

BVVS

Basaveshwar Engineering College,
Bagalkote

Department of Biotechnology

Scheme and Syllabus

2022-23

Department of Biotechnology

Vision

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

Mission

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

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.

SCHEME OF TEACHING AND EXAMINATION

III SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	HOURS/ WEEK			EXAMINATION MARKS		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	21UMA302C	Numerical Techniques and Fourier Series	03	3	0	0	50	50	100
2.	IPCC	21UBT301C	Microbiology	04	3	0	2	50	50	100
3.	IPCC	21UBT305C	Unit Operations	04	2	2	2	50	50	100
4.	PCC	21UBT303C	Biochemistry	03	3	0	0	50	50	100
5.	PCC	21UBT307L	Biochemistry lab	01	0	0	2	50	50	100
6.	UHV	21UHS324C	Universal Human Values –II	01	1	0	0	50	50	100
7.	HSMC	21UHS322C	Samskruthika	01	1	0	0	50	50	100
		21UHS323C	Kannada- Balake Kannada							
8.	AEC	21UBT306C	Cell Culture Techniques	02	2	0	0	50	50	100
Total				19	15	2	6	400	400	800

21UMA302C	NUMERICAL TECHNIQUES AND FOURIER SERIES	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I		10 Hrs.
Numerical Methods-I: Introduction to root finding problems, Newton-Raphson method. Finite differences, forward and backward difference operators (no derivations on relations between operators) Newton-Gregory forward and backward interpolation formulae. (Without proof), Lagrange's and Newton's divided difference interpolation formulae (without proof) Numerical differentiation using Newton's forward and backward formulae-problems.		
UNIT – II		10 Hrs.
Numerical Methods -II: Numerical Integration: Simpson's one third rule, Simpson's three eighth rule waddles' (no derivation of any formulae)-problems. Numerical solution of ODE: Taylors, Euler's and Modified Euler's method, Runge-Kutta 4 th order method, miles Predictor corrector method.		
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.		
UNIT – IV		10 Hrs.
Fourier transforms: Infinite Fourier transforms and inverse Fourier transforms- simple properties, Fourier sine and Fourier cosine transforms. Inverse Fourier sine and cosine transforms.		
REFERENCES		
1. Numerical Methods for Engineers by Steven C Chapra & Raymond P Canale. 2. Higher Engineering Mathematics by Dr. B.S. Grewal, Khanna Publishers, New Delhi. 3. Advanced Engineering Mathematics By H. K. Das, S. Chand & company Ltd. Ram Nagar, New Delhi 4. Advanced Engineering Mathematics by E Kreyszig ,John Wiley & Sons.		
COURSE OUTCOMES		
After completion of the course the students shall be able to, 1. Solve engineering problems using non-linear equations and interpolation techniques. 2. Solve problems using numerical differentiation and numerical integration. 3. Solve ordinary differential equations using numerical methods. 4. Solve Problems using the Fourier series. 5. Solve problems using the basic concept of Fourier transforms.		

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	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-

21UBT301C	MICROBIOLOGY	Credits: 04
L: T: P - 3: 0: 2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

UNIT-I	10 Hrs.
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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.
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Microorganisms:

Bacteria- Morphology and ultra structure of Bacteria, Culturing of bacteria, reproduction and growth (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.
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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.
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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"- 5th Edition Tata Macgraw Hill, 2010.
2. Tortora, Funke and Case, "Microbiology an Introduction" -8th Edition, Pearson Education, 2006.
3. Stainer R.Y., Ingraham J.L., "General Microbiology"- 5th Edition Mc.Millan Press, 2010.
4. Madigan, Martinko, Parker, Brock's, "Biology of Microorganisms" - 10th Edition, Prentice Hall, Pearson Education, 2003.
5. Prescott and Dunn, "Industrial Microbiology"-Agribios India, 2002.
6. J. Salle, "Fundamental Principles of Bacteriology" – 7th Edition, Tata Macgraw Hill, 2007.
7. E Alcamo I "Fundamentals of Microbiology"6th Ed, Jones &Bartlet, Pub. 2001.

8. Prescott, Harley & Klein, “Microbiology” -7th Edition, WCB/McGraw Hill, Int. Edition, 2008.

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 analyse 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

21UBT305C	UNIT OPERATIONS	Credits: 04
L: T: P - 2: 2: 2		CIE Marks: 50
Total Hours/Week: 6		SEE Marks: 50

UNIT – I	10 Hrs.
Introduction to Fluid Mechanics: Units and Dimensions, Basic and Derived units, Dimensional homogeneity, Dimensionless numbers, Rayleigh method, Buckingham's pi theorem, Similitude. Fluid definition and classification (Types of fluids – Newtonian and Non Newtonian); Rheological behaviour of fluids. Fluid statics and its applications Hydrostatic equilibrium, Pressure measurement - Manometers.	
UNIT – II	10 Hrs.
Flow Past Immersed Bodies: Types of flow - laminar and Turbulent; Reynolds number; Basic equations of fluid flow - Continuity equation and Bernoulli equation; Correction for Bernoulli's equation, Pump work in Bernoulli's equation; Flow through circular and non circular conduits – Friction factor relations for smooth and commercial pipes,.	
UNIT – III	10 Hrs.
Flow measurements: Flow measurements: Orifice meter, Venturimeter, Rota meter.Pumps, principle, construction numerical. Major and minor losses ,Centrifugal& Reciprocating pumps, Characteristics of centrifugal pumps. Pipes, fittings and valves.Dimensional Analysis.	
UNIT – IV	10 Hrs.
Mechanical Operations- Filtration: Types of filtration, Filter media and filter aids, calculation of resistances and rate of filtration, filtration equipment. Settling, Free and Hindered, Stoke's law, Newton's law, Terminal settling velocity, Batch sedimentation Agitation: Theory of mixing, Power number calculations, mixing equipment. Flow patterns in agitated tanks, mechanism of mixing, scale up of mixing systems. Size Separation: Particle shape, size, screen analysis, screening equipment. Size Reduction: Characteristics of comminute products, crushing laws and work index; Size reduction equipment.	

REFERENCE BOOKS*

1. McCabe WL, Smith JC and Harriott (2005) Unit operations of Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Gavhane KA (2012) Unit Operations I & II, 22nd Edn., 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. R. P. Chhabra V. Shankar (2017) Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA
5. R.P. Chhabra Basavaraj Gurappa (2019) Coulson and Richardson's Chemical Engineering Volume 2A: Particulate Systems and Particle Technology. 6th Edition, Elsevier, USA.

LIST OF EXPERIMENTS

1. Friction in circular and non-circular pipes
2. Flow rate measurement using Orifice meter
3. Flow rate measurement using Venture meter
4. Batch sedimentation test
5. Constant pressure /constant filtration using leaf filter
6. Verification of Stoke's law in Free / Hindered settling
7. Determination of screen effectiveness and sieve analysis
8. Verification of Bernoulli's theorem
9. Unsteady state flow
10. Study of pump characteristics
11. Study of packed bed characteristics
12. Distillation

COURSE OUTCOMES**

At the end of the course the student should be able to:

- 1 Understand the basic concept of fluid mechanics and flow measurements.
- 2 Predict the dimensional analysis and solution for fluid flow problems.
- 3 Predict the pressure drop in fluid flow and flow through packed beds.
- 4 Estimate the flow rate of fluids and design the pumps for transportation of fluids.
- 5 Analyse and solve the problems on filtration and settling.
- 6 Analyse the forces involved in flow through solids and its operations

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21UBT303C	BIOCHEMISTRY	Credits: 03
L: T: P - 3: 0: 0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT – I	12 Hrs.
Principles of Bioenergetics: Energy Flow cycle, energy conversion. Structure and properties of ATP, Bioenergetics of metabolic pathway Carbohydrate Metabolism: Glycolysis, TCA cycle, Electron transport chain and oxidative phosphorylation and respiration energetics. Calvin Cycle, Glyoxylate cycle, Pentose Phosphate Pathway, Gluconeogenesis and regulation of gluconeogenesis. Disorders of carbohydrate metabolism- Galactosemia, Lactose intolerance, Glycogen storage disorder etc. (Defective enzyme lead to disorder during metabolism). Osazone formation to identify the carbohydrates.	
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- Sphingolipidoses etc.	
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-Lesch-Nyhan Syndrome and Gout	
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- Phenylketonuria, Albinism, Maple Syrup Urine Disease, Tyrosinemia.	

REFERENCES*

1. David L. Nelson and Michael Cox, "Lehninger Principles of Biochemistry" –6th Edition Lubert Stryer, "Biochemistry" -Freeman & Co., Pub, 2010.
2. Voet & Voet, "Biochemistry"- 3rd Edition, John Wiley, New York Pub., 2004.
3. Thomas M. Davlins "Biochemistry with clinical correlations" Wiley-Liss; 5 edition, 2001.
4. Mathews, Vanholde & Arhen "Biochemistry" -3rd Edition, Pearson Education Pub., 3 edition 2010.
5. K. Trehan, "Biochemistry" -New Age International Pub, 2nd edition, 2003
6. Elliot & William H, "Biochemistry & Molecular Biology" Oxford Pub., 2005.
7. Helmreich JEM, "Biochemistry of cell signaling" –Oxford Pub. 2005.
8. U. Sathyanarayana, "Biochemistry" -Books and Allied Pub, 2007
9. Berg J.M., Stryer, Tymoczko J.L. "Biochemistry" Freeman & co 2010.
10. Freifelder D. "Molecular Biology" -Narosa Publications, 2nd Edition 2003.

COURSE OUTCOMES**

1. Ability to understand the principles of high energy compounds & interpret the metabolic pathways in the carbohydrates and their disorders
2. Ability to recognize the regulation of lipid metabolism along with the in born errors.
3. Ability to understand the origin of atoms in purine and pyrimidine & also interpret the pathways in the nucleic acid metabolism disorders
4. Ability to comprehend 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	

21UBT307L	BIOCHEMISTRY LABORATORY	Credits: 01
L: T: P - 0: 0:2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS

1. pH measurements, volume / weight measurements, concentration units, Specificity, precision, Accuracy.
2. Classes of carbohydrates, lipids and proteins.
3. Reagent preparation and preparation of buffers of constant strength.
4. Qualitative tests for carbohydrate and lipids.
5. Qualitative tests for amino acids and proteins.
6. Estimation of sugar by Folin and O-toluene method.
7. Estimation of amino acid and protein by ninhydrin method
8. Determination of Saponification value of lipids.
9. Determination of Iodine value of lipid.
10. Determination of acetyl value of a lipid.
11. Estimation of urea by diacetylmonooxime method.

REFERENCE BOOKS*

1. Rodney Boyer, "Modern Experimental Biochemistry"-Pearson Education Pub, (2000).
2. Keith Wilson, "Practical Biochemistry" Cambridge University Pub, (2003).
3. Pattabhiraman, "Practical Biochemistry"
4. BeeduSashidharRao and Vijay Deshpande, "Experimental Biochemistry" -I.K.Intl
5. Plummer D. T "Practical Biochemistry" -TMH Pub., 1988

COURSE OUTCOMES**

1. Ability to understand the basic aspects of standard reagent & buffer preparations.
2. Ability to identify various biomolecules qualitatively.
3. Ability to estimate the concentration of carbohydrates in a given sample
4. Ability to evaluate the concentration of amino acid quantitatively.
5. Ability to analyze the types of lipids.
6. Ability 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				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
CO 5	2	2	2	2		1	2	2				3	3	2	1
CO 6	2	2	3	3		3		3				2	3	2	1

21UBT306C	CELL CULTURE TECHNIQUES	Credits: 02
L: T: P - 2: 0: 0		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

UNIT – I		8 Hrs.
Plant cell culture: History and introduction, requirements, lab organisation, media constituents, choice of media sterilization of media, explant selection, sterilisation and preparation for inoculation, role of growth hormones in cell culture. Cellular totipotency, cytodifferentiation, organogenic differentiation, somatic embryogenesis. Plant growth hormones - auxins, gibberlins, cytokinins. Stoichiometry of cell growth and product formation.		
UNIT – II		6 Hrs.
Culture techniques and applications: Protoplast culture, somatic hybridization, haploid production, micro propagation, somaclonal variation, crop improvement, hairy root culture, synthetic seeds. Regeneration of plantlets-shooting, rooting and hardening.		
UNIT – III		6 Hrs.
Animal cell culture Techniques History and development of mammalian cell culture. lab layout and equipments, cell culture media (Natural and Artificial) - components of the medium, functions of media components. Role of antibiotics in media. Types of primary culture, establishment of primary culture, cell lines – mechanical and enzymatic mode of desegregation. Subculture - passage number, split ratio, seeding efficiency, criteria for subculture.		
UNIT – IV		6 Hrs.
Cell line Characterization and Maintenance Measurement of Cell viability and Cytotoxicity assay –MTT, LDH dehydrogenase, . Dye exclusion and inclusion tests, clonogenic assay. Characterization. Cell line contaminations, detection and control. Stem cells & their applications		
REFERENCES BOOKS*		
1. Culture of Animal cells-3 rd Edition-R. Ian Freshney. Wiley Less, 2010 2. Introduction to Plant biotechnology by H. S. Chawla, 2 nd Edition, Oxford and IBH Publishers, 2010 3. Biotech Expanding Horizons-B. D. Singh, Kalyani Publishers, 2010. 4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter Molecular biology of The Cell, GS publishers, 2002		
COURSE OUTCOMES**		
1. To use the plant cells to produce in vitro cultures 2. To comprehend the applications of plant tissue culture techniques in various fields 3. To acquire working knowledge of culture of animal cells in <i>in vitro</i> conditions. 4. To identify, and classify the cell culture techniques		

