15BT101	Biology for Engineers	L	T	P	C
		2	0	0	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	B BASIC SCIENCES	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	The purpose of this course is to provide a basic understanding of biological mechanisms of living organisms from the perspective of engineers. In addition, the course is expected to encourage engineering students to think about solving biological problems with engineering tools.			
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**		
At the end of the course, student will be able to				
1.	appreciate the basic organization of organisms and living being.	a		
2.	understand the machinery of the cell that is ultimately responsible for various daily activities.	a	b	
3.	acquire knowledge about biological problems that requires engineering expertise to solve them.			j

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I-BASIC CELL BIOLOGY	**06**			
1.	Introduction to Biology	1	C	1	1
2.	The cell: the basic unit of life	1	C	1	1,3
3.	Expression of genetic information - protein structure and function	1	C	1	1,2
4.	Cell metabolism; Cells respond to their external environments	1	C	1	1,2,3
5.	Cells grow and reproduce	1	C	1	1,3
6.	Cellular differentiation	1	C	1	1,3
	UNIT II- BIOCHEMISTRY AND MOLECULAR ASPECTS OF LIFE	**05**			
7.	Biodiversity - Chemical bonds in Biochemistry; Biochemistry and Human biology	1	C	1,2	1,2
8.	Protein synthesis –DNA; RNA	1	C	2	1,2,3
9.	Transcription and translation factors play key roles in protein synthesis	1	C	2	1,2,3
10.	Differences between eukaryotic and prokaryotic protein Synthesis	1	C	2	1,2
11.	Stem cells and their applications	1	C	1,2	1,3
	UNIT III-ENZYMES AND INDUSTRIAL APPLICATIONS	**05**			
12.	Enzymes – significance, factors	1	C	2	1,2
13.	Mechanism and effective catalysis – proteases, carbonic anhydrase	1	C	2	1,2
14.	Restriction Enzymes; Nucleoside Monophosphate Kinases	1	C	2	1,2,3
15.	Photosynthesis and carbon fixation; Biological energy production	1	C	2	1,2
16.	Metabolism-anabolism and catabolism	1	C	2	1,2
	UNIT IV-MECHANOCHEMISTRY	**07**			
17.	Protein motors convert chemical energy into mechanical work	2	C	2,3	1,2
18.	ATP synthase structure	1	C	2,3	1,3
19.	The bacterial flagellar motor	1	C	2,3	1,3
20.	Cytoskeleton	1	C	2,3	1,2
21.	Biosensors - types, applications	1	C	2,3	1,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
22.	Bioremediation	1	C	2,3	1,5
	UNIT V-NERVOUS SYSTEM, IMMUNE SYSTEM AND CELL SIGNALING	**07**			
23.	Basics of nervous system and "neural networks"	2	C	3	1,6,7
24.	The cellular basis of immunity	1	C	3	1,6,7
25.	The functional properties and structure of antibodies	2	C	3	1,6
26.	T cell receptors and subclasses	1	C	3	1,6
27.	General principles of cell signaling	1	C	1,3	1,6,7
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	ThyagaRajan.S., Selvamurugan. N., Rajesh.M.P., Nazeer.R.A., Richard W. Thilagaraj, Barathi.S., and Jaganthan.M.K., *"Biology for Engineers"*, Tata McGraw-Hill, New Delhi, 2012.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, *"Biochemistry"*, W.H. Freeman and Co. Ltd., 6th Ed., 2006.
3.	Robert Weaver, *"Molecular Biology"*, MCGraw-Hill, 5th Edition, 2012.
4.	Jon Cooper, "*Biosensors A Practical Approach"*, Bellwether Books, 2004.
5.	Martin Alexander, "*Biodegradation and Bioremediation"*, Academic Press, 1994.
6.	Kenneth Murphy, "*Janeway's Immunobiology"*, Garland Science; 8th edition, 2011.
7.	Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, *"Principles of Neural Science"*, McGraw-Hill, 5th Edition, 2012.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT102	**Human Physiology and Health**			**L**	**T**	**P**	**C**
				2	**0**	**0**	**2**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To provide a basic understanding of human physiological systems for a better comprehension of the problems faced by human.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Correlate cellular organization and subsequent development to organ systems.	a	f					
2.	Conceive the physiological integration of organ systems to maintain homeostasis.	a	f					
3.	Understand the function and regulation of human system.	a	f					
4.	Familiarize with cellular and molecular mechanisms of action in health and disease.	a	f					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: PHYSIOLOGY OF CELLS AND MOLECULES	**6**			
1.	Cell: Death, Adaptation, Degeneration and aging. Cell junctions – Gap, Tight and contact.	1	C	1-4	1
2.	Active, Passive and special type of Transport of molecules across biological membranes.	1	C, D	1-4	1
3.	Homeostasis – Chemical equilibrium, tonicity and osmolality, role of ions, action potential, Positive and Negative feedback regulation of Homeostasis.	2	C	1-4	1
4.	Acid-Base Balance: Hydrogen Ion and pH, Regulation – volatile and non-volatile acids, compensatory mechanism, Regulation by buffer systems, Acidosis and Alkalosis.	1	C	1-4	1
5.	Cell signaling and Signal transduction – Primary and secondary messengers. Types of Receptors involved in Transduction.	1	C	1-4	1
	UNIT II: CELLULAR PHYSIOLOGY OF NERVOUS SYSTEM	**7**			
6.	Classification of Nervous Sytem, Neuron structure, Nerve fibres classification and properties.	2	C	1-4	1
7.	Receptors – Exteroceptors and Interoceptors. Synapse – Classification, Anatomy, Functions (IPSP and EPSP) and properties, Neurotransmitters.	2	C	1-4	1
8.	Spinal cord – Grey and White matter, Ascending and Descending tracts of spinal cord.	1	C	1-4	1
9.	Limbic system: Introduction, Components – Archicortical, Paleocortical, Juxtallocortical, Subcortical structures, Connections and Functions.	1	C	1-4	1
10.	Autonomic Nervous System – Effects on various organ systems.	1	C	1-4	1
	UNIT III: CARDIOVASCULAR AND RESPIRATORY SYSTEMS	**6**			
11.	Heart: Chambers, actions – chronotropic, ionotropic, dromotropic and bathmotropic, blood vessels – thromboembolism, atherosclerosis and arteriosclerosis. Septal and valvular defects. Circulation – Systemic and Pulmonary.	1	C	1-4	1
12.	Properties of cardiac muscle: Excitability – electrical potential and action potential, Rhythmicity – Natural and artificial pacemakers, Conductivity, Contractility and Refractory period.	1	C	1-4	1
13.	Cardiac cycle and heart sounds	1	C	1-4	1
14.	Respiratory system: Introduction, Types – external and internal, Phases – Inspiration and expiration, Anatomy, functional unit, Non-respiratory functions of respiratory tract	1	C	1-4	1
15.	Mechanics of respiration, Pulmonary function tests: Lung volume – Tidal, Inspiratory, Expiratory, Residual volumes; Lung capacities – Inspiratory, vital, Functional residual, Total lung capacities.	1	C	1-4	1
16.	Exchange and transport of respiratory gases	1	C	1-4	1
	UNIT IV: GASTROINTESTINAL AND RENAL SYSTEMS	**6**			
17.	Mouth and Salivary glands	1	C	1-4	1
18.	Stomach: Parts, Structure, Glands, Functions, Properties, composition and functions of gastric juice, applied physiology.	1	C	1-4	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
19.	Pancreas, Liver, Gall bladder, small intestine, large intestine and movements of gastrointestinal tracts, Gastrointestinal hormones.	1	C	1-4	1
20.	Kidney, Nephron, Juxtaglomerular apparatus and urine formation	2	C	1-4	1
21.	Acid-Base balance, dialysis and artificial kidney, diuretics.	1	C	1-4	1
	UNIT V: ENDOCRINE SYSTEM	**5**			
22.	Pituitary gland: Parts, Regulation, Histology, Hormones secreted, functions and applied physiology.	1	C	1-4	1
23.	Thyroid gland: Histology, Hormones, Synthesis of Thyroxine, mode of action and function, Regulation and applied physiology	1	C C	1-4	1
24.	Parathyroid gland and bone physiology	1	C C	1-4	1
25.	Endocrine functions of pancreas and Diabetes	1	C	1-4	1
26.	Adrenal gland – Cortical and medullary hormones	1	C	1-4	1
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Sembulingam. K, Sembulingam. P, *"Essentials of Medical Physiology"*, Jaypee Brothers medical publishers, New Delhi, 6th Edition.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Guyton and Hall, *"Textbook of Medical Physiology"*, Saunders, 12th Edition (2010).

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT103	**Biochemistry**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To provide an understanding of the functions of various biomolecules and their metabolism.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	appreciate structural and functional properties of carbohydrates, proteins, lipids and nucleic acids	a						
2.	understand the role of biomolecules related to metabolic diseases and disorders	a	d					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO BIOCHEMISTRY	**12**			
1.	History of Biochemistry, Chemical bonds, pH and Buffers	1	C	1	1,2
2.	Introduction to carbohydrates, Classification of carbohydrates, Monosaccharides and Oligosaccharides – structure and function	3	C	1	1,2
3.	Polysaccharides – structure and function	1	C,D	1	1,2
4.	Glycoproteins and lectins	1	C,D	1	1,2,4
5.	Classification of lipids - Lipids and cell membranes	1	C	1	1,2
6.	Phospholipids and glycolipids and Phospholipid bilayer	1	C,D	1	1,2
7.	Introduction to amino acids and proteins	2	C,D	1	1,3,4
8.	Structure of proteins - Primary, Secondary, Tertiary, Quaternary and functions of proteins	1	C,D	1	1,2,3,5
9.	Introduction to Nucleic acids – DNA and RNA	1	C	1	2
	UNIT II: METABOLISM OF CARBOHYDRATES	**8**			
10.	Introduction to metabolism, Role of enzymes and importance of Carbohydrate metabolism	2	C	2	1,3,4,6
11.	Glycolysis and energetics	2	C,D	2	1,2,3,4,6
12.	Citric acid cycle, Gluconeogenesis and Energetics	2	C,D	2	1,2,3
13.	Glycogen metabolism, Glycogenesis, Glycogenolysis and energetics	1	C,D	2	1,2,3,
14.	Disorders of carbohydrate metabolism – Biochemical aspects of Diabetes mellitus	1	C,D	2	1,2,3,4,6
	UNIT III: PROTEIN METABOLISM	**9**			
15.	Introduction to amino acid metabolism and Proteins	1	C	2	1,2 ,6
16.	Transamination, Deamination – oxidative and non oxidative, and Decarboxylation	2	C,D,	2	1,2
17.	Urea cycle	1	C,D	2	1
18.	Biosynthesis of amino acids and its catabolism, Medically important peptides and amino acid derivatives	3	C,D	2	1,2,4,5
19.	Disorders of tyrosine/phenylalanine metabolism	2	C,D	2	1,4,5
	UNIT IV: FATTY ACID METABOLISM AND NUCLEIC ACID METABOLISM	**8**			
20.	Fatty acids and β – oxidation	1	C	2	1,2,4
21.	Biosynthesis of fatty acids, Ketone body metabolism, Energetics of fatty acid metabolism	2	C,D	2	1,2,5
22.	Disorders of Lipid metabolism	1	C,D	2	1,2
23.	Biosynthesis of Purine and Pyrimidines	2	C,D	2	1,2
24.	Degradation of purine nucleoitides and pyrimidine nucleotides	1	C	2	1,2
25.	Disorders of Purine and pyrimidine metabolism	1	C	2	1,2
	UNIT V: OXIDATIVE PHOSPHORYLATION	**8**			
26.	Introduction -Bioenergetics, High energy compounds, Biological oxidation - Electron transport chain	2	C,D	2	1,2,5,6
27.	Chemiosmotic theory and Oxidative Phosphorylation	2	C	2	1,2,5,6
28.	Shuttle pathway – Glycerol phosphate Shuttle, Malate aspartate Shuttle	1	C	2	1,4
29.	Photosynthesis and Light reaction	3	C,D	2	1,3,5,6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Satyanarayana.U & U. Chakrapani, *"Biochemistry"*,Books and Allied (p) Ltd., ISBN: 8187134801.
2.	Jain, J L, Jain, Nitin, Sunjay Jain, *"Fundamentals of Biochemistry"*, S. Chand Group, ISBN: 8121924537.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	David L. Nelson, Albert Lester Lehninger, Michael M. Cox, *"Lehninger Principles of Biochemistry"*, Edition 5, illustrated, W. H. Freeman, 2008.
4.	Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, *"Biochemistry"*, Ed. 7, W. H. Freeman, 2012.
5.	Voet, D. & Voet, J. G. *Biochemistry*. 4th edn, 2010.
6.	Fell, D. *Understanding the Control of Metabolism*. Portland Press, 1996.
7.	http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=OMIM

