristics, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Correction, Rework, Regrade, Repair, Scrap, Concession, Deviation Permit, Release; Terms Relating to Documentation, Information, Document, Specification, Quality Manual, Quality Plan, Record; Terms Relating of Examination, Objective Evidence, Inspection, Test. Metrological Confirmation.		
REFERENCE BOOKS*		
1. Pharmaceutical Process Validation, 3rd Edition, Edited by Robert Nash and Alfred Wachter, Marcel Dekker, 2003 2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker, 5th Ed., 2000, 723 pp., 3. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James		

Agalloco (Ed.), Marcel Dekker, 2nd Ed., 1998.

4. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance
5. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. . Cloud, Interpharm Press, 1998.
6. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series, 2001.

COURSE OUTCOMES**

1. Ability to comprehend the validation techniques, process, concepts.
2. Ability to analyse the good practices in lab, clinical and manufacturing practices
3. Ability to retrieve the regulations , fundamentals of validations and its procedures
4. Capable of understanding the ISO standards and environmental management systems
5. An ability to analyse the analytical methods of validation, issues and automated system and standards
6. Ability to interpret guidelines and discuss the case studies
7. Ability to discuss the quality control measures used in industries
8. Ability to analyse the Quality Management System

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2					2	3	1						1	3
CO 2	2			2		3	3	3					2	2	3
CO 3	3					3	2	2				3	2	3	2
CO 4	2					3	1	3				3	2	3	3
CO 5	2					2	3	3				2	2	2	3
CO 6	2			2		2	1	2				2	2	3	2
CO 7	2			1		3	1	2				1	2	3	2
CO8	2			2		3	1	2				3	3	2	2

UBT834E	PRODUCT DEVELOPMENT	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.
Essentials of product development The product development process, privacy policies and Knowledge of basic laboratory procedures, Standard Operating Procedure (SOPs), process flows in manufacturing, product life cycle and competitor studies. Stability studies – Stability Testing of new Drug Substances and Products –types and stages of testing, Stress Testing, storage conditions. Manufacturing Process for Recombinant pharma Products. Production of pharmaceuticals by genetically engineered cells- hormones and vaccines. Approved Biotech Drugs.	
UNIT-II	12Hrs.
Interpersonal Skills Understand work output requirements, company policies, delivery of quality work on time and report any anticipated reasons for the delay, effective interpersonal communication, conflict-resolution techniques, importance of collaborative working, multi-tasking, training the team members, knowledge of project management.	
UNIT-III	10 Hrs.
Reporting and formulations Reporting – power point presentations, technical writing, Principal investigator, communication with upstream and downstream teams.Problem Solving and Decision Making. Types of adverse drug reactions (ADR) and their treatment. Activity screening, formulations of energy drinks, bars, sports drinks, fortified products, geriatric products, veterinary products, immune boosters	
UNIT-IV	10 Hrs.
Safety and Security at workplace Different types of occupational health hazards, knowledge of chemical substances -characteristics & safety measures. Use of safety gears, masks, gloves and accessories, evacuation procedures for workers and visitors. Health, safety and security issues – types (illness, fire accidents). Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines. Safety in bulk storage of hazardous substances.	
REFERENCE BOOKS*	
1. Endrenyi, L., Declerck, D. and Chow, S. (2017). Biosimilar Drug Product Development. Boca Raton: CRC Press. 2. Jain, N. (2011). Pharmaceutical product development. New Delhi: CBS Publishers	
COURSE OUTCOMES**	
1. Understand analyze and apply the techniques and essentials of product development. 2. Ability to understand the various techniques in Pharma industries. 3. Demonstrate the different interpersonal skills. 4. Demonstrate the methodologies and applications of Project development and management. 5. Ability to comprehend various techniques involved in Reporting. 6. Describe the different formulations of various energy drinks 7. Analyse and list the various health hazards in industry. 8. Ability to understand importance of safety and implement in various Industries.	

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1		2	2	3	1			3	1		2	2	2	1	1
CO 2		2	2	3	3		2					3	2	1	
CO 3					2	3		2	3	3	3	3	2	1	1
CO 4		3	3	3	3	3	2	3	3	3	3	3	2	1	2
CO 5			3	3	3		2			2	2	3	2	1	
CO 6					2							3	2	1	
CO 7				2	3	3		3					2	1	
CO 8					2	3	3	3				2			

UBT835E	VALIDATION & QUALITY ASSURANCE	Credits: 2
L: T: P – 2-0-0		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

UNIT-I		7 Hrs.
Introduction Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & how it Differs from Qualification (IQ, OQ & PQ) Procedures, Validation life cycle, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation . FDA and ICH guidelines.		
UNIT-II		6 Hrs.
Types of Validation Validation of Water & Thermal Systems, including HVAC Facilities & Cleaning Validation. Validation of Active Pharmaceutical Ingredients (APIs) Packaging Validation Issues, Validation of Analytical Methods, Computerized & Automated Systems under 21 CFR Part 11.		
Standards Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Preservation and Delivery, Control of Quality Records, ISO-9001-2000, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Measurement, Analysis and Improvement, ISO-14001 - Environmental Management Systems		
UNIT-III		7 Hrs.
Quality Assurance The Influence of Good Automated Manufacturing Practice (GAMP), Quality System, Contract Review, Design Document and Data Control, Purchasing, Control of Customer Supplied Product, Process Control, Corrective and Preventive Action, Handling, Storage, Packaging, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement.		
UNIT-IV		6 Hrs.
Quality Control Efficiency; Relating to Process and Product, Process characteristics, Quality Characteristics, Documentation, Information, Specification, Quality Manual, Quality Plan, Record of Examination, Objective, Inspection. Quality Requirement, Customer Satisfaction, Capability; Management System, Quality Management System, Quality Policy, Continual Improvement.		
REFERENCE BOOKS*		
1. Pharmaceutical Process Validation, 3rd Edition, Edited by Robert Nash and Alfred Wachter, Marcel Dekker, 2003 2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker, 5th Ed., 2000, 723 pp. 3. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker, 2nd Ed., 1998. 4. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance 5. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. Cloud, Interpharm Press, 1998.		

6. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series, 2001.

COURSE OUTCOMES**

1. Ability to comprehend the validation techniques, process, concepts.
2. Ability to analyse the good practices in lab, clinical and manufacturing practices
3. Capable of understanding the ISO standards and environmental management systems
4. Ability to analyse the analytical methods of validation, issues and automated system and standards
5. Ability to discuss the quality control measures used in industries
6. Ability to analyse the Quality Management System

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	2	2	3	2	2					3	3	3	3
CO 2	3	3	2	2	3	3	2					3	3	3	3
CO 3	3	3	2	2	3	3	2					3	3	3	3
CO 4	3	3	2	2	3	3	2					3	3	3	3
CO 5	3	3	2	2	3	2	2					3	3	3	3
CO 6	3	3	2	2	3	2	2					3	3	3	3