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

B. E. IV SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	21UBT401C	Biostatistics & Biomodeling	03	2	2	0	50	50	100
2.	IPCC	21UBT402C	Immunotechnology	04	3	0	2	50	50	100
3.	IPCC	21UBT403C	Heat & Mass Transfer	04	3	0	2	50	50	100
4.	PCC	21UBT404C	Molecular Biology	03	3	0	0	50	50	100
5.	PCC	21UBT405C	Bioprocess Principles and Calculations	03	3	0	0	50	50	100
6.	PCC	21UBT406L	Molecular Biology Lab	01	0	0	2	50	50	100
7.	PCC	21UBT407L	Biostatistics Lab	01	0	0	2	50	50	100
8.	HSMC	21UHS421C	CIP	01	1	0	0	50	50	100
9.	INT	21UBT408I	Internship	02	0	0	4	100	-	100
Total				22	15	2	12	500	400	900

21UBT401C	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, RCB, 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(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. 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	-

21UBT402C	IMMUNOTECHNOLOGY	Credits: 04
L: T: P - 3 : 0: 2		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10Hrs.
The immune system: Introduction, Cells and Organs of the immune system: Lymphoid cells, phagocytes, mast cells and dendritic cells. Primary (thymus, bone marrow and lymphatic system) and secondary Lymphoid organs (lymph nodes, spleen, MALT, CALT). Innate and adaptive immunity. Antigens, Antibodies, Complement system-complement activation,(classical, alternative and lectin pathway) regulation and biological consequences of compliment activation. Cytokines and their role in immune response. Monoclonal antibodies and applications.	
UNIT-II	10 Hrs.
Humoral and cell mediated immunity: Introduction to humoral and cell mediated immunity. B-lymphocytes and their activation; Basic structure of immuno globulins; immunoglobulin classes (IgG, IgA, IgE, IgD and IgM) and biological activity. Antigenic determinants on immunoglobulin's- Isotype, Allotype and Idiotyp. Thymus derived lymphocytes (T cells) and types, T-cell maturation and activation, mechanisms of T cell activation. Cell death and T-cell populations. Major Histocompatibility Complex and antigen presentation. Antigen presenting cells, dendritic cells, macrophages, mechanism of phagocytosis.	
UNIT-III	10 Hrs.
Immunological disorders: Hypersensitivity reactions and its types. Autoimmune disorders- Organ specific, Systemic Autoimmune diseases, Animal models for autoimmune diseases 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, Non-isotopic methods of detection of antigens - Enhanced chemiluminescence assay. Purification and synthesis of antigens.

LIST OF EXPERIMENTS

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)
4. Radial Immunodiffusion (RID)
5. Countercurrent immunoelectrophoresis (CCIEP)
6. Rocket immunoelectrophoresis (RIEP)
7. Western blot (IGg Purification)
8. ELISA/ DOT Blot.
9. Quantitative precipitin assay (QPA).

REFERENCE BOOKS *

1. Roitts, (2017), Essential Immunology (13th edition), Wiley Blackwell
2. Kuby, J.(2019), Immunology(8th edition), W H Freeman publishers
3. Chakravarthy, A.K.(2006),Immunology & Immunotechnology, Oxford University Press
4. Rastogi, S. C. (2005), Immunodiagnostics (1st Edition), New Age International

COURSE OUTCOMES**

After completion of the course student will be able to

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.

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

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

21UBT403C	HEAT AND MASS TRANSFER	Credits-04
L: T: P - 3 : 0: 2		CIE Marks : 50
Total Hours/week : 05		SEE Marks : 50

UNIT – I		10 Hrs.
Introduction to Heat Transfer: Modes of heat transfer; Conduction – steady state heat conduction through uni-layer and multilayer plane wall sphere, cylinder; Insulation – types, critical radius, Optimum thickness of insulation. Forced and Natural convection; Significance of Dimensionless numbers (Nu, Gr, Pr, Re, Pe numbers only); Heat transfer without phase change, heat transfer in laminar and turbulent flow inside closed conducts, concepts of film heat transfer coefficients.		
UNIT – II		10 Hrs.
Heat Transfer Equipments: Equations and numerical problem for calculations of film heat transfer coefficients, Heat transfer with phase change - Condensation – film wise and drop wise; Boiling – types of boiling. Co current and counter current flow. Individual and overall Heat transfer coefficients, LMTD, Elementary design of double pipe heat exchanger and shell and tube heat exchanger.		
UNIT – III		10 Hrs.
Basics of Mass Transfer: Diffusion - Fick's law of diffusion. Measurement of diffusivity, Theories of mass transfer, Mass transfer coefficients and their correlations. Liquid-Liquid, Solid-Liquid, Liquid-Gas, Solid-Liquid-Gas Mass transfer. Principles, mass transfer considerations, design equations and equipments for leaching, extraction, absorption, adsorption, crystallization and evaporation		
UNIT – IV		10 Hrs.
Mass transfer Operations- Distillation: Methods of distillation –Simple, Flash distillation of binary mixtures – relative volatility, fractionation of binary mixtures -McCabe Thiele method, Extractive and Azeotropic distillation, numerical. Drying: Drying rate, drying curve and calculations, drying equipment.		
REFERENCES*		
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 (2018) Coulson and Richardson's Chemical Engineering Volume 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.		
LIST OF EXPERIMENTS		

1. Friction in circular and non-circular pipes
2. Flow rate measurement using Orifice meter
3. Flow rate measurement using Venture meter
4. Batch sedimentation test
5. Constant pressure /constant filtration using leaf filter
6. Verification of Stoke's law in Free / Hindered settling
7. Determination of screen effectiveness and sieve analysis
8. Verification of Bernoulli's theorem
9. Unsteady state flow
10. Study of pump characteristics
11. Study of packed bed characteristics

COURSE OUTCOMES**

- 1 Define the different modes of heat transfer and solve the problems
- 2 Determine heat flux and temperature distribution in steady state one- dimensional problems using thermal resistance concept.
- 3 Estimate the heat transfer rate for different types of heat exchangers.
- 4 Predict mass transfer rates and mass transfer coefficients.
- 5 Estimate the number of theoretical plates required for effective separation of liquid mixtures.
- 6 Determine various parameters of mass transfer operations.

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		
CO 5	2	3	3	2	1							1	2		
CO 6	2	2	2	1	1							1	2		

21UBT404C	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
1. 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	2	1	1	-	-	-	-	-	1	1	1
CO4	1	-	3	3	3	2	3	-	-	-	-	-	2	2	1

21UBT405C	BIOPROCESS PRINCIPLES AND CALCULATIONS	Credits-3
L: T: P - 3 : 0: 0		CIE Marks : 50
Total Hours/week : 03		SEE Marks : 50

UNIT – I		10 Hrs.
Units and Dimensions Fundamental and derived quantities. Inter-conversion of units from one system to another.(FPS, CGS, MKS, SI). Basic Chemical Calculations: Concept of mole and molecule. Compositions of mixtures of solids, liquids and gases. Composition of mixtures and solutions: Percentage by weight, mole and volume; Normality, Molarity, Molality, and ppm. Introduction to Bioprocesses: Role of a bioprocess engineer in the biotechnology industry, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses; Generalized process flow sheet and unit operations in chemical and bioprocess industries; General material balance equation for steady and unsteady states.		
UNIT – II		10 Hrs.
Material Balance without Chemical Reactions Generalized material balance equations for distillation, absorption, extraction, crystallization, mixing, drying and evaporation, Material balances calculation in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing and Evaporation Operations, Material balances calculation involving bypass, recycle and purge operations.		
UNIT – III		10 Hrs.
Material Balance Involving Chemical Reactions Generalized material balance equations, Principles of stoichiometry, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, Selectivity, unit process – neutralization, oxidation, hydrogenation, nitration, hydrolysis, esterification, alkylation and amination, problems relating to these unit processes. Fuels and combustion: Ultimate and Proximate analysis of fuels; Excess air and Air-fuel ratio.		
UNIT – IV		10 Hrs.
Energy Balance General energy balance equation for steady state. Thermo-physics and thermo-chemistry; Heat capacity, Estimation of heat capacity for solids, liquids, gases and their mixtures, Enthalpy, Standard heat of formation, Standard heat of reaction, Standard heat of combustion and calorific value. Calculation of delta H _R at elevated temperature. . 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; maintenance coefficients.		

REFERENCES*

1. Introduction to process calculation by K A Gavane, Nirali Publications, 2016
2. Stoichiometry by B.I.Bhatt and S.M. Vora, Tata McGraw Hill Publishing, 4th Edition, 2004
3. Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI, 2005
4. Biochemical Engineering Fundamentals: by J. E. Bailey & D. F. Ollis (McGraw Hill), 2005
5. Bioprocess Engineering by Shule and Kargi (prentice Hall), 2010
6. Principles of Biochemistry by David L. Nelson (Editors), 4th edition, W. H. Freeman and company Newyork, 2005.

COURSE OUTCOMES**

1. Define the process operations and terms of calculations
2. Prepare the process flow diagram and identify the input and output streams
3. Apply the general procedure for solving the material balance problems
4. Analyze the types of process and material balance
5. Calculate the material balance and energy problems
6. Evaluate the orasat and ultimate analysis
7. Calculate the Enthalpy, latent heat of vaporization and heat of condensation
8. Apply the common skills and logical skills for solving material and energy balance

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	
CO 5	3	2	3									1	2	1	
CO 6	3	3	2									1	2	1	
CO 7	3	3	2									1	2	1	
CO 8	3	3	2									1	2	1	

21UBT406L	MOLECULAR BIOLOGY LAB	Credits: 01
L: T: P - 0 : 0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS

1. Study of standard practices in Molecular Biology Lab
2. Standard Operating Procedure for Centrifuge.
3. Standard Operating Procedure for Gel Documentation Unit.
4. Study of absorption spectra of nucleic acids.
5. Agarose gel electrophoresis.
6. Isolation of genomic DNA (plant / animal / microbial sources).
7. Isolation of plasmid DNA from E. coli.
8. Estimation of DNA by diphenyl method.
9. Estimation of RNA by orcinol method.
10. Purity of nucleic acids, protein by UV-Vis Spectrophotometer.
11. PAGE (DEMO).

REFERENCE BOOKS *

1. Sadashiva and Manickam, (2017), Biochemical Methods, (2nd Edition), W.H. Freeman
2. Sambrook& Russell, (2002), Molecular Cloning, (3rd Edition), Cold Spring Harbor Lab.