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15BT103L	**Biochemistry Laboratory**			**L**	**T**	**P**	**C**
				0	**0**	**3**	**2**
Co-requisite:	15BT103						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To establish the basics of practical biochemistry and to provide a platform for understanding and analyzing biomolecules							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	understand the importance of laboratory safety and standard operating procedures of common laboratory equipment's	b						
2.	Prepare biological buffers and Regants	b						
3.	analyze and estimate biomolecules in normal and diseased conditions	b						
4.	apply modern separation techniques for biomolecules	b	j					

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Introduction to commonly used instruments (pH meter, Spectrophotometer,Centrifuge, Microscopes etc.) and laboratory safety	3	C	1-4	1
2.	Preparation of buffers and pH measurements	3	C,D	1	1
3.	Qualitative analysis of carbohydrates (Monosaccharide – Hexo, Pentose, Aldo, Keto sugars, Disaccharides – Reducing and non-reducing sugars, Polysaccharides)	3	C,D	3,4	1
4.	Qualitative analysis of carbohydrates in different food samples	3	D	1-4	1
5.	Estimation of blood glucose and comparison of normal and diabetes mellitus samples	3	C,D	3,4	1
6.	Estimation of blood plasma proteins	3	C,D	3,4	1
7.	Separation of amino acids on Thin Layer Chromatography	3	C,D	3,4	1
8.	Quantification of cholesterol and triglycerides from blood	3	C,D	3,4	1

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
9.	Biochemical estimation of nucleic acid using spectrophotometer	3	C,D	3,4	1
10.	HPLC determination of caffeine in urine – Demo	3	C,D	1-4	1
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model Examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15BT201	**Cell Biology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	15BT103				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To provide a basic understanding of cell structure and function, and cell regulation							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	study cell structure and functions of organelles and understand the mechanism of cellular transport within and outside the cell membrane	a						
2.	focus on different receptors and model of signaling and introduce the concept of cell signaling and their role in diseases	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: AN OVERVIEW OF CELLS AND CELL RESEARCH	**10**			
1.	Introduction to Cell Biology; Origin and evolution of cell	1	C	1	1
2.	Evolution of metabolism, Origin of Prokaryotes, Origin of Eukaryotes, Development of multicellular organisms	2	C	1	
3.	Cells as experimental models, Tools of cell biology	2	C	1	
4.	Molecular composition Biosynthesis of cellular constituents	2	C	1	
5.	Central role of enzymes as biocatalysts	2	C	1,2	2
6.	Cell membrane	1	C	1	1
	UNIT II: CELL STRUCTURE AND FUNCTION–I	**9**			
7.	Nucleus	2	C	1	1
8.	Endoplasmic reticulum	2	C	1	
9.	Golgi apparatus	1	C	1	
10.	Lysosomes	1	C	1	
11.	Bioenergetics and metabolism: Mitochondria	2	C	1	
12.	Chloroplasts and Peroxisomes	1	C	1	1
	UNIT III: CELL STRUCTURE AND FUNCTION–II	**8**			
13.	Cytoskeleton: Actin and myosin filaments	2	C	1	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
14.	Intermediate filaments and Microtubules	2	C	1	
15.	Transport of molecules: passive diffusion, active diffusion, ion channels, endocytosis, phagocytosis	2	C	1	
16.	Cell-cell interactions: Adhesion junctions, tight junctions, gap junctions and plasmodesmata	2	C	1	
	UNIT IV: CELL SIGNALING –CELL REGULATION	**11**			
17.	General principles of cell signaling-Modes of cell-cell signaling	2	C	2	1
18.	Pathways of intracellular signal transduction-function of cell surface receptors; GPCR pathway , cAMP pathway, Receptor protein tyrosine kinase pathway, MAPK pathway.	2	C	2	
19.	Cell division : Cell cycle	1	C	2	
20.	Mitosis - Stages of mitosis; Meiosis - Meiosis I and Meiosis II	3	C	2	
21.	Cell death: Necrosis, Programmed cell death-apoptosis-Extrinsic pathway, Intrinsic pathway	2	C	2	
22.	Cell differentiation: Stem cells-embryonic stem cells, adult stem cells, therapeutic applications of stem cells	1	C,D	2	3
	UNIT V: DISEASES OF CELLS	**7**			
23.	Cancer-Introduction to cancer, types of cancer, Epithelial cell cancer: Oral, lung	3	C	1,2	4
24.	Cervical and breast cancer	2	C	1,2	1
25.	Neurodegenerative diseases- Dementia, Alzheimer's disease	2	C	2	3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Channarayappa, "*Cell biology*," Universities Press, 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Rastogi, S.C, "*Cell biology*," New Age International publishers, 2005.
3.	ThyagaRajan *et al*., "*Biology for Engineers* " Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012
4.	Ajoy Paul, "Text book of cell and molecular biology", Second edition, Books & Allied (P) Ltd., 2009.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT201L	**Cell Biology Laboratory**			**L**	**T**	**P**	**C**
				0	**0**	**3**	**2**
Co-requisite:	15BT201						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To facilitate the use of theoretical concepts and to develop skills in cell biology techniques							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Develop skills in the basic cell biological techniques	b						
2.	Improve their ability in isolation and identification of cell organelles	b	e					
3.	Understand the developmental biology in vertebrates	b						
4.	Equip themselves familiar with basic cytogenetic techniques	b						

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Cell morphology: Microscopic observation of eukaryotic cells	3	I	1	1,2
2.	Cell organelle: Nuclear staining of cells	3	C,D	1,2	1
3.	Isolation of cell organelle: chloroplast	3	C,D	1,2	2
4.	Cell Viability: Determination of cell viability using tryphan blue	3	C	1	1,2
5.	Cell cycle : Mitotic cell division in onion root tip	3	C	1	1,2
6.	Cell development : Embryogenesis in zebra fish	3	C	3	1
7.	Chromosome preparation : Metaphase spread preparation	3	C	1,4	1,3
8.	Cell proliferation: Mitotic index determination	3	C,D	1,4	1,3
9.	Karyotyping: G- banding	3	C,D	1,4	1,3
10.	Heterochromatin: Polytene chromosomes	3	D	1,4	1,3
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	John Davey, Mike Lord, “Essential Cell Biology: A Practical Approach”, Oxford University Press, 2003.
3.	Thomas Robert Mertens, Robert L Hammersmith, “Genetics Laboratory Investigations”, Benjamin Cummings, 2006.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination Weightage :		**40%**

15BT202	**Microbiology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL -CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	This course introduces the fundamentals of Microbiology, characteristics of microorganisms, infectious diseases and applications of microorganisms in various fields.							
INSTRUCTIONAL OBJECTIVES								
At the end of the course, student will be able to		**STUDENT OUTCOMES**						
1.	Highlight the roles and characteristics of microorganisms	a	c					

2.	Acquire knowledge in the growth of microorganisms and impact of environment on their growth and theoretical knowledge on the applications of advanced microscopic techniques	a	b	e				
3.	Understand the role of microbes in public health and antimicrobial agents	a	f					
4.	Acquire the knowledge on the applications of microbes and their products in various field	a	c	f				
5.	Gain knowledge on the host-microbe interactions	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - INTRODUCTION TO MICROBIOLOGY	**10**			
1.	Introduction about the overall syllabus Basic of microbial existence- History of Microbiology	2	C	1	1,5,6
2.	Classification, and nomenclature of microorganisms	1	C	1	1,5,6
3.	Microscopy-Light, Electron and Advanced Microscopic techniques	4	C	1,2	1,6
4.	Microscopic examination of microorganisms-morphology and fine structure of Bacteria	3	C	1	1,6
	UNIT II - MICROBIAL NUTRITION, GROWTH AND METABOLISM	**9**			
5.	Nutritional requirements of bacteria-Types of microorganisms based on the nutritional requirements and physicochemical conditions	2	C	1,2	1,6
6.	Growth curve and kinetics and Different methods to quantitative bacterial growth	3	C	1,2	1,6
7.	Bioenergetics- utilization of energy	2	C	1,2	1
8.	Biosynthesis of small and macromolecules	2	C	1,2	1
	UNIT III - MICROBIAL PHYSIOLOGY	**8**			
9.	Fungi-Importance,morphology,characteristics, Classification, cultivation and Reproduction	2	C	1,2	1,5,6
10.	Bacteriophages- General characteristics, Morphology and structure	1	C	1,2	1,6
11.	Replication-Viruses of bacteria	1	C	1,2	1,6
12.	Replication-Viruses of animals	2	C	1,2	6
13.	Replication-Viruses of plants	2	C	1,2	6
	UNIT IV - MICROBIAL INFECTIONS, TRANSMISSION, AND THEIR MODE OF ACTION	**9**			
14.	Sources of infection - Portals of entry and Exit of microbes.	1	C	3	7
15.	Epidemiological terminologies-Infectious diseases caused by *Vibrio cholerae*	2	C	3	7
16.	Transmission of diseases	2	C	3	7
17.	Antibacterial agents - Mode of action	2	C	3	7
18.	Antifungal agents - Mode of action	1	C	3	7
19.	Antiviral agents- Mode of action	1	C	3	7
	UNIT V - APPLIED MICROBIOLOGY	**9**			
20.	Microbial applications in agricultural field	1	C	1,4	3,6
21.	Microbial applications in Biotechnological field	2	C	1,4	3,6
22.	Microbial applications in Pharmaceutical field	1	C	1,4	5,7
23.	Microbial applications in Environmental field	2	C	1,4	1,6
24.	Host-microbe interactions: Microbe-Microbe interaction	1	C	1,5	1,3,6
25.	Host-microbe interactions: Plant-microbe interaction	1	C	1,5	1,3,6
26.	Host-microbe interactions: Animal-microbe interaction	1	C	1,5	1,3,6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Pelczar *et al*., *"Microbiology*", 7th ed., Mc Graw Hill, 2011.
2.	Madigan *et al*., *"Brock Biology of microorganisms"*, 12th ed., Prentice Hall, 2008.
3.	Davis *et al., "Microbiology"*, 6th ed., Lippincott Williams and Wilkins, 2010.
4.	Joklik *et al., "Zinsser's Microbiology"*, 11th ed., Mc Graw-Hill Professional, 2010.
5.	Stainer Ry *et al*., *"General Microbiology"*, 5th ed., Prentice Hall 1986.
	REFERENCE BOOKS/OTHER READING MATERIAL
6.	Prescott *et al*., *"Microbiology"*, 11th ed., Mc Graw Hill, 2011.
7.	Brooks *et al*., *"Medical Microbiology"*, 26th ed., Lange Med. 2012.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT202L	**Mcirobiology Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**
Co-requisite:	**15BT202**				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	Provides an opportunity to experimentally verify the theoretical concepts studied in Microbiology. It also helps in understanding the theoretical principles in a more explicit and Concentrated manner.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the basic concepts involved in the isolation, identification and characterization of different kinds of microorganisms	b						
2.	get proper handling experience of microorganisms	b						
3.	Have complete practical experience on microbiological methods and getting useful microbial products.	b						
4.	Gain knowledge to operate the microscopes for the morphological identification of microorganisms	b	e					

Sl. No.	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Aseptic techniques and Media preparation (Both liquid and solid)	3	C-D-O	1,2,3	1,2
2.	Isolation and enumeration of microorganisms from given sample (Pour and spread plate)	3	C-D-O	1,2,3	1,2
3.	Purification techniques of microorganisms (Streak plate) and preservation methods of bacterial cultures	3	C-D-O	1,2,3	1,2
4.	Staining Techniques (Simple, Gram staining, and spore staining)	3	C-D-O	2,4	1,2
5.	Motility test by Hanging drop method	3	C-O	2,4	1,2
6.	Biochemical Characterization of Bacteria –a) IMViC test	3	C-O	1,2,3	1,2
7.	b) Catalase, Oxidase, and Urease Tests		C-O	1,2,3	1,2
8.	c) H_2S production Test	3	C-O	1,2,3	1,2

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
9.	d) Oxidation/Fermentation Test		C-O	1,2,3	1,2
10.	e) Casein and Starch Hydrolysis		C-O	1,2,3	1,2
11.	Kirby-Bauer assay	3	C-I-O	1,2,3	1,2
12.	Identification of bacteria using 16s-rRNA method	3	C-O	1	1,2
13.	Identification of Bacterial morphology by Phase Contrast Microscopy/fluorescence Microscopy (live and dead cells)	3	D-I-O	4	1,2
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Russell Bey, "Microbiology Laboratory Manual", Thomson Learning, 2000.
3.	Tabo.N,"Laboratory Manual in Microbiology", Rex Bookstore, Inc 2004.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15BT203	**Genetics & Cytogenetics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	15BT201				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	This course introduces the fundamentals of genetics, pattern of inheritance, linkage maps and population analysis.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the basic laws governing the pattern of inheritance.	a						
2.	Familiarize the basic concepts and principles of nucleic acids in prokaryotic and eukaryotic organisms.	a						
3.	Understand the concepts and experiments in the preparation of linkage map.	a						
4.	Understand the pattern of inherited disorders and population genetics.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: MENDELIAN GENETICS	**10**			
1.	Mendel's experiments, Mendel's laws	2		1	1-4
2.	Gene interaction - Allelic and non-allelic	3		1	1,4
3.	Multiple allelism – ABO and Rh factor inheritance	2		1	1,3
4.	Cytoplasmic inheritance, sex determination	2		1	1,3,4
5.	Pedigree analysis – Autosomal, sex linked, Cytoplasmic	1			1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT II: LINKAGE AND RECOMBINATION MAPPING	**10**			
6.	Chromosome structure and organization, giant chromosomes	2		2	1,3
7.	Linkage and crossing over, cytological basis of crossing over – Sterns experiment	3	C	2-3	1,2,3
8.	Mapping – two and three factor cross, preparation of linkage map	3	C	2-3	1,2,3
9.	somatic cell hybridization	2		2-3	1,3
	UNIT III: MUTATION AND HUMAN CYTOGENETICS	**9**			
10.	Changes in chromosome structure and number	2		2	1-4
11.	Non-disjunction, Aneuploids in humans – Autosomes and Allosomes, mosaics, position effect	2		2	1,3
12.	chromosome preparation – leucocytes, bone marrow, amniotic fluid, chorionic villi, Banding, karyotype preparation and analysis	3	C	2	1,3
13.	FISH, Prenatal diagnosis and CGH	2	C	2	1,3
	UNIT IV: RECOMBINATION AND MAPPING IN BACTERIA	**8**			
14.	Mechanisms of recombination, Mapping – transformation	2		3	1,3
15.	Transduction mapping – generalized and specialized transduction	2		3	1,3
16.	conjugation – interrupted mating analysis	3	C	3	1,3
17.	Fine structure in merozygotes	1	C	3	1,3
	UNIT V: POPULATION GENETICS	**8**			
18.	Hardy Weinberg equilibrium, calculating allelic frequency	3	C	4	1,3
19.	Application of Hardy Weinberg equilibrium	2	C	4	1,3
20.	Changes in Allele Frequency – Mutation, migration, selection, Random genetic drift - genetic equilibrium.	3	C	4	1,3
	Total Contact Hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Gardner, Simmons, Sunstad, "Principles of Genetics," 8 edition – John Wiley and Sons, Inc., 2003.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Monroe W. Strickberger, "Genetics," 3 rd edition – Phi Learning, 2008.
3.	D. Peter Snustad and Michael J. Simmons, "Genetics" 6th edition - John Wiley and Sons, 2011.
4.	P.S. Verma and V.K. Agarwal, "Genetics" 9th edition – S.Chand, 2009.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT204	Molecular Biology	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15BT201, 15BT203				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To provide the fundamental understanding of gene and its expression and regulation at the molecular level.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize the basic concepts and principles of nucleic acids in prokaryotic and eukaryotic organisms.	h						
2.	Understand the structure and machinery of nucleic acids responsible for cell functioning.	a						
3.	Understand the mechanism and role of the nucleic acids in gene expression.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO MOLECULAR BIOLOGY– DNA AND RNA	**9**			
1.	Scope and history -Structure of DNA: Nucleoside – Nucleotide - Base pairing - Base stacking	3		1	1,4
2.	Double helix - Features of Watson and crick model - Major and minor groove	2	C	1	1,3,4
3.	Supercoiling – Twist - Writhe and linking number	2	C	1	1
4.	Forms of DNA - A, B, Z - Structure and function of RNAs – mRNA- rRNA – tRNA - Secondary structures in RNA	2	C	1	1,3,4
	UNIT II: REPLICATION AND REPAIR	**9**			
5.	Types and functions of DNA polymerases in prokaryotic and eukaryotic replication and proof reading activity	3		1,2	1,3,4
6.	5'-3' exonuclease activity, Topoisomerase activity and Telomeric DNA replication	2	C	1,2	1,3
7.	Plasmid replication-theta model, Strand displacement model and Rolling circle model-Bidirectional-Unidirectional	3	C	1,2	1,4
8.	DNA repair: Nucleotide excision repair - Mismatch repair - Photo-reactivation - Recombination repair - SOS repair	1		1,2	1,4
	UNIT III: TRANSCRIPTION AND POST TRANSCRIPTIONAL MODIFICATIONS	**9**			
9.	RNA polymerases in prokaryotic and eukaryotic cells-Types and their function	2		3	1,2,3
10.	Structure and function of the promoters involved in mRNA, rRNA, and tRNA genes	1		3	1,2
11.	Transcription of mRNA, rRNA, and tRNA genes in prokaryote and eukaryote - Processing – Fine structure of prokaryotic and eukaryotic genes	4	C	3	1,2,3
12.	Post transcriptional processing of mRNAs – 5'capping, splicing (including different types) and polyadenylation	2	C	3	1,2,3
	UNIT IV: TRANSLATION AND POST TRANSLATIONAL MODIFICATIONS	**9**			
13.	Genetic code and wobble hypothesis	1		1,3	1,3
14.	Translation in prokaryotic and eukaryotic cells	4	C	3	1,3
15.	Post translational modifications	1		3	1,2,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
16.	Principles of protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast and nucleus	3		1,3	1,3,4
	UNIT V: GENE REGULATION	**9**			
17.	Principles of gene regulation - Transcriptional and post transcriptional gene regulation	2	C	2	1,3,4
18.	Activators – Co-activators – Suppressors – Co-suppressors – Moderators – Silencers – Enhancers.	2	C	2	1,3,4
19.	Operons: Lac operon - Trp operon – Ara operon - Gal operon	5	C	2	1,3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	James D Watson, "Molecular Biology of Gene,"Pearson Education, 2011.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Robert Weaver, "Molecular Biology", McGraw-Hill, 2011
3.	Benjamin Lewin, "Genes VIII",Benjamin Cummings, 2003.
4.	G.M. Malacinski, David Friefelder,"Essentials of Molecular Biology", 4th Edition, Narosa Publishers,2005.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT204L	**Molecular Biology Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**
Co-requisite:	15BT204				
Prerequisite:					
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To provide an opportunity to experimentally verify the theoretical concepts of nucleic acids							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the principle of isolation of nucleic acids through different techniques.	b						
2.	Understand the techniques used in manipulation of nucleic acids.	b						
3.	Understand the applications of nucleic acids in biotechnology.	b						

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Isolation of genomic DNA from bacteria	3	I	1,3	1
2.	Plasmid DNA isolation	3	I	1,3	1
3.	Qualitative and quantitative analyses of DNA	3	I	1,3	1
4.	Polyacrylamide gel electrophoresis of DNA	3	I	1,2	1
5.	Isolation of RNA	3	I	1.3	1
6.	Qualitative and quantitative analyses of RNA	3	I	1,3	1

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
7.	Restriction digestion of Plasmid DNA	3	I	2	1
8.	Ligation of digested DNA	3	I	2	1
9.	UV mutation	3	I	1	1
10.	Polymerase Chain Reaction	3	I	2	1
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Sambrook et al., "Molecular Cloning" A Laboratory Manual

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15BT205	**Immunology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	Aimed at introducing the science of immunology and a detailed study of various types of immune cells, immune systems and their classification, structure, and mechanism of immune activation.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	understand the immune system , their structure and classification, genetic control of antibody production, cellular immunology, mechanism of activation in hypersensitive immune reaction	a	c					
2.	understand the role of the immune molecules in infectious diseases, autoimmunity, and cancer will be discussed	a	d	h				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: OVERVIEW OF THE IMMUNE SYSTEM	**12**			
1.	Introduction – overview of the immune system Lymphatic system, Lymphoid organs, Cells of the immune system and their functions,	2	C	1	1
2.	Immune system-Innate and Acquired immunity	4	C	1	1
3.	Comparative immunity: Anatomical and Physiological barriers; Innate immune response and their recognition structures; Pathogen elimination; Plant Immune system	4	C	1	1
4.	Immunogens and Antigens: Requirements for immunogenicity; major classes of antigens; antigen recognition by B and T lymphocytes	4	C	1	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT II: ANTIBODY STRUCTURE AND FUNCTIONS, B CELL FUNCTION	**12**			
5.	Immunoglobulin structure and function	2	C	1	1
6.	Antibody classes and biological activities	2	C	1	1
7.	Monoclonal antibodies	2	C	1	1
8.	B Cell differentiation and B cell receptor; Ab diversity: Genetic basis; B cell signal transduction	4	C	1	1
9.	Cytokine	1	C	1,2	1
10.	Complement system	1	C	1,2	1
	UNIT III: ANTIGEN - ANTIBODY INTERACTIONS ANTIBODY INTERACTIONS	**10**			
11.	Isolation of immune cells from Human and animals; Antigen- antibody interaction –antibody affinity and activity- precipitation reaction, agglutination reaction	3	C,D	1	1
12.	Radio-immunoassay, ELISA, Western Blot, Immunoprecipitation	2	C,D	1	1
13.	Immunofluoresence, flow cytometry	2	C,D	1	1, 2
14.	Cell culture and experimental models, analysis of gene expression	3	C,D	1	2
	UNIT IV: T-CELL MATURATION, ACTIVATION, & DIFFERENTIATION	**11**			
15.	MHC, antigen processing and presentations	3	C	1	1
16.	T-cell receptors	2	C	1	1
17.	T-cell maturation, activation and differentiation	3	C	1	1
18.	Cell mediated effector responses - Function of CD8+ T cells	3	C	1	1
	UNIT V: IMMUNE SYSTEM IN HEALTH & DISEASE	**10**			
19.	Hypersensitive reactions	1	C	1,2	1
20.	Immune responses to infectious diseases	3	C	1,2	1
21.	Vaccines	2	C	1,2	1
22.	Tumor immunology and auto immunity	4	C	1,2	1
	Total contact hours	**55**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Richard Coico, Geoffrey Sunshine, "Immunology: A short course" 6th Edition. Wiley-Blackwell.2009
2.	Kenneth Murphy, "Janeway's Immunobiology," 8th Edition, Garland, 2011.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Sudha Gangal and Shubhangi Sontakke, "Textbook of basic and clinical immunology," Universities Press, 2013.
4.	Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, "Kuby Immunology,"6th Edition, W. H. Freeman and Company, 2006.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT205L	Immunology Laboratory			L	T	P	C
				0	0	3	2
Co-requisite:	15BT205						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	A laboratory course with an opportunity to experimentally design and verify the theoretical concepts already studied							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	understand the theoretical concepts in Immunology.	a						
2.	perform methods used in immunology, particularly the use of specific antibody in biomolecular applications.	b	k					
3.	understand various methods and their applications, and interpretation of results	b	e					