COURSE OUTCOMES**

After completion of the course student will be able to

1. Apply absorption spectra and analyze SOP for various lab equipments.
2. Conduct and analyze the concentration and purity of DNA.
3. Conduct and analyze Agarose gel electrophoresis.
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	3	2	1
CO2	1	2	2	1	3	2	-	-	-	-	-	1	3	2	1
CO3	1	2	2	1	3	1	-	-	-	-	-	1	3	1	1
CO4	2	2	3	2	3	2	-	-	-	-	-	1	3	2	1

21UBT407L	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. Calculation of Regression and correlation 4. Procedure and calculation of t, Z and F test. 5. Calculation of Chi-square test. 6. ANOVA- one-way analysis 7. ANOVA- two-way analysis. 8. Experimental Research Design – CRD- Analysis. 9. Experimental Research design – RBD- Analysis. 10. Experimental Research design – Latin square Design- Analysis. 11. Placket-Burman Design for media optimization. 12. 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. Draw graphs, charts, enter the data using statistical software tools 2. Calculate measures of dispersion and central tendency 3. Analyse the t, z and f test 4. Solve and analyze ANOVA 5. Know the different types of experimental designs with case studies 6. Aware of media optimization techniques using statistical designs												

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
CO 5	2	3	1	3	3	-	-	-	-	-	1	2	2	1	1
CO 6	1	3	1	3	2	-	-	-	-	-	-	2	2	1	1

V-Semester

2022-23

SI No	Subject Code	Subject Name	Credits	Hours			Examination Marks		
				L	T	P	CIE	SEE	Total
1	UBT516C	Bioprocess & Reaction Engineering	3	3	0	0	50	50	100
2	UBT519C	Genetic Engineering & Applications	3	3	0	0	50	50	100
3	UBT520C	Fundamentals of Bioinformatics	3	2	2	0	50	50	100
4	UBT52XE	Elective-I	3	3	0	0	50	50	100
5	UBT506H	Industrial Safety and Bioethics	3	3	0	0	50	50	100
6	UBT514L	Bioinformatics Lab	1	0	0	2	50	50	100
7	UBT515L	Genetic Engineering Lab	1	0	0	2	50	50	100
8	UCS559L	Advanced C Programming Lab	2	0	0	4	50	50	100
9	UHS002N	Advance Quantitative Aptitude and Soft Skills	1	1	0	0	50	50	100
10	UXX5XXN	Open Elective-I	3	3	0	0	50	50	100
Total			23	18	2	8	500	500	1000

Elective-I

UBT521E: Environmental BT

UBT522E: Biomedical Instrumentation

UBT525E: Stem cell technology

UBT527E: Nutraceuticals

UBT516C	BIOPROCESS & REACTION ENGINEERING	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I	10 Hrs.
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Kinetics of Homogeneous reactions

Basic Concepts of Bioreactor 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	10Hrs.
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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 catalyzed reactions, irreversible reaction in series, irreversible reactions in parallel, reactions of shifting order, autocatalytic reactions, reversible reactions, differential method of analysis of data and numerical.

UNIT-III	10 Hrs.
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Introduction to Reaction Design

Introduction. Factors to be consider for designing a reactor, Types of reactors, Basic design equation, relation between Concentration and conversion, Performance equation for ideal batch reactor, MFR/CSTR and PFR, space time and space velocity for flow reactors, design of flow reactors and numerical.

UNIT-IV	10 Hrs.
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Design for single reactions

Introduction .Size comparison of single reactors, multiple reactors CSTR in series /MFR in series, CSTR in parallel .PFR in series, in parallel, Reactors of different types in series, and numerical.

REFERENCE BOOKS

1. Scott Fogler, H (2016) Elements of Chemical Reaction Engineering, 6th edn., Prentice Hall India Pvt. Ltd. a
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. BaileyJE 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. Tapobrata Panda., Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill

Education Private Limited, New Delhi, 2011.

COURSE OUTCOMES

1. Understand the basic concept of reaction engineering.
2. Predict the order and rate of the different reactions.
3. Analyze the batch bioreactor data for different reactions.
4. Design the suitable bioreactor for different biochemical reactions.
5. Predict the residence time distribution to determine the conversion in non ideal flow reactors
6. Analyze bioreactors for various cell cultures.

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							3	3	2	
CO 2	3	3	2	2	2							3	3	3	
CO 3	3	3	3	2	2							3	3	3	
CO 4	3	3	3	2	2		2					3	3	3	
CO 5	3	3	2	1	2							3	3	2	
CO 6	3	3	3	2	2							3	3	2	

UBT519C	GENETIC ENGINEERING & APPLICATIONS	Credits: 03
L:T:P - 3 : 0: 0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction: Hours 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		10 Hrs.
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		12 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 (Bacillus thuringiensis 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 *		
3. Bernard Glick and J. Pasternak (2017). Molecular Biotechnology – Principles and		

- applications of recombinant DNA, 2nd edition, ASM Press.
4. Watson (2010), Recombinant DNA, 2nd edition, Freeman Publishers.
 5. Primrose S.B, Richard Twyman and Bob (2010), Principles of gene manipulation Blackwell 6th edition, Scientific Publications.
 6. NPTEL Course material.

COURSE OUTCOMES**

After completion of the course student will be able to

1. Emphasize on the basic aspects of genetic engineering; the key areas and apply the knowledge in vectors used in genetic engineering experiments.
2. Apply the properties of various enzymes and vectors in gene and genome manipulation.
3. Acquire working knowledge on the mechanism of methods of nucleic acid detection, hybridization and amplification and their applications in the research.
4. Acquire working knowledge on the construction of genomic and cDNA libraries, their applications in the research and biology of *Bacillus thuringiensis*.
5. Identify the various gene transfer techniques in plants, animals and microbes that are essential for controlled protein production in the industry and acquire knowledge on various strategies of Gene therapy and its application in therapeutics.
6. Identify and apply the current applications and advances of biotechnology and describe the steps involved in the production of biopharmaceuticals in microbial systems and industrial utilization.

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	-	1	2	3	1	-	-	-	-	-	3	3	3	3
CO2	2	-	2	2	3	2	-	-	-	-	-	3	3	3	3
CO3	2	-	3	2	3	2	-	-	-	-	-	3	3	3	3
CO4	2	-	3	2	3	2	-	-	-	-	-	3	3	3	3
CO5	2	-	3	2	3	3	-	-	-	-	-	3	3	3	3
CO6	2	-	2	2	3	3	-	-	-	-	-	3	3	3	3

UBT520C	FUNDAMENTALS OF BIOINFORMATICS	Credits: 3
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 04		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						3	3	3	
CO 2	3	2	2	2	3	1		-				3	3	3	
CO 3	3	2	2	2	3	2		2				3	3	3	2
CO 4	3	2	-	2	3	-		-				3	3	3	
CO 5	3	2	-	-	2	-						3	3	2	
CO 6	3	1	2	-	3	2						3	3	3	

UBT527E	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*		
6. Israel Goldberg (Ed.) (1999) Functional foods, designer foods, pharma foods, Nutraceuticals, Aspen publishers Inc., USA. 7. L. Rapport and B. Lockwood, Nutraceuticals, Pharmaceutical Press., 2 nd Edition, 2002. 8. M. Maffei, Dietary Supplements of Plant Origin, Taylor & Francis, 1 st Edition, 2003. 9. Shahidi and Weerasinghe, Nutraceutical beverages Chemistry, Nutrition and health		

Effects, American Chemical Society, 1 st Edition, 2004.
10. Richard Neeser & J. Bruce German (2004) Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean, Marcel Dekker, Inc.
11. 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	2	2	-	1		1						3	2	3	
CO 2	2	2		1		1						3	2	3	
CO 3	2	2	-	2		-						3	2	3	
CO 4	2	2	2			2						3	2	3	
CO 5	2	2	2			2	2					3	2	3	
CO 6	2	2	2	2	2	2	2	2				3	2	3	2

UBT506H	INDUSTRIAL SAFETY & BIOETHICS	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to Bioethics & Biosafety: Definition and scope of bioethics and biosafety, Ethical implications and need for biosafety, Legal and Socio-Economic impacts of Biotechnology. Convention on biological weapons. Bioterrorism-classification of biological agents with examples.	
Biosafety regulation guidelines Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety committee(IBC), Review Committee on Genetic Modification (RCGM), Genetic Engineering Approval Committee(GEAC), Biosafety guidelines- national guidelines, Cartagena Protocol on Biosafety.	
UNIT-II	10Hrs.
Biosafety Regulation: Genetically modified organisms and their release in environment, Laboratory associated infections and other hazards, Good Lab Practices and Good Manufacturing Process (GLP &GMP). Biosafety levels for microorganism BL1, BL2, BL3, BL4) plants (BL1-P, BL2-P, BL3-P, BL4-P) animals (BL1-N, BL2-N, BL3-N, BL4-N). Risk assessment during laboratory research and risk groups. Recombinant organisms and transgenic crops. Guideline for labeling GM crops. Containments; Physical, Biological. Field trial methods using transgenic plants.	
UNIT-III	10 Hrs.
Food and Pharma safety: Biosafety assessment procedures for biotech foods and Pharma products. Procedure to apply patent, Copy right, Plant Breeder's Right, Environmental aspects of biotech applications. Special application of patent laws in biotechnology and case studies. Flavr Savr Tomato as model case, case studies of relevance (Eg. Bt cotton, Bt brinjal). Licensing and cross licensing.	
UNIT-IV	10 Hrs.
Industrial safety Need for safety, importance of occupational safety, Health and safety programs, Safe and unsafe conditions. Accidents: Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention Safety policy Fire: Fire extinguishers and fire exits, extinguishing agents. Importance of safety in food and Pharma industry. Food safety, Biological, chemical and Physical Hazards-HAACP system, Pharma safety. Food and safety act. Injuries by industrial sector	

REFERENCE BOOKS*

1. Sateesh M.K.(2012),Bioethics and Biosafety, I.K.International Publication
2. Singh B.D.(2010), Biotechnology Expanding Horizon (3rd revised edition), Kalyani Publishers.
3. Goel D and Parashar S (2010), IPR-Biosafety and Bioethics (2nd edition), Pearson Education India Publishers..

COURSE OUTCOMES**

1. Interpret ethical issues connected with BT and biosafety guidelines.
2. Use GLP and GMP at work place.
3. Identify biosafety assessment procedures and patent laws.
4. Use the safety measures at 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	2				-	3	-	3	-	-	-	3	2	3	3
CO2	2				2	3	-	3	-	-	-	3	2	3	3
CO3	2				-	3	-	3	-	-	-	3	2	3	3
CO4	2				2	3	-	3	-	-	-	3	2	3	3

UBT521E	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 Mahapatra. 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	3		2	2			3					3	3	3	3
CO 2	3		2				3					3	3	3	3
CO 3	3		2				3					3	3	3	3
CO 4	3		2				3	2				3	3	3	3
CO 5	3		2				3					3	3	3	3
CO 6	3		2				3					3	3	3	3

UBT522E	BIOMEDICAL INSTRUMENTATION	Credits: 03
L:T:P - 3:0:0		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

UNIT-I		10 Hrs.
Introduction Sources of Biomedical signals, Basic medical instrumentation system, Performance requirements of medical instrumentation systems, PC based medical instruments, General constraints in design of medical instrumentation systems.		
Bioelectric Signals and Electrode Origin of bioelectric signals, Recording electrodes, - Electrode-tissue interface, metal electrolyte interface, electrolyte -skin interface, Polarization, Skin contact impedance, Silver – silver chloride electrodes, Electrodes for ECG, EEG, EMG, Electrical conductivity of electrode jellies and creams, Microelectrode. Patient Safety: Electrode shock hazards, Leakage currents.		
UNIT-II		12 Hrs.
ECG & EEG Electrical activity of heart, Genesis & characteristics of Electrocardiogram (ECG), Block diagram description of an Electrocardiograph, ECG Lead Systems, Multichannel ECG machine Genesis of Electroencephalogram (EEG), Block diagram description of an Electroencephalograph, 10-20 Electrode system, Computerized analysis of EEG.		
Cardiac pacemakers and defibrillators Need for Cardiac pacemaker, External pacemaker, Implantable pacemaker, Programmable pacemakers, DC defibrillator, AC defibrillator and Implantable Defibrillator.		
UNIT-III		10 Hrs.
Patient monitoring system Bedside monitors, Central Monitoring System, Measurement of Heart rate -Average heart rate meter, Instantaneous heart rate meter, (Cardio tachometer), Measurement of Pulse Rate, Blood pressure measurement -direct and indirect method, Rheographic method, Oscillometric method, Ultrasonic Doppler shift method, Measurements of Respiration rate -Thermistor method, impedance puenmography, CO2 method, and Apnea detector. Blood flow meters: Electromagnetic and its types, Ultrasonic, NMR, Laser Doppler. Blood gas analyzers: Blood pH measurement, Measurement of Blood pCO2, pO2.		
Physiological transducers Introduction, classification, performance characteristics of transducers-static and dynamic transducers, Displacement, position and motion transducers, Pressure transducer, Transducers for body temperature measurement, Optical Fiber sensor and Biosensor		
UNIT-IV		10 Hrs.
Recording systems Basic recoding system, general considerations for signal conditioners, preamplifiers-instrumentation amplifier, isolation amplifier, ink jet recorder, potentiometric recorder, thermal array recorder and electrostatic recorder.		
Analysis of Cardiac output measurement: Indicator dilution method, Dye dilution method, Thermal dilution techniques, Measurement of Continuous cardiac output derived from the aortic pressure waveform, Impedance technique. Pulmonary function analysis: Pulmonary		

function measurement, Spirometry, Puemotachometer, Measurement of Volume, Nitrogen washout technique.

REFERENCE BOOKS *

1. Khandpur R S (2003), Hand book of Biomedical Instrumentation (2nd Edition), Tata McGraw-Hill Publishing Company Limited.
2. Enderle J, Blanchard S & Bronzino J (2005), Introduction to Biomedical Engineering, Elsevier.
3. Carr J J, Brown J M (2005), Introduction to Biomedical equipment technology (4th Edition), Prentice hall.