Session	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Lab. safety and Blood grouping	3	C, I	1,2	1
2.	Leukocyte counting – Total leukocyte and differential leukocyte	3	C, I	2,3	1
3.	Precipitation reaction - Widal and VDRL	3	C,D, I	2,3	1, 2
4.	Immunodiffusion – Single Radial Immuno Diffusion (SRID)	3	C,D, I	2,3	1, 2
5.	Immunodiffusion – Double Immuno Diffusion (DID)	3	C,D, I	2,3	1, 2
6.	Immunoelectrophoresis – Rocket Immunoelectrophoresis	3	C,D, I	2,3	1, 2
7.	Immunoelectrophoresis – Counter Current Immunoelectrophoresis	3	C,D, I	2,3	1, 2
8.	ELISA	3	C,D, I	2,3	1, 2
9.	Immunoprecipitation and Demonstration of Flow cytometry	3	C,D, I	2,3	1
10.	Western blotting and Demonstration Immunofluroscence	3	C,D, I	2,3	1
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Immunology Laboratory manual.
2.	Arti Nigam,Archana Ayyagari,"Lab Manual in Biochemistry, Immunology and Biotechnology", Mc Graw Hill Education, India, 2007.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination Weightage :		**40%**

15BT206	Bioprocess Principles	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15BT202, 15CH251				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	This subject emphasizes on the basic engineering principles of bioprocess and to understand the internal machinery of living cells

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Study the design and operation of fermenter and types of fermentation process	a						
2.	Acquire knowledge about formulation of medium and its prerequisites	a	c	k				
3.	Interpret stoichiometry and energetics of cell growth and product formation	a	c	e				
4.	Analyze the modes of operation of bioreactor and its design equations	a	c	d				
5.	Evaluate the kinetics and mechanism of microbial growth by using various models	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I :FERMENTER AND FERMENTATION PROCESS	**7**			
1.	Outline of an integrated bioprocess: Upstream and downstream	1	C	1,2,4	2
2.	Process flow sheets of metabolites production	1	C	1	1
3.	Types of fermentation	2	C,D,O	1	2
4.	Basic design and construction of fermenter and its ancillaries	2	C,D,O	1,4	2
5.	Main parameters to be monitored and controlled in fermentation processes	1	C,D,O	1	3
	UNIT II :MEDIA DESIGN AND STERILIZATION KINETICS	**9**			
6.	Media design and formulation for industrial fermentation process	1	C,D	2	2,3
7.	Screening and optimization of medium components: One factor at a time method	2	I,O	2	2,3
8.	Plackett Burman screening method- Response surface methodology	2	D,O	2	2
9.	Sterilization: Types of sterilization of media	1	C,I	2	3,4
10.	Air sterilization, Design of sterilization equipment	1	C	2	3
11.	Kinetics of sterilization process	1	C,I	2	3,4
	UNIT III :METABOLIC STOICHIOMETRY AND ENERGETICS	**9**			
12.	Stoichiometry of cell growth and product formation	2	C	3	1
13.	Elemental balances, degrees of reduction of substrate and biomass available	1	C,I	3	1
14.	Electron balances - yield coefficient of biomass and product formation	2	C,I	3	1
15.	Maintenance coefficients	1	C,I	3	1
16.	Energetic analysis of microbial growth and product formation	1	C	3	
17.	Heat evolution in aerobic cultures	1	C	3	1
18.	Thermodynamic efficiency of growth.	1	C	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV – BIOREACTOR STRATEGIES	**10**			
19.	Types of bioreactor	2	C	4	2
20.	Modes of operation of bioreactor	1	I,O	4	2
21.	Kinetics of cell growth in batch culture	2	C,I	4,5	5
22.	Kinetics of cell growth in fed-batch culture	2	C,I	4,5	5
23.	Kinetics of cell growth in continuous culture	2	C,I	4,5	5
24.	Stability analysis of bioreactor	1	C	4	3
	UNIT V: MICROBIAL GROWTH AND PRODUCT FORMATION KINETICS	**10**			
25.	Simple unstructured and structured kinetic models for microbial growth	2	C	5	6
26.	Monod model, William's two compartment model	2	C,I	5	6
27.	Growth associated (primary) and non-growth associated (secondary) product formation kinetics	2	C	5	6
28.	Leudking - Piret models	1	C	5	6
29.	Substrate and product inhibition on cell growth and product formation - Ramakrishna model	1	C	5	6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Shuler. M.L., Kargi. F., "*Bioprocess Engineering: Basic Concepts*", 2nd Edition. Pearson, 2002
2.	Stanbury.P.F., Whitaker.A., Hall.S.J., "*Principles of Fermentation Technology*", 2nd Edition, Butterworth– Heinemann, 1995.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Rao. D. G., *" Introduction to Biochemical Engineering"*Tata McGraw-Hill,2006
4.	Doran. P. M., "*Bioprocess Engineering Principles*", Academic press, 1995
5.	Scragg. A. H., *" Bioreactors in Biotechnology"*, Ellis Horwood Limited, 2001
6.	Blanch. H.W., Clark.D.S., "*Biochemical Engineering*", Marcal & Dekker, Inc., 1997.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT206L	**BIOPROCESS AND ENZYME TECHNOLOGY LABORATORY**			**L**	**T**	**P**	**C**
				0	**0**	**3**	**2**
Co-requisite:	**15BT206**						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	Enables the student to develop their skills in the field of bioprocess to understand the basic principles using biocatalysts, optimization of parameters for maximum enzyme activity, kinetic studies, inhibition studies, enzyme immobilization and microbial fermentation for production of bioproducts

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Develop practical skills in enzyme kinetics and immobilization techniques	b	k					
2.	Optimize the environmental conditions for maximal enzyme activity	b	k					
3.	Reveal the effect of inhibition and analyze their kinetics	b	k					
4.	Expose with techniques of enzyme immobilization and their kinetics	b	k					
5.	Produce value added bioproducts by applying fermentation skills	b	c	k				

Session	**Description of experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Isolation and screening of microorganisms for industrial enzymes	3	D-I-O	5	1,2
2.	Enzyme Kinetics - Batch Study	3	D-I-O	1	1,2
3.	Effect of pH on enzyme activity	3	D-I-O	2	1,2
4.	Effect of temperature on enzyme activity	3	D-I-O	2	1,2
5.	Effect of inhibitors on enzyme activity	3	D-I-O	3	1,2
6.	Immobilization of enzymes – Entrapment Method	3	D-I-O	4	1,2
7.	Comparison of free and immobilized enzyme kinetics	3	D-I-O	4	1,2
8.	Bioreactor operation – Demonstration	-	D-I-O	5	1,2
9.	Batch Experiment for production of viable bio products	3	D-I-O	5	1,2
10.	Ethanol fermentation in an immobilized cell reactor using *Saccharomyces cerevisiae*	3	D-I-O	5	1,2
11.	Production of citric acid by *Aspergillus niger* by Solid Substrate Fermentation	3	D-I-O	5	1,2
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Doran. P. M., "*Bioprocess Engineering Principles*", Academic press, 1995

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15BT301	**Plant Biotechnology**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	15BT204						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	The course is tailored to provide an understanding of the basic concepts and state of art techniques and methods underlying plant biotechnology research including the genetic bases of several important plant properties and the molecular basis of plant breeding. The students will gain an understanding of theoretical principles enabling them to employ the knowledge to solve problems related to plant production and protection through biotechnological approaches.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	understand the structural complexity and diversity of plants	a						
2.	explore the principles underlying the tissue culture and gene manipulation	a	c					
3.	realize the principles underlying intermediary metabolism in plants	a						
4.	understand the principles underlying breeding and protection	a						
5.	appreciate the utility of plants as production systems	a						

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: DIVERSITY AND COMPLEXITY OF PLANTS	**9**			
1.	Introduction	1		1	2
2.	Evolution of plant diversity	2	C	1	2
3.	Variation in plant populations and species –speciation origins of reproductive isolating mechanisms	2	C	1	2
4.	Overview of plant phylogeny -phylogenetic relationships of angiosperms- molecular systematics	2	C	1	2
5.	Morphology anatomy and embryology	2	C	1	2
	UNIT II: TECHNIQUES FOR GENETIC MANIPULATION	**9**			
6.	Features of Ti-plasmid	1	C	2, 5	3
7.	Process of T- DNA transfer, integration, transformation	2	C		3
8.	Basic features of vectors	2	C-D	2,5	3
9.	Direct gene transfer methods	2	C- D -	2,5	3
10.	Vector optimization and clean gene technology	2	C- D -	2,5	3
	UNIT III: METABOLIC PHYSIOLOGY	**9**			
11.	Carbon reactions in C3 plants – Photorespiration - Variations in mechanisms of CO2 fixation	2	C	3	1,7
12.	Carbohydrate metabolism- sucrose and starch- cell wall polysaccharides- non-starch storage polysaccharides	2	C-D-I	3	1,7
13.	Nitrogen metabolism	2	C-D-I	3	1,7
14.	Sulphur metabolism	1	C-D-I	3	1,7
15.	Transport Processes	2	C-D-I	3	1,7
	UNIT IV: PLANT BREEDING AND PROTECTION	**9**			
16.	Sexual hybridization Mutagenesis - Polyploidy	2	C-D	4	2,4
17.	Genetic resources for breeding, Germplasm conservation	1	C-D	4	2,4
18.	Marker assisted selection, cultivar release and commercial seed production.	2	C-D-I	4	2,4
19.	Biotic stress factors and natural disease resistance pathways	2	C-D	4	2,4
20.	Abiotic stress factors - tolerance mechanisms	2	C-D	4	2,4
	UNIT V: PLANT PRODUCTION SYSTEMS	**9**			
21.	Plant tissue culture-, Principles and Requirements	1	C-D	5	3
22.	Culture types and Plant regeneration	2	C-D	5	3
23.	Hairy root cultures - Production of secondary metabolites-	1	C-D-I	5	3
24.	Carbohydrate and Lipid production	2	C-D-I	5	3,4,5,6
25.	Molecular pharming of proteins	2	C-D-I	5	3,4,5,6
26.	Emerging applications for producing fine chemicals, drugs and alternative fuels.	1	C-D-I	5	3,4,5,6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Taiz. L and Zeigler.E, "Plant Physiology," Panima Publishing Corporation, New Delhi, Third edition. 2003.
2.	C Neil Stewart Jr. "Plant Biotechnology and Genetics "- John Wiley & Sons, Inc., New Jersey 2008
3.	Slater. A, Scott.N.W and Fowler,M.R, "Plant Biotechnology - The genetic manipulation of plants", Oxford University Press 2008
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Murray.D.R, "Advanced methods in plant breeding and biotechnology" CAB International 1991.
5.	Stephanopolous.G.N, Aristidou. A.A and Neilsen.J, "Metabolic engineering- Principles and Methodologies," Academic Press 1998
6.	Smolke.C, "The metabolic pathway engineering- Tools and applications" - CRC Press 2009
7.	Salisbury. F.B and Ross.C.W, "Plant Physiology", Wadsworth Publishing Company Fourth edition 1992.
8.	Robert Wayne Allard John, "Principles of Plant Breeding", Wiley & Sons Second edition 1999.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT301L	**Plant Biotechnology Laboratory**			**L**	**T**	**P**	**C**
				0	**0**	**3**	**2**
Co-requisite:	15BT301						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	-- Academic Council Meeting ----------, 2016						

PURPOSE	To facilitate understanding of the practical use of theory behind the emerging techniques in the field of plant biotechnology, enabling practice of the gained knowledge to solve problems related to plant production through biotechnological approaches.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	carry out experiments related to representative plant tissue culture techniques and explore their applications.	a	b					
2.	employ advanced techniques in plant biotechnology such as gene manipulation and molecular genetics.	a	b					
3.	discuss and appreciate the potential applications of plant biotechnology for the benefit of mankind	a	b	h				

Session	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1.	Preparation of tissue culture medium and callus induction	3	**C-D-I**	1,4,5	1,2
2.	Demonstration of direct and indirect organogenesis	3	**C-D-I**	1,4,5	1,2
3.	*In vitro* and *in vivo* embryogenesis	3	**C-D-I**	1,4,5	1,2
4.	Protoplast isolation, electro fusion and regeneration	3	**C-D-I**	2,4,5	1,2
5.	*Agrobacterium* mediated transformation, Electroporation	3	**C-D-I**	2,4,5	1,2
6.	Extraction and detection of nucleic acids from plants	3	**C-D-I**	2,4,5	1,3
7.	Understanding plant pathogen interactions using confocal microscopy	3	**C-D-I**	3,4,5	1
8.	Production of secondary metabolites in suspension cultures	3	**C-D-I**	1,4,5	1,3

Session	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
9.	Purification and quantification of secondary metabolites using TLC and HPLC	3	**C-D-I**	1,4,5	1,3
10.	SNP based multiplex PCR	3	**C-D-I**	3,4,5	1
	Total Contact Hours	**30**			

LEARNING RESOURCES	
S. No.	**REFERENCES**
1.	Laboratory Manual
2.	S.S. Bhojwani and Razdan, M. K. (Eds) Plant Tissue Culture Theory and Practice Elsevier Science Netherlands, 2006
3.	J. B. Harborne, Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. Springer, 1984

Course Nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination Weightage		**40%**

15BT302	**Environmental Biotechnology**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	15BT202,15BT206						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL -CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To acquire the knowledge on the biological approach for the conversion of various environmental pollutants, biological treatment processes, and bioproduct recovery from industrial wastes							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the biotechnological solutions for the treatment of industrial liquid and solid wastes	a						
2.	Acquire knowledge in aerobic and anaerobic biological treatment technologies	a	d	f				
3.	Understand the bioconversion pathways for the degradation of various xenobiotic compounds	a	b	f				
4.	Gain knowledge on the recovery of high value-added bioproducts from industrial wastes	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I – BIOTECHNOLOGICAL PROSPECTS	**9**			
1.	Perspectives of Wastewater, Waste, Off-Gas and Soil Treatment	1	C	1	1,2,5
2.	Contributions of Biotechnology to waste treatment and environmental managements	2	C,O	1	7
3.	Overcoming persistent pollutants by cooperation between anaerobic and aerobic bacteria	2	C	2	1,2,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
4.	Role of Biocatalysts in pollutant removal –Immobilized Enzymes and Cells	2	C,I,O	2,3	7
	UNIT II - RECENT TRENDS IN BIOLOGICAL WASTEWATER TREATMENT	**10**			
5.	Aerobic and Anaerobic Biological treatment processes for liquid and solid wastes	3	C,D,O	2	1
6.	Biofilm Technologies	2	C,D,O	2	1,3
7.	Recent advances in Nitrogen removal	2	C,D,O	1,2	1,3
8.	Enhanced Biological Phosphorous Removal	2	C,D,O	1,2	1,3
9.	Use of Genetically Engineered Organisms in wastewater treatment	2	C,O	1,2	4
	UNIT III –XENOBIOTICS AND RECALCITRANTS	**9**			
10.	Mechanisms of biodegradation of xenobiotics– Reductive/Oxidative/Hydrolytic	2	C	3	4
11.	Biotransformations of Aliphatics and Aromatic Hydrocarbons	3	C	3	4
12.	Biotransformations of Polyaromatic and Polycyclic aromatic Hydrocarbons	2	C	3	4
13.	Biotransformations of halogenated hydrocarbons	2	C	3	4
	UNIT IV – NOVEL TRENDS IN BIODEGRADATION	**9**			
14.	Microbial decolourization/degradation of Dyes polluted wastewater	3	C	2,3	3
15.	Microbial cells Dead or Alive: Prospect, potential and innovations for heavy metal removal	2	C	2,3	7
16.	Metabolism of organopollutants by microfungi	2	C	2,3	8
17.	Laccases and their role in Bioremediation of Industrial Effluents	2	C	2,3	7
	UNIT V – VALUE-ADDED BIOPRODUCTS FROM INDUSTRIAL WASTES	**8**			
18.	Recovery of bioproducts from slaughterhouse industry waste for industrial applications	2	C,O	4	7
19.	Recovery of bioproducts from leather industry wastes for industrial applications	2	C,O	4	7
20.	Extracellular polysaccharide from activated sludge	2	C,O	4	7
21.	Single cell protein and biomass from wastewater	1	C,O	4	3
22.	Recycling of plastic wastes - Bioplastics	1	C,O	4	7
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Bruce E.Rittmann and Perry L.McCarty, Environmental Biotechnology: Principles and Applications, McGraw Hill.
2.	Bimal C Bhattacharyya, Environmental Biotechnology, Oxford
3.	Milton Wainwright, An Introduction to Environmental Biotechnology, Springer
4.	P.Rajendran, P.Gunasekaran, Microbial Bioremediation, MJP Publishers, India
5.	Pradipta Kumar Mohapatra, Textbook of Environmental Biotechnology, I.K International publishing house, India.
6.	D. L. Wise (Ed.) Biotreatment Systems, Vol. 22, , CRC Press, INC.
	REFERENCE BOOKS/OTHER READING MATERIAL
7.	Ram Chandra, Advances in biodegradation and bioremediation of industrial wastes, CRC Press, Taylor&Francis.
8.	Hanes Joachim Joardening, Environmental Biotechnology, Concepts and Applications.
9.	Chatterjee A.K, Introduction to Environmental Biotechnology, Prentice Hall of India, 2004.

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15BT303	**Ethical Issues, Research Methodology and Intellectual Property Rights**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**2**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	B	BASIC SCIENCES	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	The course is designed to outline the methodology for research in biotechnology and provides an understanding of the ethical issues underlying biotechnology research and innovation in addition to protection of the acquired intellectual property. The student will gain an understanding research methodology, the ethical issues underlying biotechnology research and the importance of protection of intellectual property.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	understand the nature of hazards related to biotechnology and the importance of biosafety in research.	a	f	h				
2.	debate on ethical issues related to biotechnology research.	a	f	h				
3.	understand methods used in scientific research and to emphasize on the importance of statistical concepts.	a	f	h				
4.	realize the importance of intellectual property and its protection under the constitution.	a	f	h				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS IN INDIA	**9**			
1.	Regulatory Frame Work in India governing Transgenic Research and Field Trials	2		1	5
2.	Specific roles of various regulatory bodies	2	C	1	5
3.	Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells	2	C	1	5
4.	The Food Safety and Standards Bill (2005), Plant Quarantine Order (2003), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007),	1	C	1	5
5.	National Biodiversity Authority and National Environment Policy	2	C	1	5
	UNIT II: BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS AT INTERNATIONAL LEVEL	**9**			
6.	Convention of Biological Diversity (1992) –Benefits of becoming a party to the Cartagena Protocol-status of implementation in India.	2	C	1	2
7.	Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol –	3	C	1	2
8.	Advanced Information Agreement (AIA) procedure – procedures for GMOs risk management-handling, transport, packaging and identification	2	C-D	1	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
9.	Biosafety Clearing House-unintentional transboundary movement of GMOs	2	C- D - I	1	2
	UNIT III: BIOETHICS	**9**			
10.	The legal and socioeconomic impacts of biotechnology	3	C	2	1,7
11.	Public education of the process of biotechnology involved in generating new forms of life for informed decision-making	3	C-D-I	2	1,7
12.	Ethical concerns related to biotechnology research and innovation.	3	C-D-I	2	1,7
	UNIT IV: RESEARCH METHODOLOGY	**9**			
13.	Introduction to the design, analysis, and presentation of scientific projects - and,-	2	C-D	4	3
14.	Methods used in scientific research - hypothesis testing	1	C-D	4	3
15.	Measurement of functional relationships	2	C-D-I	4	3
16.	Observational research-important features of experimental design	2	C-D	4	3
17.	Control of errors- instrument calibration	1		4	3
18.	Data analysis	1	C-D	4	3
	UNIT V: INTELLECTUAL PROPERTY RIGHTS	**9**			
19.	Intellectual property rights-TRIPs-GATT-International conventions patents and methods of application of patents-Legal implications	2	C-D	4	1
20.	Objectives of the patent system	2	C-D	4	1
21.	Basic principles and general requirements of patent law-biotechnological inventions and patent law	1	C-D-I	4	1
22.	Patentable subjects and protection in biotechnology-	2	C-D-I	4	1
23.	Biodiversity and Plant variety protection and farmer rights.	2	C-D-I	4	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	*Biotechnology and Patent protection*- Beier, F.K., Crespi, R.S. and Straus, T. Oxford and IBH Publishing Co. New Delhi.
2.	*Cartagena Protocol on Biosafety* (2006) Ministry of Environment and Forest, Government of India, New Delhi
3.	Research methods for Science Michael P. Marder Cambridge University Press
4.	*Intellectual Property rights in Biotechnology*, Singh K, BCIL, New Delhi
	REFERENCE BOOKS/OTHER READING MATERIAL
5.	*Regulatory Framework for GMOs in India* (2006) Ministry of Environment and Forest, Government of India, New Delhi
6.	*Biotechnologies and Development* ,Sasson A, UNESCO Publications

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
				End semester examination Weightage :			**50%**