COURSE OUTCOMES**

After completion of the course student will be able to

1. Able to understand basic concepts of biomedical signals.
2. Able to know ECG and EEG.
3. Able to understand the patient monitoring system and recording systems
4. Able to know characteristics of transducers
5. Able to understand various analysis techniques
6. Able to understand the recording systems.

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	-	-	-	-	-	-	-	1	-	2	-
CO2	2	3	2	-	-	-	-	-	-	-	-	-	2	3	1
CO3	2	3	2	1	-	-	-	-	-	-	-	-	3	3	1
CO4	1	2	2	3	-	-	-	-	-	-	-	-	1	3	-
CO5	1	3	2	2	-	-	-	-	-	-	-	-	2	3	1
CO6	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-

UBT525E	STEM CELL TECHNOLOGY	Credits: 03
L:T:P - 3:0:0		CIEMarks:50
Total Hours/Week: 40		SEEMarks:50

UNIT-I		10 Hrs.
Stem cells and cellular pedigrees Scope of stem cells – definition of stem cells – concepts of stem cells – differentiation , maturation , proliferation , pluripotency, self – maintenance and self – renewal – problems in measuring stem cells – preservation protocols.		
UNIT-II		12 Hrs.
Stem cell concept in plants Stem cell and founder zones in plants – particularly their roots – stem cells of shoot meristems of higher plants.		
UNIT-III		10 Hrs.
Stem cell concept in animals Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles –Tumour stem cells, Embryonic stem cell biology - factors influencing proliferation and differentiation of stem cells – hormone role in differentiation.		
UNIT-IV		10 Hrs.
Haemopoietic stem cell Biology – growth factors and the regulation of haemopoietic stem cells. Potential uses of stem cells Cellular therapies – vaccines – gene therapy – immunotherapy – tissue engineering –blood and bone marrow – Fc cells.		
REFERENCE BOOKS *		
1. Mao J. J, Vunjak-NovakovicG (2008), Translational Approaches in Tissue Engineering & Regenerative Medicine, Artech House, INC Publications. 2. Lanza R et al.(2007), Principles of Tissue Engineering(3rd Edition), Academic Press.		
COURSE OUTCOMES**		
After completion of the course student will be able to 1. Isolate and Culture of Hematopoietic Stem cells 2. Isolate and Culture of Mesenchymal Stem cells 3. Analyse Differentiation of Pluripotent stem cells 4. Interpret Cell culture in Scaffolds 5. Analyse growth of haemopoietic stem cells 6. Apply the potential uses of stem cells		

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	2
CO2	2	3	2	-	-	-	-	-	-	-	1	1	2	3	1
CO3	2	3	2	1	-	-	-	-	-	-	-	1	3	3	1
CO4	1	2	2	-	-	-	-	-	-	-	1	2	1	3	-
CO5	1	3	2	2	-	-	-	-	-	-	-	1	2	3	1
CO6	-	-	-	-	-	-	-	-	-	-	1	3	2	2	2

UBT532N	BIOFUELS TECHNOLOGY	Credits: 03
L:T:P - 3:0:0		CIEMarks:50
Total Hours/Week: 03		SEEMarks: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	12 Hrs.
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 biodisel, bioalcohols, bioethers, biogas syngas, solid biofuels. Second generation and third generation biofuels,	
UNIT-III	10 Hrs.
Technologies for biofuels Historical background. Biochemical platform – bioethanol production, standardization, emissions and properties of bioethanol. Innovations in 2G technology. Thermochemical platforms - biodiesel production, Innovations in Biodiesel productions, standardization, properties and emissions of biodiesel. Biomethanation- AD technology and innovations in Biomethanation process. Biohydrogen processing and uses. Converting solid wastes to pipeline gas. 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 biodisel, Issues with biofuel production & use. Impact of biofuel in global climate change & food production. 1 st versus 2 nd generation biofuels. Strategies for new vehicle technologies. Current research on biofuel production. Market barriers of biofuels.	
REFERENCE BOOKS *	
1. Environmental Biotechnology by Foster C. F., John ware D.A., Ellis Horwood Limited, 1987. 2. Fuels from Waste by Larry Anderson and David A Tillman. Academic Press, 1977. 3. Biofuels by Ayhan Demirbas publ. Springer 4. Biofuels (Series - Energy For The Future And Global Warming) 5. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.	

6. Environmental Biotechnology by Pradipta Kumar Mahopatra, 2007.

COURSE OUTCOMES**

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	-

UBT514L	BIOINFORMATICS LABORATORY	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

UBT515L	GENETIC ENGINEERING LABORATORY	Credits: 1
L: T: P – 0-0- 2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

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. SOP for PCR 9. SOP for Gel Documentation 10. SOP for UV-Spectrophotometer 11. SOP for Lyophilizer 12. PCR (Amplification with specific primers)															
REFERENCE BOOKS*															
1. Sadashiva and Manickam, “Biochemical Methods”, 2nd Edition, New age international Publishers, 2017. 2. Sambrook & Russell, “Molecular Cloning”, Cold Spring Harbor Lab, 3rd Edition, 2002. 3. Current protocols in molecular biology-Greena Publishing Associates, NY, 1988															
COURSE OUTCOMES**															
1. To demonstrate proficiency in Transformation and screening of transformants. 2. To apply the knowledge of thermal denaturation to calculate T _m value. 3. To evaluate the functions of restriction digestion and Ligation on DNA. 4. To demonstrate proficiency in Electro-blotting and detection. 5. To demonstrate understanding of SOP and PCR. 6. To gain knowledge in common and advanced laboratory practices in Genetic engineering lab.															

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

VI SEMESTER

2022-23

SI. No	Subject Code	Subject Name	Credits	Hours/Week			Examination Marks		
				L	T	P	CIE	SEE	Total
1	UBT615C	Enzyme kinetics and Biotransformation	3	3	0	0	50	50	100
2	UBT616C	Upstream Processing Technology	3	2	2	0	50	50	100
3	UBT617C	Bioprocess Equipment Design	3	2	2	0	50	50	100
4	UHS003N	Career Planning and Professional Skills	1	1	0	0	50	50	100
5	UBT62XE	Elective -2	3	3	0	0	50	50	100
6	UBT63XE	Elective -3	3	3	0	0	50	50	100
7	UXX6XXN	Open Elective-2	3	3	0	0	50	50	100
8	UBT614L	Upstream Processing Lab	1	0	0	2	50	50	100
9	UBT615L	Bio-kinetics & Enzyme Technology Lab	1	0	0	2	50	50	100
10	UBT609P	Mini Project	3	0	0	3	50	50	100
Total			24	17	4	7	500	500	1000

Elective- 2

UBT621E Microbial BT

UBT623E Plant BT

UBT625E Biofuels technology

UBT627E Tissue engineering

Elective- 3

UBT631E Genomics & Proteomics

UBT633E Pearl programming

UBT632E Animal BT

UBT634E Transport phenomena

UBT615C	ENZYME KINETICS AND BIOTRANSFORMATION	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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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	12Hrs.
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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.
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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.
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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. Enzymes: Biochemistry , Biotechnology, Clinical Chemistry by Trevor Palmer, Horwood Publishing Ltd, East-West Press, 2nd Edition, 2008
2. David L. Nelson and Michael Cox, "Lehninger Principles of Biochemistry" –7th Edition 2017
3. Nicholas C. Price and Lewis Stevens Fundamentals of Enzymology , Oxford university Press, 3rd edition, 2009
4. U. Sathyanarayana, "Biochemistry" -Books and Allied Pub, 5th Edition, 2017.
5. James R Hanson "An Introduction to Biotransformation in Organic Chemistry" Oxford university Press, 1997.

6. Daniel L. Purich, Melvin I. Simon, John N. Abelson” Contemporary Enzyme Kinetics and Mechanism” Academic press, 3rd edition, 2009.
7. K. Faber” Biotransformations in Organic: Springer- Verlag.1st Edition, 1999.
8. Bailey and Ollis, “Biochemical Engineering Fundamentals”, McGraw Hill (2nd Ed.), 2017.
9. Plowman, ‘Enzyme Kinetics’ McGraw Hill, 2010

COURSE OUTCOMES**

1. Ability to understand mechanism of enzyme reactions.
2. Ability to understand how to characterize the enzymes.
3. Ability to apply the techniques of immobilization of enzymes and know its uses.
4. Ability to know the importance of enzymes in diagnostics.
5. Ability to know the application of enzymes in wool, leather and detergent industries.
6. Ability to apply knowledge of using enzymes in food 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											3	3	2	
CO 2	2											3	3	3	
CO 3	2		2		2		2					3	3	3	2
CO 4	2		2			3	2					3	3	3	
CO 5	2		2		2	3	2					3	3	3	
CO 6	2		2		2	3	2					3	3	3	
Avarage	2		2		2	3	2					3	3	3	2

UBT616C	UPSTREAM PROCESSING TECHNOLOGY	Credits: 3
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 04		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

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

UBT617C	BIOPROCESS EQUIPMENT DESIGN	Credits: 3
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT-I		10 Hrs.
Process design of double pipe heat exchanger		
Introduction to heat exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter current), Heat transfer coefficients (inside, outside & overall), area, length, number of hair pins, diameter of tube. Pressure drop calculations. Detailed drawing of sectional front view of Heat exchanger.		
UNIT-II		12Hrs.
Process design of shell & tube heat exchanger		
Introduction to Heat Exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter current), Heat transfer coefficients (inside, outside and overall), area, length, number of tubes, tube sheet diameter, pitch type, diameter of tube sheet. Mechanical design – baffle, thickness of shell, thickness of tube sheet, thickness of head, pressure drop calculations – tube side and shell side. Detailed drawing of sectional front view of Heat exchanger (1-1,1-2) with tube sheet layout.		
UNIT-III		10 Hrs.
Process design of fermenter		
Functional design- Based on the type of bioreactor (batch reactor& MFR) and cell growth kinetics and performance equation, determines the volume of the reactor, according to H/D ratio determine height and diameter. Mechanical design- Thickness of the shell (cylindrical, spherical), thickness of top & bottom cover, flange calculations – width and thickness of gasket, number of bolts, bolts circle diameter and bolt diameter		
UNIT-IV		10 Hrs.
Process design of plate column distillation column		
Functional design- material balance, energy balance, height of the packed column using McCabe Thiele's method, Mass transfer coefficients, Diameter of columns (Top and bottom), top and bottom free space. Detailed drawing for the above design (showing clearly inlets, outlets liquid distributors, packing support)		
REFERENCE BOOKS*		
1. Joshi, M.V., Process Equipment Design, Macmillan India, 1991. 2. Brownell, L.E. and Young, E.H., Process Equipment Design - Vessel Design, John Wiley and Sons, Inc.1959. 3. Ludwig, E.E., Applied Process Design for Chemical and Petrochemical Plants, Vol. 1 and 2, 3rd Ed., Gulf Publishing Co. 1997. 4. Indian Standards Institution, Code for Unfired Pressure Vessels, IS – 2825. 5. Bhattacharya, B.C, Introduction to Chemical Equipment Design, CBS Publications, 1985.		