15BT304	Animal Biotechnology	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15BT204				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To provide a basic understanding of animal biotechnology and its applications							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Develop an understanding on basic pattern of animal breeding, controlling characters and disorders	a		f	i			
2.	Inculcate the understanding of cell culture technique, significance of its cultivation and its application in the production of valuable products	a	c	f				
3.	Give emphasis to animal health thereby improving livestock production	a		f				
4.	Impart knowledge on production of transgenic animals and how to improve the meat and milk production	a		f				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ANIMAL BREEDS	**7**			
1.	Breed – Species – different types of breeding, upgrading	2	C	1	2
2.	Economic traits – Quantitative trait loci – Marker assisted selection	2	C	1	
3.	Genetic disorders	1	C	1	
4.	Chromosomal aberrations in farm animals	2	C	1	
	UNIT II: EMBRYO TRANSFER & TRANSGENIC ANIMALS	**8**			
5.	Artificial insemination, Superovulation, Embryo transfer	2	C	3	1
6.	In vitro fertilization – Pregnancy diagnosis – Sexing of embryos, Embryo splitting; Cryopreservation of embryo-Cloning for conservation of endangered species	3	C	3	1
7.	Transgenic animals: Therapeutic protein expression using transgenic animals – Transgenic fish	2	C, D	3	3
8.	Animal as bioreactors	1	D	3	1
	UNIT III: ANIMAL CELL CULTURE & IN VIVO MODELS	**14**			
9.	Principles of sterile techniques and cell propagation – Primary cell culture, secondary cell culture, continuous cell lines, suspension cultures	2	C	2	4 4
10.	Chemically defined and serum free media for cell culture; Scaling up of animal cell culture	3	C,D	2	
11.	Contamination: sources, types and eradication	1	C	2	
12.	Preservation and characterization of animal cells	1	C	2	
13.	Application of animal cell culture in vitro testing of drugs: Cytotoxicity and viability assays	2	C	2	
14.	Cell culture as source of therapeutic protein production	2	C,I	2	1
	UNIT IV: VACCINES FOR ANIMAL HEALTH	**8**			
15.	Common viral, bacterial and parasitic diseases affecting animals	3	C	3	1
16.	Live vaccines, killed vaccines	1	C	3	
17.	Conjugate vaccines- Anti Idiotypic vaccine	1	C	3	
18.	Subunit vaccines	1	C	3	
19.	Recombinant vaccines – DNA vaccines	2	C	3	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V: BIOTECHNOLOGY IN ANIMAL PRODUCTION	**8**			
20.	Manipulation of Growth hormone – somatotropic hormone – Thyroid hormone	2	C	4	1, 5
21.	Probiotics as growth promoters – Ideal characteristics of probiotics, Mode of action – uses of probiotics probiotics	2	C	4	
22.	Manipulation of lactation – Lactogenesis – galactopoiesis	2	C	4	
23.	Manipulation of wool growth	1	C,D	4	
24.	Manipulation of rumen microbial digestive system	1	C,D	4	
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	*Animal Biotechnology: Recent concepts and developments* - P.Ramadas, MJP Publications, 2015.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	*Animal breeding plans*- Joy L. Lush, IInd edition, 1943.
3.	*Animal Biotechnology* – M.M.Ranga, IIIrd edition, 2007.
4.	*Culture of animal cells; a manual of basic technique* - R.Ian Freshney, Vth edition, Wiley publications, 2006.
5.	*Textbook of Animal Biotechnology – P.Ramadas & S.Meerarani, IInd edition, 2002.*

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT304L	**Animal Biotechnology Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**
Co-requisite:	15BT304				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To experimentally verify the theoretical concepts and gain hands on training in animal cell culture							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
5.	Implement the theoretical knowledge on animal biotechnology in *in vitro* culturing of mammalian cells	b						
6.	Develop skills in animal cell culture techniques	b	e	f				

Session	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Preparation of cell culture media	3	C	1	1,2
2.	Isolation and culturing of splenocytes	3	C,D	1,2	1
3.	Cell Viability : Determination of cell viability of hepatocytes cultured *invitro*	3	C,D	1,2	1

Session	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
4.	Primary cell culture: Isolation and culturing of fibroblast from chick embryo	3	C,D	1	1
5.	Cell culture : Cell passaging	3	C	1,2	1,2
6.	Cell culture maintenance : Cryopreservation of cells	3	C	1,2	1,2
7.	Revival of cryopreserved cells	3	C	1,2	1,2
8.	Cell death: Nuclear staining using fluorochromes	3	C,D	2	1
9.	Cell cytotoxicity: MTT assay	3	C,D,I	2	1,2
10.	Cellular assay: Glucose uptake assay in L6 myotubes	3	I	2	1
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Freshney.R.I, "Culture of Animal cells", Fifth edition, Wiley Publishers, 2010.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15BT305	**Bioprocess Engineering**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	15BT206, 15CH252						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	This subject focus on the design, development and analysis of biochemical processes with the applications of modern tools of biotechnology							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Strengthen the knowledge on design, performance and operation of reactors	a	e					
2.	Develop skills to design appropriate bioreactors for maximizing production of useful bioproducts from various sources	a	c	e				
3.	Integrate various methods of monitoring and control of bioreactor operation parameters	a						
4.	Familiarize with notions of bioreactor scale up for large scale operation	a	e					
5.	Accomplish knowledge about the fundamentals of modeling and simulations of bio process	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : FUNDAMENTALS OF REACTOR ENGINEERING	**9**			
1.	Introduction to ideal reactors: performance equations	4	C	1	1
2.	Non-ideal reactors: Tanks-in-series and Dispersion models	4	D-I,O	1	1
3.	Applications to design of continuous sterilizers	1	I-O	1	3,6

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT II :NOVEL BIOREACTORS	**9**			
4.	Design and operation of novel reactors	4	C-D-I-O	1,2	3,4
5.	Bioreactor configurations for production of primary and secondary metabolites from various sources	3	C-D-I-O	1,2	2
6.	Bioreactor strategies for maximizing product formation	2	C-I	1,2	2
	UNIT III : INSTRUMENTATION AND CONTROL SYSTEMS	**9**			
7.	Monitoring and control of physico-chemical and biochemical parameters	2	C-O	3	4
8.	Methods of on-line and off-line biomass estimation	1	C-I-O	3	4
9.	Microbial calorimetry	1	C	3	4
10.	Flow injection analysis for measurement of substrates, products and other metabolites	2	C	3	3,4
11.	State and parameter estimation	1	C	3	5
12.	Computer-based data acquisition: monitoring and control-LABVIEW Software	2	C-I	3	4
	UNIT IV : SCALE-UP	**8**			
13.	Transport phenomena in bioprocess systems: Oxygen transfer in fermentation broth	2	C	1,4	3,6
14.	Rheological effects	1	C	1,4	3,6
15.	Regime analysis of bioreactor processes	1	C-I	1,4	3,6
16.	Correlations for oxygen transfer	1	C-I	1,4	3,6
17.	Scale-up: Criteria for bioreactors based on oxygen transfer and power consumption.	3	C-D-I-O	1,2,4	3
	UNIT V: MODELLING AND SIMULATION	**10**			
18.	Introduction to mathematical modelling of biological systems	1	C	5	3
19.	Formulation of model	1	D-I	5	3
20.	Single cell model, Metabolic model	2	C	5	3
21.	Models of gene expression and regulation	2	C	5	3
22.	Simulation software packages: Running simulation in MATLAB, SIMULINK and ISIM	2	I-O	1,5	4
23.	Dynamic simulation studies: Batch, continuous and fed batch fermentation process	2	I-O	1,5	4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Scott F.H., " *Elements of Chemical Reaction Engineering*", 6th Edition, Pearson Education, Inc.,2006
2.	Shuler. M.L.,Kargi. F., "*Bioprocess Engineering: Basic Concepts*", 2nd Edition. Pearson, 2002.
3.	Blanch. H.W., Clark.D.S., "*Biochemical Engineering*", Marcal& Dekker, Inc., 1997.
4.	Rao. D.G., "*Introduction of Biochemical Engineering*", Tata McGraw-Hill Publishing Company Limited, 2006.
	REFERENCE BOOKS/OTHER READING MATERIAL
5.	Bailey. J. E.,Ollis.D.F, "*Biochemical Engineering Fundamentals*", 2nd Edition, McGraw-Hill, 1986.
6.	Doran. P. M., "*Bioprocess Engineering Principles*", Academic press, 1995.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT305L	Bioprocess Engineering Laboratory	L	T	P	C
		0	0	3	2
Co-requisite:	**15BT305**				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	B PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	Provides an opportunity to experimentally analyze the theoretical concepts studied inBioprocess Engineering. It also helps in understanding the theoretical principles in a more explicit and concentrated manner.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Enable the students to understand the importance of sterilization kinetics	b	c	k				
2.	Analyze the growth kinetics of microorganisms and estimation of their kinetic parameters	b						
3.	Experiment the techniques of screening of medium components and their concentration optimization	b	c	k				
4.	Evaluate the oxygen mass transfer coefficient by various methods	b						
5.	Investigate the rheology of fermentation broth and analyze the effect of dimensionless numbers	b						

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Sterilization kinetics- determination of holding time	3	I,O	1	1,2
2.	Temperature effect on growth-estimation of energy of activation and Arrhenius constant for microorganisms	3	I,O	1	1,2
3.	Growth kinetics of bacteria- evaluation of specific growth rate, yield coefficient and doubling time	3	I,O	2	1,2
4.	Growth kinetics of yeast- evaluation of specific growth rate, yield coefficient and doubling time	3	I,O	2	1,2
5.	Estimation of Monod parameters	3	D,I,O	2	1,2
6.	Screening of Medium composition – Plackett -Burman design	3	D,I,O	3	1,2
7.	K_La determination by sulphite oxidation method	3	I,O	4	1,2
8.	K_La determination by dynamic gassing method	3	I,O	4	1,2
9.	K_La determination by power correlation analysis	3	I,O	4	1,2
10.	Power correlation analysis	3	I,O	5	1,2
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Blanch. H.W., Clark. D.S., "*Biochemical Engineering*", Marcal& Dekker, Inc., 1997

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination Weightage :		**40%**

15BT306	Pharmaceutical Biotechnology	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15BT103, 15BT205				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To provide basic concepts of pharmacology and the role of biotechnological products in pharmaceutical industries. The course ensures to impart brief knowledge on current technologies, requirements and futuristic demand in pharmaceutical sector.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be								
1.	Acquainted with parameters desired in an ideal drug	a	c					
2.	Familiarized with mechanism of action and clinical uses of few Pharmaceutical agents.	a	f					
3.	Knowing the current industrial methods of preparing certain special Pharmaceutical agents,	a	f					
4.	Aware of laws and regulations of Pharmaceutical sector in India	i						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: GENERAL PHARMACOLOGY	**12**			
1.	**Definitions**: Pharmacology, Pharmacokinetics, Pharmacodynamics, Drug, Pharmacodynamic agents, chemotherapeutic agents, Pharmaceutical agents. **Drug Nomenclature** – Chemical name, Non-proprietary and Proprietary name (official and approved names). Essential drug list and orphan drugs. **Routes of drug administration** – Local and systemic routes. Preferances of the route of administration and limitations.	2	C	1	1
2.	**Pharmacokinetic processes** – Transport of molecules across biological membrane and influence of pH. **Absorption of Drug** – Factors affecting absorption based on route of administration. Bioavailability of the drug. **Distribution** – volume of distribution, plasma binding of drug, tissue storage and redistribution, movement of drug through Blood brain barrier and placenta. **Metabolism** – Biotransformation of drugs, Non-synthetic, synthetic and Hofmann reaction **Excretion** – routes of excretion. Kinetics of elimination – Clearance, Plasma half-life, steady state plasma concentration, loading and maintanence dose. Prolongation of drug action.	5	C, D	1	1
3.	**Principles and Mechanism of drug action** – Physical, chemical, enzymatic and receptor mediated actions. **Transducer mechanism** – GPCR, Ion channels, Enzymatic receptor, nuclear receptor and regulation of receptors. **Dose-Response relationship** – Therapeutic window, Lethal dose, Effective dose, Potency and efficacy, combined effect of drugs. Factors modifying drug action.	5	C, D	1,2	1
	UNIT II: INDUSTRIALLY RELEVANT BIOPHARMACEUTICALS	**10**			
4.	**Drugs affecting blood formation:** **Iron** – requirement, absorption, transport, storage and excretion, Preparations and dose, Poisoning and treatment.	6	C	2,3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Vitamin B12 and Folic acid – requirement, Functions, Industrial production and preparations. Erythropoiesis and **erythropoietin.**				
5.	**Immunosuppressants** – Specific T-cell inhibitors, cytotoxic drugs, Glucocorticoids, Antibodies obtained by hybridoma technology	4	C	2,3	1,2
	UNIT III: CHEMOTHERAPEUTIC AGENTS	**7**			
6.	Structrue, Mechanism of action, industrial production and uses of: (i) Beta-lactum antibiotics –Pencillin &Cephalosporins (ii) Aminoglycoside – Streptomycin (iii) Griseofulvin (iv) Rifampicin (v) Mitomycin C (vi) Rituximab (Cancer therapy – lymphoma)	7	C	2,3	1,2
	UNIT IV: SECONDARY METABOLITES AND GENETICALLY ENGINEERED PHARMACEUTICALS	**9**			3.6
7.	Structure, Properties, Industrial production and applications of ethanol and riboflavin	4	C	2,3	2
8.	Pathology of Diabetes – Structure, Production and use of Human insulin hormone	2	C, I	2,3	1,2
9.	Cause, signs and symptoms, treatment of Hepatitis A and B – Production of vaccines	1	C, I	2,3	1,2
10.	Causative agent, Life cycle, signs and symptoms, treatment of malaria – Production of anti-malarial vaccines	2	C, I	2,3	1,2
	UNIT V: PHARMACEUTICAL INDUSTRY & REGULATIONS	**7**			
11.	CDSCO – Hierarchy, regulation on import of drugs (custom clearance and central drug inspectors), conduction of clinical trials (licensing and monitoring clinical research organizations)	2	C	4	3
12.	Role of state government in regulation of pharmaceutical sector – State drug inspectors, periodical visits and testing of samples from industries, distributors and pharmacy shops. Licenses for manufacturing industry, drug distributors and medical shops.	3	C	4	3
13.	Drugs and Cosmetics Act, 1945.	2	C	4	3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Tripathi.K.D, *"Essentials of Medical Pharmacology"*,Jaypee Brothers Medical Publishers, New Delhi, 7th Edition.
2.	Patel.A.H, *"Industrial Microbiology"*, 2nd Edition, Macmillan India Limited, 2011.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	http://www.cdsco.nic.in/forms/contentpage1.aspx?lid=1888