6. Perry's Chemical Engineers Handbook. 7th Edition Mc Graw Hill Publications

COURSE OUTCOMES**

- 1 Problems on basic heat transfer through convection
- 2 Problems solving steps and referring the data book
- 3 Design a Double pipe Heat Exchanger as per standard procedure.
- 4 Design a Shell and Tube Heat Exchanger as the procedure
- 5 Design a Reaction Vessel Fermentor as per the Procedure
- 6 Design a Distillation column as per the procedure

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	2	2	2	-	-	-	-	-	-	3	3	3	-
CO2	3	3	2	3	2	-	-	-	-	-	-	3	3	3	-
CO3	3	3	3	2	2	-	-	-	-	-	-	3	3	3	-
CO4	3	3	3	3	2	-	-	-	-	-	-	3	3	3	-
CO5	3	2	3	2	2	-	-	-	-	-	-	3	3	3	-
CO6	3	3	3	2	2	-	-	-	-	-	-	3	3	3	-

UBT625E	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		3	-	-	-	-	3	3	2	3
CO 2	3				2		3	-	-	-	-	3	3	2	3
CO 3	3		2		3		3	-	-	-	-	3	3	2	3
CO 4	3			2			3	-	-	-	-	3	3	2	3

UBT631E	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, NNPREDICT 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		-				3	3	3	
CO 2	3				3	2		2				3	3	3	2
CO 3	3	2			3	-		-				3	3	3	
CO 4	3	2			3	2						3	3	3	

UBT621E	MICROBIAL BT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Microbial biotechnology a) In Bacteria: Genetic Transfer in bacteria, Transformation, Conjugation, Translation, cloning techniques, polymerase chain reaction, expression of cloned Genes, Recovery and purification of expressed proteins. b) In Yeast: Introduction of DNA into yeast cells, yeast cloning vectors, expression of foreign genes in yeast, expression of foreign gene products in secreted form.	
UNIT-II	10 Hrs.
Industrial microbiology Vitamins as laxatives and analgesics; non steroidal contraceptives, external antiseptics, antacids and others. Antibiotics and hormones. Impact of Biotechnology on vaccine development; sub unit vaccines, fragments of antigen sub unit as synthetic peptide vaccines. Production of Microbial enzymes, strain -medium, fermentation processes. Large scale application of Microbial enzymes - starch processing, textile designing, detergents, cheese industry.	
UNIT -III	10 Hrs.
Microbial by products Bacillus thuringiensis, Sphaericus, Popilliae, Baculoviruses. Bacterial Polysaccharides - structure & role in nature xanthan Gum - structure, production & Biosynthesis polyesters. Saccherification & fermentation. Metabolites from microorganisms, Amino acids, antibiotics. Organic synthesis & Degradation, classification of enzymes, microbial transformation of steroids & sterols.	
Environmental microbiology Sewage & Waster water microbiology, Microbiological Degradation of xenobiotics microorganisms in mineral recovery microorganisms in the removal of heavy metals from aqueous effluents.	
Food microbiology Microbial spoilage of food and its control; food preservatives; fermented foods; single cell protein (SCP) and single cell oil (SCO); food borne infections and their control.	
UNIT-IV	10 Hrs.
Bioremediation and bioleaching Uses of Bacteria in Bioremediation – Biodegradation of hydrocarbons, Granular sludge consortia for bioremediation, crude oil degradation by bacteria, Immobilization of microbes for bioremediation, Methanotrophs, PCB dechlorination, Genetic engineering of microbes for bioremediation. Phytoremediation – plants capable of assimilating heavy metals. Studies of Pyrite Dissolution in Pachuca Tanks and Depression of Pyrite Flotation by Bacteria, Factors Effecting Microbial Coal Solubilization, Sulfur Leaching by Thermophilic Microbes of Coal	

Particles Varying in size, Microbiological Production of Ferric Ion for Heap and Dump Leaching, New Bacteriophage which infects Acidophilic, Heterotrophic Bacteria from Acidic Mining Environments, Treatment of Coal Mine Drainage with Constructed Wetlands

REFERENCE BOOKS *

1. Fundamentals of Biotechnology. Edited by Paule Prave, Uwe Faust, Wolfgang Sitting and Dieter A Sukatsch. VCH Publishers.
2. Principles of fermentation Technology, P.F. Stanbury and A. Whitaker, Pergamon Press, 1984.
3. Alexander N Glazer, Hiroshi Nikaido by Microbial Biotechnology, W H Freeman & Company New York, 2005
4. Bernard Davis & Renato Dulbecco Microbiology by, Lippincott Company, Philadelphia. 2000
5. Prit S J Principle of Microbe & Cell Cultivation, Blackwell Scientific co). 1975

COURSE OUTCOMES**

After completion of the course student will be able to

1. Able to study about Genetic Transfer in bacteria cloning techniques.
2. Able to study industrial microbiology.
3. Able to study production & Biosynthesis microbial by products.
4. Able to know Uses of Bacteria in Bioremediation
5. Able to analyse microbial products.
6. Able to understand phytoremediation.

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

UBT623E	PLANT BT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Plant genetic engineering Induction of tumours by Agrobacterium, introduction of binary vectors into Agrobacterium by triparental mating, leaf disc transformation using Agrobacterium, GUS expression in transformed tissues, extraction of DNA from transformed plants, Southern hybridization to check plant transformation, PCR amplification of T-DNA in transformed plant tissues. Agrobacterium mediated gene transfer and cloning. Types of plant vectors and their use in gene manipulation. Viruses as a tool to delivery foreign DNA.	
Transformation technology Plant transformation technology -Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanisms of T-DNA transfer, role of virulence genes, use of Ti and Ri-plasmids as vectors, binary vectors. Vectorless or direct DNA transfer-particle bombardment, electroporation, microinjection, transformation of monoctos. Mechanism of transgene interaction - Transgene stability and gene silencing. Generation and maintenance of transgenic plants.	
UNIT-II	10 Hrs.
Applications Application of plant transformation for productivity and performance – Herbicide resistance - phosphinothricin, glyphosate, atrazine, insect resistance -bt genes, Structure and function of Cry proteins – mechanism of action, critical evaluation of its impact in on insect control. Non-bt like protease inhibitors, alpha amylase inhibitor, virus resistance -coat protein mediated, nucleocapsid gene, disease resistance -chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, RS proteins, abiotic stress – drought and salinity, post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, barstar and barnase systems.	
UNIT -III	10 Hrs.
Secondary metabolites & gene markers Metabolic engineering and industrial products -Plant secondary metabolites. Industrial enzymes, biodegradable plastics, polyhydroxybutyrate, antibodies, edible vaccines. Molecular marker-aided breeding -RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL, map-based cloning, molecular marker assisted selection.	
UNIT-IV	10 Hrs.
Nitrogen fixation Nitrogen fixation and biofertilizers -Diazotrophic microorganisms, nitrogen fixation genes. Two	

CO 3	3	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 4	3	2	3	-	2	-	-	-	-	-	-	1	3	1	1
CO 5	2	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 6	2	2	2	3	2	-	-	-	-	-	-	1	1	1	-

UBT627E	TISSUE ENGINEERING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to tissue engineering, Cell and Tissue Biology Basic definition of tissue engineering;current scope of development; use in therapeutics. Introduction to cell – biology and biochemistry. Tissue development and organization. Stem cells (embryonic), Stem cells (adult). Introduction to cell adhesion, Adhesion Receptors in Tissue Structures, Cell Adhesion to Biomaterials, Measurement of Cell Adhesion, Effect of Biomaterial on Physiological Behavior. Introduction to cell migration, Characteristics of Mammalian Cell Migration, Measurement of cell characteristics morphology, number viability, cell-fate processes, cell motility, cell function.	
UNIT-II	10 Hrs.
Extracellular Matrix Introduction, ECM and Functional Integration of Implanted Materials, Basement Membranes and Focal Adhesions, Focal Adhesions as Signaling Complexes, ECM and Skeletal Tissues, Sources of ECM for Tissue Engineering Applications, Properties of ECM , Mining the ECM for Functional Motifs, Summary of Functions of ECM Molecules, Polymeric Materials and their Surface Modification, Formation of Gradient Structures.	
UNIT -III	10 Hrs.
Biomaterials & Drug Delivery Systems Introduction to synthetic polymers, Biodegradable materials vs permanent materials, Natural biopolymers and hydrogels, Mechanical properties of biomaterials, Surface modification and characterization of polymers, Immune response to biomaterials, In vitro assessment/biocompatibility/protein adsorption. Polymeric scaffolds for tissue engineering applications. Drug delivery, Mechanisms of Drug Delivery, Protein-Drug Properties, Drug Delivery in Tissue Engineering.	
UNIT-IV	10 Hrs.
Tissue Engineering Bioreactors - Design and Fabrication Introduction, Most common Bioreactors in Tissue Engineering, Cell Seeding in Bioreactors, Bioreactor Applications in Functional Tissues, Design Considerations, Challenges in Bioreactor Technologies.	
Clinical & Regulatory Aspects of Engineered Tissues Tissue Engineering of Skin, Bone Tissue Engineering, Cartilage Tissue Engineering, Neuronal, Tissue Engineering, Cardiovascular Tissue Engineering, Musculoskeletal Tissue Engineering, (tendon/ligament/muscle).	
REFERENCE BOOKS *	

1. Channarayappa, Cell Biology, Universities Press, kindle Edition, 2010.
2. Robert Lanza Robert Langer Joseph Vacanti Anthony Atala Principles of Tissue Engineering Academic Press 5th Edition 2020.
3. Patrick CW, Mikos AG, McIntire LV, Frontiers in Tissue Engineering, Pergamon Press, 1st Edition, 1998.
4. Bernhard O Palsson, Sangeeta N Bhatia, Tissue Engineering, Pearson Prentice Hall. 1st Edition 2003.

COURSE OUTCOMES**

After completion of the course student will be able to

1. Identify and differentiate between various stages of tissue development & stem cells.
2. Differentiate between various stages of tissue development & stem cells.
3. Analyze the mechanism and organization of ECM and its functions.
4. Apply the knowledge of drug delivery mechanism in therapeutics.
5. To strengthen the concept of protein drug interactions.
6. Integrate the knowledge of clinical and regulatory aspects on different engineered tissues in medical human tissue products and pharmaceutical sector

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

UBT624E	ANIMAL BT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Cell lines Primary culture – Mechanical and enzymatic mode of desegregation, establishment of primary culture. Subculture -passage number, split ratio, seeding efficiency, criteria for subculture. Cell lines -definite and continuous cell lines, characterization, authentication, maintenance and preservation of cell lines. Contamination -bacterial, viral, fungal and mycoplasma contaminations, detection and control, cell transformation – normal vs. transformed cells, growth	
Cell culture Scale-up of animal cell culture – Factors to be considered. Scale-up of suspension cultures Batch reactor, continuous culture, perfusion systems. Scale-up of monolayer cultures – roller bottles, Nunc cell factory, microcarrier cultures, organotypic culture, matrices, factors affecting culture and perspectives.	
UNIT-II	10 Hrs.
Invitro fertilization & cloning Conventional methods of animal improvement, predominantly selective breeding and cross-breeding. Embryo biotechniques for augmentation of reproductive efficiency and faster multiplication of superior germ plasm. Super ovulation Oestrus synchronization. Embryo collection, evaluation and transfer. Invitro maturation of oocytes. Invitro fertilisation and embryo culture. Embryo preservation. Micro manipulation and cloning. Artificial insemination, preparation of foster mother, surgical and non-surgical methods of embryo transfer, donor and recipient aftercare. Cloning -concept of nuclear transfer, nuclear reprogramming and creation of Dolly. Stem cells -embryonic and adult stem cells, plasticity and concept of regenerative medicine.	
UNIT- III	10 Hrs.
Human genome Human genome complexity of the genome, outlines of human genome project, human disease genes. Molecular biological techniques for rapid diagnosis of genetic diseases. Chemical carcinogenesis, transfection, oncogenes and antioncogenes. Cryo preservation and transport of animal germ plasm (i.e. semen, ovum and embryos). Genetherapy -ex vivo and in vivo gene therapy methods, applications.	
Transgenics Transgenic animals -retroviral, microinjection, and engineered embryonic stem cell method of transgenesis. Application of transgenic animals -biopharming, disease models, functional knockouts.	
UNIT-IV	10 Hrs.
Other applications Application of animal cell culture -Vaccine production, specialized cell types. Concepts of tissue engineering -skin, liver, kidney, bladder and heart. Principles and species suitable for aquaculture (Indian major carps and prawns). Genetic status of culture stocks. Chromosome manipulations - Production of all male and sterile populations, Hypophysation in fishes and prawns. Pearl culture	

-pearl producing mollusks, rearing of oysters, nucleation for pearl formation and harvesting of pearls. Probiotics and their significance in aquaculture. Molecular tools for the identification of diseases in aquatic species.

REFERENCE BOOKS *

1. Ian Fredhney. Culture of Animal Cells, (3rd Edn) R Wiley-Liss Animal Cell Biotechnology, - Spier, RE and Griffith, JB Academic Press, London 1990
2. Animal Biotechnology by Murray Moo-Young (1989), Pergamon Press, 2000
3. Oxford Animal Cell Technology, Principles and practices, 1987, Butter, M Oxford press
4. Molecular Biotechnology by Primrose.
5. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods Ed. JP Mather and D Bames. Academic Press Fish and Fisheries India VG Jhingram
6. Living resources for Biotechnology, Animal cells by A. Doyle, R. Hay and B.E. Kirsop (1990), cambridge University Press, cambridge.
7. Animal Cell Culture – Practical Approach, Ed. John RW. Masters, Oxford Animal
8. Cell Culture Techniques Ed Martin Clynes, Springer Cell Culture Lab Fax. Eds. M
9. Butler & MDawson, Bios Scientific Publications Ltd. Oxford

COURSE OUTCOMES**

After completion of the course student will be able to

1. Study cell lines and cell culture
2. Study Invitro fertilization & cloning.
3. Study human genome and Transgenic animals
4. Know Application of animal cell culture
5. Understand transgenic science
6. Understand and analyse cell culture applications.

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

UBT626E	PERL PROGRAMMING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hrs.
Introduction An overview of Perl: Getting started, interpreted vs compiled source code, documentation in perl, statement blocks, ASCII and Unicode, Escape sequences, whitespaces, numerical data type, strings in perl, alternative delimiters, conversion between numbers and strings, Arithmetical operators, bitwise operators, Boolean operators, string operators, string comparison, operator precedence, variables, modifying a variable, autoincrement and autodecrement operators, multiple assignments, scoping, special variables, regular expression variables, input/ output variables, filehandle / format variables, error variables and system variables variable interpolation .		
Lists, Arrays and Hashes Introduction to lists, simple lists, complex lists, accessing list values, list slices, ranges, combining ranges and slices, arrays, assigning arrays, scalar vs list context, adding elements to an array, accessing single and multiple elements from an array, running through arrays, array functions (pop, push, shift, unshift, and sort, Introduction to Hashes, creating a hash, working with hash values, adding, changing and taking values from a hash, accessing multiple values.		
UNIT–II		10 Hrs.
Loops and Decisions Introduction, Changing Array Size, Interacting Over an Array by Reference, Extracting Unique Elements from a List, Computing Union, Intersection, or Difference of Unique Lists, Appending One Array to Another, Reversing an Array, Processing Multiple Elements of an Array, Finding All Elements in an Array Matching Certain Criteria, Sorting an Array Numerically		
Regular Expression Introduction to regular expressions, patterns, interpolation, escaping special characters, anchors, character classes, word boundaries, posix and Unicode classes, detecting repeating words, well defined repetition, back reference variables, match operator, substitution operator and transliteration operator, binding operators, meta characters, changing delimiters, modifiers, usage of split and join keywords, inline comments and modifiers, grouping and alternation, grouping with back references.		
UNIT- III		10 Hrs.
Files and References Introduction to Filehandles, STDIN, STDOUT, STDERR file handles, reading lines, creating filters, line separator, reading paragraphs, reading entire files, writing to files, writing on a file handle, accessing filehandle, writing binary data, selecting a filehandle, buffering, file		

permissions, opening pipes, piping in, piping out, file tests, reading directories and globbing, introduction to references, lifecycle of a reference, anonymous reference, dereferencing, reference modification, array and hash referencing, reference counting and destruction.

Subroutines and Modules

Introduction to subroutines, difference between subroutines and modules, defining subroutines, order of declaration, subroutines for calculations, return values, caching, context, subroutine prototypes, scope, global variables, lexical variables, runtime scope, aliases, passing references, arrays, hashes and filehandles to a subroutine, modules, usage of keywords do, require and use, changing @INC, package hierarchies, exporters, standard modules in perl.

UNIT-IV

10 Hrs.

Running and Debugging Perl

Examining syntax errors, runaway strings, brackets around conditions, missing semicolons, braces, commas and barewords. Diagnostic modules, use warnings, scope of warnings, use strict, strict on variables, references, subroutines, use diagnostics, perl command line switches, usage of -e, -n, -p, -c, -l, -M, -s, -I, @INC, -a, -F and -T switches, Debugging techniques, usage of print, comments, context, scope and precedence in debugging, Defensive programming.

Bioperl

Overview, Bioperl Objects, Brief descriptions (Seq, PrimarySeq, LocatableSeq, RelSegment, LiveSeq, LargeSeq, RichSeq, SeqWithQuality, SeqI), Location objects, Interface objects and implementation objects, Representing large sequences (LargeSeq), Representing changing sequences (LiveSeq), Using Bioperl: Accessing sequence data from local and remote databases, Accessing remote databases (Bio::DB::GenBank, etc), Indexing and accessing local databases Bio::Index::*, bp_index.pl, bp_fetch.pl, Bio::DB::*), Transforming sequence files (SeqIO), Transforming alignment files (AlignIO);

REFERENCE BOOKS *

1. Harshawardhan P Bal, Perl Programming for Bioinformatics, Tata McGraw Hill, 2003.
2. James Tisdall, Mastering Perl for Bioinformatics, O'Reilly, 1st Edition, 2003.
3. D. Curtis Jamison, Perl Programming for Bioinformatics & Biologists, John Wiley & Sons, INC., 2004
4. Michael Moorhouse, Paul Barry, Bioinformatics Biocomputing and Perl, Wiley, 1st Edition 2007.

COURSE OUTCOMES**

After completion of the course student will be able to

1. Study the over view of perl
2. Study about loops and decisions.
3. Study of regular expression paterns.
4. Study of files and references.
5. Understand the subroutines and modules.
6. Understand the concept of running and debugging perl.

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

UBT628E	TRANSPORT PHENOMENA	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
Momentum Transfer and Overall Balances Fluid Statics, General molecular transport equations for momentum, heat and mass transfer, Viscosity of fluids, Overall balances: mass balance/continuity equation, energy balance, momentum balance, shell momentum balance and velocity distribution in laminar flow, design equation for laminar and turbulent flow in pipes. Momentum transfer – Principles and Applications: Flow past immersed objects, packed beds, Non-Newtonian fluids, Differential equations of continuity, momentum transfer (motion).	
UNIT-II	10 Hrs.
Steady State Heat Transfer Mechanisms of heat transfer, conduction – through solids in series, steady state conduction and shape factors, Forced convection - heat transfer inside pipes, natural convection heat transfer, boiling and condensation, heat exchangers. Unsteady State Heat Transfer: Derivation of basic equation, simplified case for systems with negligible internal resistance.	
UNIT -III	10 Hrs.
Mass Transfer: Mass transfer and diffusion, molecular diffusion in gases, liquids and solids. Mass transfer coefficients. Separation Processes - Evaporation, Drying, Humidification, and Absorption.	
UNIT-IV	10 Hrs.
Separation Processes: Distillation, Adsorption, Ion Exchange, Leaching, Crystallization, Membrane processes.	
REFERENCE BOOKS *	
1. Transport Processes and Separation Process Principles – C. J. Geankoplis, 4th Edition 2. Momentum, Heat and Mass Transfer – Bennett and Myers 3. Welty, Wicks and Wilson Fundamentals of momentum, heat and mass transfer, 2000. 4. Sawhney Gs Fundamentals of Fluid Mechanics IK Publishers ,2008	
COURSE OUTCOMES**	

After completion of the course student will be able to

1. Define the units, dimensions and dimensional analysis
2. Analyze the dimensional analysis methods
3. Define the fluid, property and types of fluid
4. Apply the Hydrostatic and Bernoulli's theorem
5. Apply the applications of Bernoulli's theorem in venture meter, Orifice meter, etc
6. Evaluate the working of size reduction equipments and mixing equipments

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	-	-	-	-	-	3	1	-
CO 2	3	3	3	-	-	-	1	-	-	-	-	-	3	1	-
CO 3	2	3	2	-	-	-	1	-	-	-	-	-	3	1	-
CO 4	3	2	2	-	-	-	1	-	-	-	-	-	3	1	-
CO 5	2	3	3	-	-	-	1	-	-	-	-	-	2	1	-
CO 6	3	2	2	-	-	-	1	-	-	-	-	-	2	1	-

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

UNIT-I		10 Hrs
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 Mahopatra, 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. 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

UBT614L	UPSTREAM PROCESSING LABORATORY	Credits: 1
L: T: P – 0-0-2		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. Artificial seed production (Auxiliary buds) 6. Production of secondary metabolite by shake flask studies; Comparison of yield in various media 7. Fed batch culture – Assessment of yield 8. Development of inocula; lag time effect 9. Study of operational functions of the fermentor 10. Production of Ethanol in fermentor – Study of Growth kinetics, product formation, substrate utilization												
REFERENCE BOOKS*												
1. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.2nd Edition,1995 2. Introduction to plant Biotechnology by H.S. Chawla, , Oxford & IBH Publishers, 3rd Edition,2018. 3. Culture of Animal cells-3rd Edition-R.IanFreshney.Wiley2010. 4. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Butterworth- Heinemann; 3rd Edition,2016												
COURSE OUTCOMES**												
1. Able to prepare/reproduce the protocols for the experiments 2. Able to produce callus using plant tissue culture techniques 3. Able to prepare the industrial media and inoculum for the fermentation process 4. Able to operate lab fermenter and prepare the fermentation process to study growth kinetics, substrate utilization and product formation 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 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	2	-		2	-	1	-	-	-	-	1	3	2	-

CO2	3	3	-	3	-	-	2	-	-	-	-	1	2		-
CO3	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO4	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-
CO5	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO6	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-

UBT615L	BIOKINETICS & ENZYME TECHNOLOGY LABORATORY	Credits: 1
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 (Km & Vmax) 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)		
REFERENCE BOOKS*		
1. Laboratory manual of Biochemistryby Pattabiraman, 4 th Edition, International Book Publishers, India, 2017. 2. Sadasivam and Manickam, Biochemical methods, 2 nd Edition, New age International Publishers, 2017.		
COURSE OUTCOMES**		
7. Ability to aquire knowledge how to isolate enzymesand plot calibration curves. 8. Ability to estimate the enzyme activity and specific activity. 9. Ability to evaluate the optimum pH and temperature required for enzyme activity. 10. Ability to analyze the effect of inhibitors for enzyme activity. 11. Ability to apply knowledge of Km & Vmax for enzyme activity. 12. Ability to immobilize enzymes and fine the activity of enzymes		

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

BASAVESHWAR ENGINEERING COLLEGE (A), BAGALKOTE
DEPARTMENT OF BIOTECHNOLOGY
Scheme and Syllabus
VII-Semester
2022-23

Sl. No	Subject Code	Subject Name	Credits	Hours/Week			Examination Marks		
				L	T	P	CIE	SEE	Total
1	UBT704C	Economics and Plant Design	3	3	0	0	50	50	100
2	UBT715C	Downstream Processing Technology	3	2	2	0	50	50	100
3	UBT72XE	Elective- 4	3	3	0	0	50	50	100
4	UBT73XE	Elective-5	3	3	0	0	50	50	100
5	UBT716H	Industrial Management and Entrepreneurship	3	3	0	0	50	50	100
6	UXX7XXN	Open Elective-3	3	3	0	0	50	50	100
7	UBT711I	Industrial Internship	2	0	0	4	50	50	100
8	UBT710L	Bioseparation Techniques Lab	1	0	0	2	50	50	100
9	UBT701T	Technical Seminar	1	2	0	0	50	50	100
Total			22	19	2	6	450	450	900

Elective- 4

UBT722E: Aquaculture & Marine biotechnology
UBT724E: Food processing technology
 design

UBT723E: Dairy Biotechnology
 UBT725E: Protein Engineering and Drug

Elective- 5

UBT731E: Nanobiotechnology & biomaterials
 UBT733E: Bioconjugative technology

UBT732E: Computational biology
 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*		
- Peters and Timmerhaus (1989) Plant Design and Economics for Chemical Engineers, 4th edn.McGraw Hill. - Rudd and Watson (1987) Strategy of Process Engineering, Wiley. - Poornima M C (2006) Entrepreneurship Development and Small Business Enterprises”, Pearson education. - Vasanth Desai (2007) Dynamics of Entrepreneurial Development & Management”,H imalaya Publishing House. - Khanka SS (2004) Entrepreneurship Development, S Chand & Co. - 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	1	2	3
CO 1	2	2	1	1			1	1	1		2		2		
CO 2	2	1	2	1			1	1	1		3		2		
CO 3	1	2	1	2			1	1	1		2		1		
CO 4	2	1	2	2			1	1	1		3		2		
CO 5	1	1	2	1			1	1	1		2		1		
CO 6	2	2	2	1			1	1	1		2		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.
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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.
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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.
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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.
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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			2			3	2	2				1	2	1	1
CO 2			2			3	2	3				1	2	1	1
CO 3			1			3	2	2				1	2	1	1
CO 4			2			3	2	2				1	2	1	1
CO 5			1			3	3	3				1	2	1	1
CO 6			1			3	2	2				2	2	1	1

UBT724E	FOOD PROCESSING TECHNOLOGY	Credits: 3
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 04		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, Kumiss 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 Roady, Oxford University Press, 2007.
2. Food microbiology by William Frazier and Westhoff D.C, 4thEdn, TATA McGraw Hill Pub(2005)
3. Modern Food Micro-Biology by James M. Jay, CBS Publishers. 2005.
4. Food Microbiology by K. Vijay Ramesh MJP 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, 5thEdn, CBS Pub, 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			2			3	2	2				1	2	1	
CO 2			2			3	2	3				1	2	1	
CO 3			1			3	2	2				1	2	1	
CO 4			2			3	2	2				1	2	1	
CO 5			1			3	3	3				1	2	1	
CO 6			1			3	2	2				2	2	1	

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

1. Recall and recollect the history theories and definition of management and its importance in society
2. Analyze and apply the basic concepts of Quantitative techniques of management
3. Know the difference between production and productivity, measurement and cost analysis
4. Explore the knowledge of production costs, planning and material management
5. Make basic economic analysis of project
6. 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
CO1	-	-	-	-	-	-	1	-	-	-	3	1	-	-	2
CO2	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO3	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO4	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO5	-	1	-	-	-	-	-	-	-	-	3	1	-	-	2
CO6	-	1	-	-	-	-	-	-	2	-	3	1	-	-	2

UBT722E	AQUACULTURE & MARINE BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
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Aquatic environment

Major physical and chemical factors (light, temperature, gases, nutrients). Aquatic biota: phytoplankton, zooplankton, benthos, periphyton, macrophytes, fish and other animals. Production & Nutrient dynamics in lakes, rivers, estuaries and wetlands. Eutrophication and water pollution: monitoring and control conservation and management of lakes, rivers and wetlands. Importance of coastal aquaculture- Design and construction of aqua farms, Criteria for selecting cultivable species. Culture systems – extensive, semi intensive and intensive culture practices

Aqua culture

Classification and Characteristics of Arthropoda. Crustacean characteristic key to important species of Prawns and Shrimps, General biology, of – Shrimp and Prawn, Finfish, Marine and freshwater fish. Preparation, culture and utilization of live food organisms, phytoplankton, zooplankton cultures, quality evaluation of Cyst, hatching and utilization, culture and cyst production.