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT390L	Internship	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting July 23, 2016				

PURPOSE	To provide short-term work experience in an Industry/ Company/ Organisation							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To get an inside view of an industry and organization/company				j			
2.	To gain valuable skills and knowledge				j			
3.	To make professional connections and enhance networking	f	g					
4.	To get experience in a field to allow the student to make a career transition			i				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	1. It is mandatory for every student to undergo this course. 2. Every student is expected to spend a minimum of 15-days in an Industry/ Company/ Organization, during the summer vacation. 3. The type of industry must be NOT below the Medium Scale category in his / her domain of the degree programme. 4. The student must submit the "Training Completion Certificate" issued by the industry / company / Organisation as well as a technical report not exceeding 15 pages, within the stipulated time to be eligible for making a presentation before the committee constituted by the department. 5. The committee will then assess the student based on the report submitted and the presentation made. 6. Marks will be awarded out of maximum 100. 7. Appropriate grades will be assigned as per the regulations. 8. Only if a student gets a minimum of pass grade, appropriate credit will be transferred towards the degree requirements, as per the regulations. 9. It is solely the responsibility of the individual student to fulfill the above conditions to earn the credits. 10. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100%, if the credits are transferred, after satisfying the above (1) to (8) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO. 11. The committee must recommend redoing the course, if it collectively concludes, based on the assessment made from the report and presentations submitted by the student, that either the level of training received or the skill and / or knowledge gained is NOT satisfactory.		D, I,O	1,2,3,4	
	Total contact hours				

Course nature		**Training – 100% internal continuous assessment**		
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	**Presentation**	**Report**	**Total**
	Weightage	**80%**	**20%**	**100%**
End semester examination Weightage :				**0%**

15BT375L/15BT376L	Minor Project I and II	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting July 23, 2016				

PURPOSE	To obtain an hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills and / or knowledge and working in at team.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To conceptualise a novel idea / technique into a product	c						
2.	To think in terms of multi-disciplinary environment		d					
3.	To understand the management techniques of implementing a project				k			
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.			g				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	A Multidisciplinary project to be taken up by a team of maximum of ten students. Development of prototype product, a 3D model, simulation, blueprint for a larger project and any other development work are permitted. The contribution of the individuals in the project should be clearly brought out. A combined report is to be submitted. A presentation is to be made for the reviewers on the work done by the candidate.		C,D,I	1,2,3,4	
	Total contact hours				

Course nature		**Project – 100% internal continuous assessment**	
Assessment Method (Weightage 100%)			
In-semester	**Assessment tool**	Refer the table	**Total**
	Weightage	Refer the table below	**100%**
End semester examination Weightage :			**0%**

Assessment components

Assessment component	Expected outcome	Evaluators	Criteria or basis	Marks
Project proposal (Review – I)	A short presentation to be delivered on: • A brief, descriptive project title (2-4 words). This is critical! • The 3 nearest competitors (existing solutions) and price. • Team members name, phone number, email, department/degree program, and year. • A description of the product opportunity that has been identified. To include: Documentation of the market need, shortcomings of existing competitive products, and definition of the target market and its size. • Proposed supervisor / guide	Panel of reviewers	Viability / feasibility of the project Extent of preliminary work done.	**0**

Assessment component	Expected outcome	Evaluators	Criteria or basis	Marks
Review II	• Mission Statement / Techniques • Concept Sketches, Design Specifications / Modules & Techniques along with System architecture • Coding	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, team work, handling Q&A.	**20**
Review III	• Final Concept and Model / Algorithm/ Technique • Drawings, Plans / programme output • Financial Model / costing • Prototype / Coding • Final Presentation and Demonstration	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, team work, handling Q&A.	**50**
Final technical Report	A good technical report	Supervisor / Guide	Regularity, systematic progress, extent of work and quality of work	**30**
			Total	**100**

15BT380L/15BT381L	**Seminar I and II**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting July 23, 2016				

PURPOSE	To enhance the disseminating skills of the student about the current and contemporary research work that are being carried out across the world.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To understand the research methodology adopted by various researchers	h	i	j				
2.	To mathematically model a problem, critically analyse it and adopt strategies to solve	b	c	e				
3.	To understand and present a well documented research	e	g					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Guidelines for conducting 15BT390L Seminar for B.Tech 1. Upon registering for the course the student must identify a sub-domain of the degree specialization that is of interest to the student and start collecting research papers as many as possible. 2. After collecting sufficient number of research papers the student must peruse all the papers, meet the course		C,D	1,2,3,4	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	faculty and discuss on the salient aspects of each and every paper. 3. The course faculty, after discussion with the student will approve TWO research papers that is appropriate for presentation. 4. The student must collect additional relevant reference materials to supplement and compliment the two research papers and start preparing the presentation. 5. Each student must present a 15-minute presentation on each of the approved research paper to the panel of evaluators. 6. The presenter must present one research paper within the first half of the semester (6 weeks) and another research paper in the next half of the semester (6 weeks) as per the schedule. 7. All other students registered for the course will form the audience. 8. The audience as well as the evaluators will probe the student with appropriate questions and solicit response from the presenter. 9. The presentation will be evaluated against 7 to 8 assessment criteria by 4 to 5 evaluators. 10. The score obtained through the presentations of TWO research papers will be converted to appropriate percentage of marks. This course is 100% internal continuous assessment.				
	Total contact hours				

Course nature		**100% internal continuous assessment.**		
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	Presentation 1	Presentation 2	**Total**
	Weightage	**50%**	**50%**	**100%**
End semester examination Weightage :				**0%**

Department of Biotechnology
EVALUATION OF SEMINAR PRESENTATIONS

Name of the Student: Date:
Register Number: Degree and Branch:
Topic:

Sl. No.	Criteria for Assessment	Evaluator 1	Evaluator 2	Evaluator 3	Evaluator 4	Evaluator 5
1	Understanding of the subject					
2	Clarity of presentation					
3	Appropriate use of Audio visual aids					
4	Whether cross references have been consulted					
5	Ability to respond to questions on the subject					
6	Time scheduling					
7	Completeness of preparation					

Poor	1		Below Average	2		Average	3		Good	4		Very Good	5

Overall Grades:
Remarks:
Signature of Course Coordinator

15BT385L/15BT386L	**Massive Open Online Courses (MOOCs) I & II**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting July 23, 2016				

PURPOSE	To offer students the opportunity to study with the world's best universities by integrating select MOOCs in a regular degree programme and providing students full credit transfer, as per university regulations, if they earn a "Verified / Completion Certificate" and take a proctored examination through a secure, physical testing center.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.	f	h	i	j			

Course nature		**Online - 100% internal continuous assessment.**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Quiz	Assignment	Non-proctored / Unsupervised Tests	Proctored / Supervised Test	**Total**
	Weightage	**25%**	**25%**	**10%**	**40%**	**100%**
End semester examination Weightage :						**0%**

Registration process, Assessment and Credit Transfer:

1. Students can register for courses offered by approved global MOOCs platforms like edX, Coursera or Universities with which SRM partners specifically for MOOCs.
2. Annually, each department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be recognised and accepted for credit transfer.
3. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring the tests, uploading the marks / grades, and collecting and submitting the graded certificate(s) to the CoE, within the stipulated timeframe.
4. Student who desires to pursue a course, from the above department-approved list, through MOOCs must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.
5. The maximum credit limits for course registration at SRM will include the MOOCs course registered.
6. The student must periodically submit the marks / grades obtained in various quizzes, assignments, tests etc immediately to the Faculty Advisor or the Course Coordinator for uploading in the university's academic module.
7. The student must take the final test as a Proctored / Supervised test in the university campus.
8. The student must submit the "Certificate of Completion" as well as the final overall Marks and / or Grade within the stipulated time for effecting the grade conversion and credit transfer, as per the regulations. It is solely the responsibility of the individual student to fulfil the above conditions to earn the credits.

9. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100% , if the credits are transferred, after satisfying the above (1) to (7) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO.