UNIT-II	10 Hrs.
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Aquaculture engineering and techniques

Principles and criteria for site selection; multi-design, layout plan for prawn, shrimp and fish hatchery; design, lay-out plan and pond construction for grow- out production, design and construction of feed mill and installation of machineries. Chromosome manipulation in aquaculture - hybridization, ploidy induction, gynogenesis, androgenesis and sex reversal in commercially important fishes. Application of microbial biotechnology in culture ponds, bioaugmentation, bioremediation, nutrient cycling, and biofertilization. Probiotics – immunostimulants. Tools for disease diagnosis in cultivable organisms Enzyme immuno assays - Dot immunobinding assay - Western blotting - Latex agglutination test - Monoclonal antibodies - DNA based diagnosis. Cryopreservation techniques.

UNIT-III	10 Hrs.
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Marine environment

Biological Oceanography: The division of the marine environment – benthic, pelagic, bathyal, littoral. Ocean waters as biological environment. Distribution and population of plants and animals. Marine ecology and fisheries potential. Effects of pollution on marine life. Geological and geophysical Oceanography: geophysical and geological processes. Ocean basin rocks and sediments.

Marine microbiology

Biology of micro-organisms used in genetic engineering (*Escherichia coli*, *Rhizobium sp.*, *Agrobacterium tumefaciens*, *Saccharomyces cerevisiae*, *phage lambda*, *Nostoc*, *Spirulina*, *Aspergillus*, *Penicillium* and *Streptomyces*). Methods of studying the marine micro-organisms collection, enumeration, isolation, culture & identification based on morphological, physiological and biochemical characteristics. Preservation of marine microbes, culture

collection centre (ATCC, IMTECH, etc.). Microbial nutrition and nitrogen fixation. Seafood microbiology - fish & human pathogens. Indicator of Pollution - faecal coliforms - Prevention & control.

UNIT-IV

10 Hrs.

Marine biotechnology and pharmacology

Physical, Chemical and Biological aspects of marine life. Air – Sea interaction – Green house gases (CO₂ and Methane). Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial). Biological indicators and accumulators: Protein as biomarkers, Biosensors and biochips. Biodegradation and Bioremediation. Separation, purification and bioremoval of pollutants. Biofouling - Biofilm formation, Antifouling and Anti boring treatments. Corrosion Process and control of marine structures. Biosafety – special characteristics of marine environment that bear on biosafety. Ethical and moral issues - food health, and environmental safety concerns. Medicinal compounds from marine flora and fauna - marine toxins –antiviral, antimicrobial. Extraction of crude drugs, screening, isolation, purification and structural characterization of bioactive compounds.

REFERENCE BOOKS *

1. Kirchman, D.L., Microbial ecology of the oceans. Wiley – liss, New York, 542 pp, 2005
2. Kenneth, C. Hingham and Leonard Hill, 1969. The comparative endocrinology of the invertebrates. Edward Arnold Ltd.
3. Farming the edge of the sea. Fishing News Ltd. London.
4. Finger man, M. Recent advances in Marine Biotechnology. Vol. 4, 2000
5. Kenneth, B.D., 2000. Environmental impacts of Aquaculture. CRC. pp. 214, 2000

COURSE OUTCOMES**

1. Ability to understand the importance of coastal aquaculture.
2. Ability to know the different Culture systems.
3. To analyse the cryopreservation techniques.
4. To understand the Seafood microbiology.
5. To understand the applications of marine biology.
6. Ability to extract crude drugs and find the bioactive compounds.

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	-
CO5	-	-	1	2	2	-	3	3	-	-	-	1	2	1	1
CO6	1	-	1	-	-	2	2	2	-	-	-	2	2	1	-

UBT723E	DAIRY BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Dairy Industry and Microbiology Overview of dairy industry, Characteristics of dairy Industry. Manufacturing & processing of dairy products, effect of processing on constituents and methods of evaluation of dairy products. Morphological and biochemical characteristics of important groups of milk microbes and their classification i.e. psychrotrophs, mesophiles, thermotolerants, and thermophiles. Impact of various stages like milking, chilling, storage and transportation on microbial quality of milk, Direct and indirect rapid technique for assessment of microbial quality of milk. Food infection, intoxication and toxic infection caused by milk borne pathogens. Microbiological changes in bulk refrigerated raw milk; Mastitis milk: organisms causing mastitis, detection of somatic cell count (SCC). Role of microorganisms in spoilage of milk Significance of antimicrobial substances naturally present in milk (responsible for its nutraceutical properties): immunoglobulin, lactoferrin, Lysozymes	
UNIT-II	10 Hrs.
Dairy biotechnology Genetic engineering of bacteria and animals intended for dairy-based products: DNA cloning, protoplast fusion & cell culture methods for trait improvement with instances cited. Enzymes in dairy industry & production by whole cell immobilization. Biotechnology of dairy effluent treatment. Ethical issues relating to genetic modification of dairy microbes & milk-yielding animals.	
Dairy engineering Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, Description, working and maintenance of can washers, bottle washers. CIP cleaning and designing of system. Homogenization, Pasteurization, sterilization septic packaging and equipment. Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine maintenance.	
UNIT-III	10 Hrs.
Dairy process engineering Evaporation: Basic principles of evaporators, Different types of evaporators used in dairy industry, Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture. Fluidization Mechanization and equipment used in manufacture of indigenous dairy products, Butter and Ghee making machine, Ice-cream and Cheese making equipments. Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis in dairy processing, membrane construction & maintenance for electro-dialysis & ultra-filtration, Ultra filtration of milk, Effect of milk constituents on operation.	
Dairy plant design and layout Introduction of Dairy Plant design and layout. Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, selection of site for location. Dairy building planning, Process schedule, basis of dairy layout, General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design.	
UNIT-IV	10 Hrs.

Quality and safety monitoring in dairy industry

Current awareness on quality and safety of dairy foods; consumer awareness and their demands for safe foods; role of codex alimentations commission (CAC) in harmonization of international standards; quality (ISO 9001:2000) and food safety (HACCP) system National and international food regulatory standards; their role in the formulation of standards for controlling the quality and safety of dairy foods. Good Hygiene Practices (GHP): Rapid assessment of dairy food for microbial and non-microbial contaminants Quality of water and Quality of air & personnel hygiene.

By products technology

Status, availability and utilization of dairy by-products in India and abroad, associated economic and pollution problems. Physico-chemical characteristics of whey, butter milk and ghee residue, by-products from skim milk such as Casein; Whey processing & utilization of products generated from whey.

REFERENCE BOOKS *

1. Dairy Science & Technology Handbook (Vols. 1-3). Ed by Hui, Y.H, Wiley Publishers, 2007
2. Handbook of Farm, Dairy & Food Machinery - Myer Kutz- Andrew Publishers, 2005
3. Dairy Microbiology Handbook (3rd Ed). Robinson, R.K., Wiley Publishers, 2001
4. Comprehensive Biotechnology (Vol. 6) Ed N.C Gautam- Shree Pblns, 2002.
5. General Microbiology (Vol. 2) – Powar & Dagainawala- Himalaya Publishers, 2005
6. Milk composition, production & biotechnology (Biotechnology in Agriculture Series). CABI Publishers, 2005

COURSE OUTCOMES**

1. Able to manufacture & processing of dairy products.
2. Ability to know the ethical issues in dairy.
3. Ability to understand principles of evaporators.
4. Ability to plan the Plant design and layout.
5. Will be aware of quality and safety of dairy foods.
6. Ability to know the regulatory standards.

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	-
CO5	-	-	1	2	2	-	3	3	-	-	-	1	2	1	1
CO6	1	-	1	-	-	2	2	2	-	-	-	2	2	1	-

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 *

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	-

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	2	3	3	-	-	1	2	-	-	-	-	-	2	2	1
CO2	1	2	3	-	-	1	-	-	-	-	-	-	3	-	-
CO3	2	2	3	-	-	2	-	-	-	-	-	-	2	2	1
CO4	3	3	3	-	-	2	-	-	-	-	-	-	2	1	1
CO5	3	3	3	-	-	1	-	-	-	-	-	1	2	-	-
CO6	2	3	3	-		3	3	-	-	-		-	3	1	-

UBT732E	COMPUTATIONAL BIOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I		10 Hours
Introduction to computational biology and sequence analysis Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.		
UNIT-II		10 Hrs.
Phylogenetics Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonious trees, Additive trees, Bootstrapping.		
Protein structure, modelling and simulations Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.		
UNIT-III		10 Hrs.
Machine learning, systems biology and other advanced topics Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modeling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA computing.		
UNIT-IV		10 Hrs.
Perl for bioinformatics Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation		
Laboratory Demonstrations for Biological Databases, Sequence alignment: BLAST family of programs, FASTA, Clustal W for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, Auto Dock, GROMACS, Prokaryotic and Eukaryotic Gene finding software, Programs in PERL.		
REFERENCE BOOKS *		
1. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004. 2. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008. 3. Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003		

4. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002
5. Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis: Probabilistic
6. Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.

COURSE OUTCOMES**

1. Ability to know the sequence analysis.
2. Ability to understand and analyze the multiple sequence alignment and applications.
3. Ability to understand the phylogenetics.
4. Ability to analyze the molecular dynamics simulations.
5. Ability to understand perl bioinformatics.
6. Ability to differentiate prokaryote and eukaryote gene finding software.

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	2	1	-
CO2	1	-	2	-	-	2	2	-	-	-	-	1	2	1	-
CO3	-	-	1	1	2	-	-	-	-	-	-	1	1	1	-
CO4	2	-	2	-	-	1	2	-	-	-	-	1	-	1	-
CO5	-	-	1	2	2	-	-	-	-	-	-	1		1	-
CO6	1	-	1	-	-	2	2	-	-	-	-	2	2	1	-

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

UNIT-I	10 Hours
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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.
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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.
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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.
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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 *		

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

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**

1. Apply the basic knowledge of Industrial hazards and safety.
2. Interpret & analyze the various types of accidents and chemical hazards.
3. Identify physical hazards and apply control measures in work place.
4. Acquire knowledge of electrical hazards and apply control measures in work place.
5. Identify various types of biological hazards and apply control measures.
6. Identify control measures and apply the knowledge in industrial toxicology and hygiene, occupational diseases in 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	1	1	1	1	1	-	-	-	-	-	3	2	1
CO2	-	1	1	3	1	1	1	-	-	-	-	-	3	2	1
CO3	-	1	3	3	3	2	1	-	-	-	-	-	3	2	1
CO4	-	1	3	2	3	2	1	-	-	-	-	-	3	2	1
CO5	-	1	3	3	3	2	1	-	-	-	-	-	3	2	3
CO6	-	1	3	3	3	3	1	-	-	-	-	-	3	2	3

UBT710L	BIOSEPARATION TECHNIQUES LAB	3 Credits: (3: 0: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		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 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		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

SCHEME & SYLLABUS

VIII-SEMESTER

2022-23

SI. No	Subject Code	Subject Name	Credits	Hours			Examination Marks		
				L	T	P	CIE	SEE	Total
1	UBT82XE	Elective -6	3	3	0	0	50	50	100
2	UBT83XE	Elective -7	2	2	0	0	50	50	100
3	UBT805P	Project	15	0	0	30	50	50	100
Total			20	5	0	30	150	150	300

Elective-6

UBT823E: Chemical plant utilities & safety

UBT824E: Metabolic engineering

UBT825E: Industrial waste water treatment

UBT827E: Pharmaceutical BT

Elective-7

UBT830E: Clinical research

UBT832E: Health diagnostics

UBT833E: Validation & quality control

UBT834E: Product development

UBT835E: Validation & quality assurance

UBT827E	PHARMACEUTICAL BIOTECHNOLOGY	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 *

7. Gary Walsh, (2013), Biopharmaceuticals Biochemistry and Biotechnology (2nd Edition), Wiley Publishers.
8. Bartram Katzung, (2009), Basic & Clinical Pharmacology (9th Edition), McGrawHill.
9. Leon Lachman, Herbert. Lieberman & Joseph Kanig, Vergese, (1987) The Theory & Practice of Industrial Pharmacy, (3rd Edition) Publishing House Bombay.

COURSE OUTCOMES**

After completion of the course student will be able to

7. Apply and classify various biological sources of pharmaceutical products to retrieve the basic concept of pharmacology, drug metabolism and their importance in biotechnology
8. Select and apply the toxicological studies of pharmaceutical products
9. Use knowledge of the techniques used in the manufacture of pharmaceutical products and apply in the field of Biopharmaceuticals.
10. Ability to discuss the concepts used in production of stem cells and analyse the applications and ethical issues of stem cells in the society.
11. Select and apply appropriate techniques advanced techniques in drug delivery system.
12. 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	-	2	2	2	3	3	1	-	-	-	-	-	3	2	1
CO2	-	3	3	3	3	2	3	-	-	-	-	-	2	2	1
CO3	-	2	3	2	3	1	-	-	-	-	-	-	3	2	-
CO4	-	2	3	2	3	1	-	-	-	-	-	-	2	2	-
CO5	-	3	3	2	3	1	-	-	-	-	-	-	2	3	-
CO6	-	3	3	3	3	2	2	-	-	-	-	-	2	2	3

UBT833E	VALIDATION & QUALITY CONTROL	Credits: 3
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.
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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.
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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.
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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.
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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: 3
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 03		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	2				2	2								1	3
CO 2	2	3	1	2	3	3							2	2	3
CO 3	3	2			3	3						3	2	3	2
CO 4	2	2	1		3	3	1					3	2	3	3
CO 5	2	1			2	2	3					2	2	2	3
CO 6	2		1	2	2	2	1					2	2	3	2

UBT823E	CHEMICAL PLANT UTILITIES AND SAFETY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Introduction Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities. Water: Water resources. Process water, Cooling water, drinking water and boiler feed water Quality Standards. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Types and selection of pumps, piping and accessories. Water pre treatment, Air Compressed air, blower air, fan air. Types of compressor and vacuum pumps and selection. Power requirements, performance and related calculations. Booster and receivers. Quality of compressed air for instruments and processes. Compressed air distribution system-piping and accessories. Air-water vapour system: humidification/ dehumidification and evaporative cooling-related calculations.	
UNIT-II	10 Hrs.
Steam and power Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Calorific value. Proximate and ultimate analysis. HHV, LHV and related calculations. Cogeneration power plants. CHPs and Boiler performance. Related Calculations. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories. Refrigeration: Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect-related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants.	
UNIT-III	10 Hrs.
Insulation Insulation Materials & Selection-Economics of insulation. Insulating factors. Properties & Classification. Cold insulation and cryogenic insulation. Introduction To Process Safety: Intrinsic & Extrinsic Safety. The Hazards-Toxicity, Flammability, Fire , Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS.	

UNIT-IV	10 Hrs.
Safety devices Pressure relief valves. Ruptures discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices.	
Process safety analysis HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis.	
REFERENCE BOOKS *	
1. Thermal Engineering, B.K. Sarkar, Tata Mc Graw Hill, 8 th Reprint, 1998. 2. Heat Engines, K.P. Roy, Media Promoters and Publishers, 1995. 3. Chemical Engineers Handbook, Perry, 8 th Edition, 2007. 4. Chemical Engineering-Vol 6, R.K. Sinnott, Coulson and Richardson's, 3 rd Edition, BH, Reprint, 2000.	
COURSE OUTCOMES**	
1. Ability to Storage and handling of water 2. Able to understand types of compressor 3. Able to analyze the economy of steam generation with different fuels 4. Able to study Hazard and risk assessment methods. 5. Ability to understand safety devices 6. Ability to compare HAZAN and HAZOP operations	

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	-		2	-	-	-	-	-	-	1	1	1
CO2	2	2	2	-	2	3	-	-	-	-	-	-	2	1	2
CO3	3	3	2	-	2	2	-	-	-	-	-	1	1	1	2
CO4	3	3	3	-	2	3	-	-	-	-	-	1	2	1	3
CO5	2	1	-	2	-	2	-	2	-	-	-	-	1	3	1
CO6	1	2	3	2	-	3	-	1	-	-	-	-	1	3	1

UBT824E	METABOLIC ENGINEERING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Introduction Basic Concept of metabolic engineering overview of metabolism. Different models for cellular reactions, Mutation, mutagens mutation in metabolic studies.	
Metabolic regulation An overview of Cellular Metabolism, Transport Processes, Passive Transport, Facilitated Diffusion, Active Transport, Fueling Reactions, Glycolysis, Fermentative Pathways, TCA Cycle and Oxidative Phosphorylation, Anaplerotic Pathways, Metabolism of Fats, Organic Acids, and Amino Acids, Biosynthetic Reaction, Biosynthesis of Amino Acids, Biosynthesis of Nucleic Acids, Fatty Acids, and Other Building Blocks, Polymerization, Growth Energetics	
UNIT-II	10 Hrs.
Metabolic flux Metabolic flux analysis and its application, Methods for experimental determination of metabolic flux by isotope dilution method.	
Applications of metabolic flux analysis Amino Acid Production by Glutamic Acid Bacteria, Biochemistry and Regulation of Glutamic Acid Bacteria, Calculation of Theoretical Yields, Metabolic Flux Analysis of Lysine Biosynthetic Network in C. glutamicum, Metabolic Flux Analysis of Specific Deletion Mutants of C. Glutamicum, Metabolic Fluxes in Mammalian Cell Cultures, Determination of Intracellular Fluxes., Computational Networks and Systems Biology	
UNIT-III	10 Hrs.
Regulation of metabolic pathways Regulation of Enzymatic Activity, Overview of Enzyme Kinetics, Simple Reversible Inhibition Systems, Irreversible Inhibition, Allosteric Enzymes: Cooperativity, Regulation of Enzyme Concentration, Control of Transcription Initiation, Control of Translation, Global Control: Regulation at the Whole Cell Level, Regulation of Metabolic Networks, Branch Point Classification, Coupled Reactions and the Role of Global Currency Metabolites.	
UNIT-IV	10 Hrs.
Metabolic engineering in practice Enhancement of Product Yield and Productivity, Ethanol, Amino Acids, Solvents, Extension of Substrate Range, Metabolic Engineering of Pentose Metabolism for Ethanol Production, Cellulose-Hemicellulose Depolymerization, Lactose and Whey Utilization, Sucrose Utilization, Starch Degrading Microorganisms, Extension of Product Spectrum and Novel Products, Antibiotics, Polyketides, Vitamins, Biopolymers, Biological Pigments, Hydrogen, Pentoses: Xylitol, Improvement of Cellular Properties, Alteration of Nitrogen Metabolism, Enhanced Oxygen Utilization, Prevention of Overflow Metabolism, Alteration of Substrate Uptake, Maintenance of Genetic Stability, Xenobiotic Degradation, Polychlorinated Biphenyls (PCBs), Benzene, Toluene, P-Xylene Mixtures (BTX).	

REFERENCE BOOKS *

1. P.F. Stanbury and A. Whitkar. 2008, Principle of Fermentation Technology pergaman press,
2. Wang D I C Cooney C I Demain, A L ,2008, “Fermentation and enzyme Technology” John Willey,
3. Roberts, 2007 “Metabolism of Agrochemicals in Plants” Willey Int.,
4. David L. Nelson and Michael Cox, 2016, “Lehninger Principles of Biochemistry” –6th Edition
5. Lubert Stryer, 2010 “Biochemistry” -Freeman & Co., Pub.

COURSE OUTCOMES**

1. Recall the concepts of cellular metabolism.
2. Explain the Basic concepts of metabolic engineering.
3. Explain Fundamentals of Metabolic flux analysis.
4. Apply the knowledge of metabolic flux analysis.
5. Apply the knowledge of regulatory mechanism for altering the metabolic pathways.
6. Design the metabolic pathways for desired product.

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			2							1	1	1
CO2	2	2	2		2	3							2	1	2
CO3	3	3	2		2	2						1	1	1	2
CO4	3	3	3		2	3						1	2	1	3
CO5	2	1		2		2		2					1	3	1
CO6	1	2	3	2		3		1					1	3	1

UBT825E	INDUSTRIAL WASTE WATER TREATMENT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours
Water and waste water engineering an overview Water quality, physical chemical and biological parameters of water, water quality standards, water quality indices. Waste water: terminology, impact of regulation on waste water engineering, health and environmental concern in waste water management, waste water characteristics and treatment methods, current status and future trends, waste water reclamation and reuse, biosolids and residual management. Constituents of waste water, physical chemical and biological parameters of waste water, sampling methods, waste water effluent standards, sewage disposal methods.	
UNIT-II	10 Hrs.
Primary and secondary treatment of waste water Screens, oil traps, grit chambers, coagulation, clariflocculation, oxidation ponds and lagoons, Attached growth biological treatment : Activated sludge process and its modifications, trickling filter, biological nitrification and denitrification, anaerobic process, sludge disposal. Advanced waste water treatment Removal of dissolved organic, inorganic constituents and biological constituents, Filtration: modeling and backwashing for slow sand and rapid sand filters, adsorption principle and isotherms, gas stripping, ion exchange, advanced oxidation process. Membrane filtration RO, UF, MF, NF, electrodialysis. Disinfection: chlorine dioxide, chloramines, ozonation, UV radiation.	
UNIT-III	10 Hrs.
Waste water reclamation and reuse Waste water reuse application, need for water reuse, public health and environmental issues in water reuse, introduction to risk assessment for water reuse, different reuse options: Agriculture and landscape irrigation, industrial reuse, ground water recharge, non-potable uses with case studies.	
UNIT-IV	10 Hrs.
Issues related to treatment plant performance Need for upgrading treatment plant performance, treatment process reliability and selection of design values, odour management, introduction to automatic process control, energy efficiency, upgrading waste water treatment plant performance by process optimization, important design consideration for new waste water treatment plants: Liquid stream, solid processing, odour control.	

REFERENCE BOOKS *

1. John C. Geyer and Daniel A Okun, Jhon Hutey, 1996. Water and Waste water engineering- Vol 2, Gordon M Fair.
2. Mark J. Hammer Jr. ,1997 ,Water and waste water Technology,, 4th Edition, Prentice Hall.

COURSE OUTCOMES**

1. Define water quality and explain methods to characterize water quality.
2. Describe water quality standards and their impact.
3. Explain primary and secondary treatment methods of waste water.
4. Apply membrane filtration techniques, and disinfection methods to purify waste water.
5. Analyze the importance of reclamation and reuse of waste water.
6. Identify various issues related to the performance of treatment plants and problems

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	-
CO5	-	-	1	2	2	-	3	3	-	-	-	1	2	1	1
CO6	1	-	1	-	-	2	2	2	-	-	-	2	2	1	-

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.
Immunodiagnosics 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. Bailey & 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
CO1	2	2	2	-		2	-	-	-	-	-	-	1	1	1
CO2	2	2	2	-	2	3	-	-	-	-	-	-	2	1	2
CO3	3	3	2	-	2	2	-	-	-	-	-	1	1	1	2
CO4	3	3	3	-	2	3	-	-	-	-	-	1	2	1	3
CO5	1	3	3	-	-	-	-	-	-	-	-	1	2	3	
CO6	1	3	3	-	1	-	2	-	-	-	-	3	3	3	3

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

UNIT-I	12 Hours
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	10 Hrs.
Interpersonal Skills Understand analyze and apply the techniques and essentials of product development and understand the various guidelines along with techniques in Pharma industries. 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). 2. Biosimilar Drug Product Development. Boca Raton: CRC Press. 3. Biochemistry and Biotechnology by Gary Walsh. (2002): John Wiley & Sons Ltd. 4. 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.,	

5. Jain, N. (2011). Pharmaceutical product development. New Delhi: CBS Publishers.

COURSE OUTCOMES**

1. Understand, analyze and apply the techniques and essentials of product development and understand the various guidelines along with techniques in pharma industry
2. Demonstrate the different inter personnel skills and project management skills
3. Ability to comprehend various techniques involved in reporting, decision making process and understand adverse effects of drugs.
4. Describe the formulation of various energy drinks and demonstrate the role of Upstream and Downstream marketing.
5. Analyze and list the various health hazards in industry.
6. Ability to understand importance of safety and implement in various 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	3	2	2	2	3	1	-	-	-	-	1	1	2	3
CO2	1	-	-	2	1	2	1	-	-	-	-	1	1	1	1
CO3	1	3	2	1	2	1	1	-	-	-	-	1	1	2	1
CO4	1	-	3	2	1	2	2	-	-	-	-	1	1	1	2
CO5	1	2	2	1	2	3	3	-	-	-	-	1	1	2	1
CO6	1	2	2	2	1	2	3	-	-	-	-	1	1	1	-