15BT490L/15BT491L	**Industry Module I & II**			**L**	**T**	**P**	**C**
				0	**0**	**3**	**2**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting July 23, 2016						

PURPOSE	To impart an insight into the current industrial trends and practices							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To obtain an insight into the current industrial trends and practices			j				
2.	To obtain an insight into the technologies adopted by industries			j				
3.	To obtain an insight into the technical problems encountered by the industries and the scope for providing solutions.		h					
4.	To network with industry	g						

Description of Topic	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1. The department will identify and shortlist few emerging topics that are trending in industry. 2. The department will identify experts from industry who are willing to deliver modules on the shortlisted topics. 3. The identified expert will assist the department in formulating the course content to be delivered as a 30-hour module, prepare lectures notes, ppt, handouts and other learning materials. 4. The department will arrange to get the necessary approvals for offering the course, from the university's statutory academic bodies well before the actual offering. 5. The department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be offered as industry module. 6. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring/supervising/assessment the quizzes, assignments, tests etc, uploading the marks, attendance etc, within the stipulated timeframe. 7. The Student who desires to pursue a course, from the above department-approved list, must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University. 8. The maximum credit limits for course registration at SRM will include the Industry Module also. 9. All academic requirements of a professional course like minimum attendance, assessment methods, discipline etc will be applicable for this Industry Module. 10. The course will be conducted on week ends or beyond the college regular working hours.		C,D,I,O	1,2,3,4	
Total contact hours	**30**			

Course nature				100% internal continuous assessment.			
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage							**50%**

15BT401	**Gene Manipulation and Genomics**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	15BT204						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To provide the basic knowledge about genetic engineering of nucleic acids for cloning and expression of proteins.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with the basic concepts and principles of utilization of different expression vectors for cloning in prokaryotic and eukaryotic organisms	h						
2.	Understand the different strategies of gene cloning and construction of genomic and cDNA libraries for applications of recombinant DNA technology	a						
3.	Familiarize the concepts of structural and functional genomics	a						

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: INTRODUCTION TO CLONING	**9**			
1.	Overview of cloning: Cell based DNA cloning - Cell free DNA cloning	2		1	1,2
2.	Plasmid vectors, Phage vectors – Cosmids	4	C	1	1,2
3.	YAC- Expression vectors	3	C	1	1,2
	UNIT II: GENOMIC AND CDNA LIBRARIES	**9**			
4.	Genomic DNA library: Overlapping and non-overlapping DNA fragments - Choice of vectors - Evaluation of genomic DNA library	2	C	2	1
5.	cDNA library: Purification and separation of RNAs - cDNA library construction	2	C	2	1
6.	Screening libraries	2	C	2	1
7.	Polymerase chain reaction (PCR): Semi quantitative PCR - Real time PCR and Applications.	3	C	2	1,2
	UNIT III: DNA SEQUENCING AND NUCLEIC ACIDS LABELING	**9**			
8.	Principles of DNA sequencing: Sanger's Dideoxy sequencing method	2		2	1,2
9.	Next generation sequencing	2	C	2	2
10.	Labeling of nucleic acids: Random priming - Nick translation - End labeling - RNA labeling - Non-isotopic labeling methods	2	C	2	1,2
11.	Structural genomics, comparative genomics	3		3	3
	UNIT IV: ANALYSIS AND MANIPULATION OF GENE EXPRESSION AND FUNCTION	**9**			
12.	Analysis of gene expression: Transcription and translation - Transcriptomics	2	C	3	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13.	Analysis of gene function	1		3	1,3
14.	Manipulation of gene expression: Small RNAs – siRNAs - MicroRNAs	2	D	3	3
15.	Expression in prokaryotic and eukaryotic host cells: *in vitro* mutagenesis	4	C	3	1
	UNIT V: APPLICATIONS OF CLONING	**9**			
16.	Medical applications: Human and genetic diseases – Gene therapy	3		2	1,2
17.	Embryonic stem cells	3	C	2	1,2
18.	Over-expression - Gene knock-in - Gene knock-out	3	C	2	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Jeremy W. Dale and Malcolm von Schantz, "From Genes to Genomes," John Willey and Sons Publications, 2002.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Old.R.W and Primrose.S.B, "Principles of Gene Manipulation, An Introduction to Genetic Engineering," Blackwell Scientific Publications, 1985.
3.	S.B.Primrose and R.M.Twyman, "Principles of Gene Manipulation and Genomics"7th Edition, Wiley-Blackwell, 2006.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT402	**Protein Engineering and Proteomics**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	15BT205						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	The course aims at imparting knowledge on proteins through a detailed study of protein structure, its characteristics property and significance in biological systems, as well as, with strategies for modifying the structures for desirable properties in industry. It briefs about the different analytical techniques available for protein structure elucidation.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be to								
1.	Appreciate the structure function correlation and the prediction of properties of protein based on its sequence.	a	c					
2.	Observe the similarities in structure at basal level in a group of having similar function, thereby predicting the strategies to modify and design novel proteins.	a	c					
3.	Understand different analytical methods to determine protein structure and protein – protein interactions.	a	f					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: BASIC STRUCTURAL PRINCIPLES	**9**			
1.	Primary Structure – Amino acids structure and properties. Role of Glycine and Proline in structure determination. Ramachandran plot and its significance.	2	C	1	1
2.	**Secondary Structure –** helices types and significance, Beta strands and formation of Beta sheets, turns and loops. Interactions that determine the type of secondary structure. Super secondary structures – Motifs and domains (structural and functional)	4	C	1	1
3.	**Tertiary Structure & Quarternary Structure –** Monomeric and polymeric proteins, hydrophobic collapse, theories of folding, Levinthal paradox, Role of chaperons and heat shock proteins.	3	C	1	1
	UNIT II: STRUCTURE FUNCTION CORRELATION IN PROTEINS	**13**			
4.	The Structure-Function correlation in Transcription factors – TATA box binding proteins, p53 and GCN4 (Leucine zipper)	7	C	1, 2	1
5.	The Structure-Function correlation in fibrous proteins – muscle fibers myosin, actin and the role in ATP in muscle contraction	2	C	1, 2	1
6.	The Structure-Function correlation in Signal transducers – GPCR and tyrosine kinase	4	C	1, 2	1
	UNIT III: PREDICTION AND DESIGN OF PROTEINS	**9**			
7.	Structural modifications for enhanced stability and activity – case study of Serine Proteinases – Catalytic properties variation in trypsin, chymotrypsin and subtilisin.	3	C, D	1, 2	1
8.	Structural modifications in complimentary determining region of IgG and its effect on the specificity of antibodies.	3	C, D	1, 2	1
9.	Homology modeling and threading for prediction of structure from its sequence – case study of T4 lysozyme with introduced disulphide linkages by reducing free sulphydral groups – enhanced affinity and stability	3	C, D	1, 2	1
	UNIT IV: PROTEIN STRUCTURE CHARACTERIZATION	**7**			
10.	X-ray crystallography – Methods for generating crystals, Instrumentation setup, Phase problem and Fourier transformation. Role of metals in structure resolution.	2	C	3	1, 3
11.	NMR – Principle, Instrumentation and working with respect to biological samples.	3	C	3	1, 3
12.	Isothermal Titration Calorimetry – Principle, Instrumentation and working. Determination of enthalpy and entropy with respect to the local minima structure obtained.	1	C	3	1, 3
13.	Circular Dichroism, Tandem MS and SALSA	3	C	3	1, 3
	UNIT V: PROTEOMICS	**7**			
14.	Methods to analyze protein – Electrophoresis and Chromatography	1	C	1, 3	2
15.	Determination of protein sequence: Edman degradation, Mass fingerprinting.	2	C, I	1, 3	2
16.	Protein synthesis and Post-translational modifications	2	C	1	2
17.	Proteomics and analysis of cancer markers	2	C	1, 3	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Brandon.C, Tooze.J, *"Introduction to Protein Structure"*, Garland Publishing, Taylor & Francis group, 2nd Edition.
2.	Twyman. R. M, *"Principles of Proteomics"*, Garland Scientific Publishers, 2004.
3.	Chatwal. G. R, *"Instrumental methods of Chemical Analysis"*, Himalaya Publishing House, 5th Edition, 2011.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15BT403	**Bioseparation Technology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	15BT305, 15CH253				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	The course provides an acquaintance of various unit operations to implement logically in bioprocess operations to recover and purify the bioproduct.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Comprehend the necessity of bioseparation processes in biotechnology	a						
2.	Accomplish knowledge on primary isolation and concentration of desired product	a	c	k				
3.	Acquire knowledge to implement suitable techniques for product purification	a	c	k				
4.	Analyze the quality and characteristics of the purified product	a	c					
5.	Ability to formulate the product to meet marketable standards	a	k					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I :INTRODUCTION TO BIOSEPARATION PROCESS	**7**			
1.	Importance of bioseparation in biotechnological processes	1	C	1	1,2
2.	Problems and requirements of bioproduct purification	1	C	1,5	1,2
3.	Process economics: Capital and operating cost analysis	1	C	1,5	1
4.	Cell disruption methods for intracellular products: Physical, chemical and mechanical.	4	C,I,O	2	1
	UNIT II :SOLID-LIQUID SEPARATION	**9**			
5.	Biomass and particulate debris separation techniques	2	C,I,O	2,3	2
6.	Flocculation	2	C,I,O	2,3	1
7.	Centrifugation	2	C,I,O	2,3	2
8.	Filtration methods	3	C,I,O	2,3	2
	UNIT III :ISOLATION OF PRODUCTS	**10**			
9.	Adsorption	1	C,I,O	2,3	2
10.	Liquid-liquid Extraction	2	C,I,O	2,3	2
11.	Aqueous two-phase extraction	1	C,I,O	2,3	4
12.	Supercritical extraction	2	C,I,O	2,3	4
13.	Precipitation, Dialysis	2	C,I,O	2,3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
14.	Membrane based separations: Micro and ultra filtration	2	C,I,O	2,3	1,2
	UNIT IV :PURIFICATION OF BIOPRODUCT	**12**			
15.	Chromatography – principles, instruments and practice	1	C	4	1,4
16.	Normal phase chromatography, reversed phase chromatography,	2	C	4	1,4
17.	Ion exchange chromatography, gel permeation chromatography,	2	I,O	4	1,4
18.	Bioaffinity chromatography, hydrophobic interaction chromatography,	2	I,O	4	1,4
19.	Chiral chromatography	2	I,O	4	1,4
20.	Analysis of purity	1	C,I	4,5	1
21.	Electrophoretic separation technique	2	C,I,O	4	1,4
	UNIT V: PRODUCT FORMULATION	**8**			
22.	Crystallization	2	C	4,5	3
23.	Batch crystallizers: Scale-up and design	1	I,O	4,5	3
24.	Drying	2	C	4,5	2
25.	Description and operation-Vacuum shelf - rotary dryer-Freeze dryer-Spray dryer	3	I,O	4,5	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Harrison. R.G., Todd. P., Rudge S.R, Petrides. D.P, "*Bioseparation Science and Engineering*" Oxford University press, 2003.
2.	Belter. P.A., Cussler, E., "*Bioseparations*", Wiley, 1985.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Nooralabettu Krishna Prasad, "Downstream Process Technology: A New Horizon In Biotechnology", PHI Learning Private Limited 2013
4.	B. Sivasankar, "Bioseparations: Principles and Techniques", PHI Learning Private Limited , 2011

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT403L	**Bioseparation Technology Laboratory**			**L**	**T**	**P**	**C**
				0	**0**	**3**	**2**
Co-requisite:	**15BT403**						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	-- Academic Council Meeting -- , 2016						

PURPOSE	Provides an opportunity to gain practical experience on bioproduct recovery and purification techniques.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Expose to techniques practiced for recovery of intracellular bioproducts	b	k					
2.	Implement the solid-liquid separation techniques	b	k					
3.	Apply the techniques for concentration and purification	b	k					
4.	Analyze the nature and quality of the bioproduct	b	k					

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Mechanical cell disruption – Ultrasonication	3	D-I-O	1	1,2
2.	Mechanical cell disruption – High pressure homogeneizer	3	D-I-O	1	1,2
3.	Enzymatic cell disruption	3	D-I-O	1	1,2
4.	Separation of insolubles by filtration –determination of specific cake resistance	3	D-I-O	2	1,2
5.	Flocculation	3	D-I-O	2	1,2
6.	Aqueous two phase extraction	3	D-I-O	3	1,2
7.	Ammonium sulphate precipitation and dialysis	3	D-I-O	3	1,2
8.	Ultra and microfiltration	3	D-I-O	3	1,2
9.	Gas chromatography	3	I-O	4	1,2
10.	Lyophilization	3	I-O	4	1,2
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Belter. P.A., Cussler. E.L., Houhu. W., " *Bioseparations – Downstream Processing For Biotechnology"*, Wiley Interscience Publishers, 1988.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15BT404M	**Multi-Disciplinary Design**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:							
Prerequisite:							
Data Book / Codes/Standards							
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting July 23, 2016						

PURPOSE	Students of any specialization at an undergraduate level learn courses related to various sub-domains (Multi-disciplinary) of their specialization individually. They are not exposed to understanding how the various multi-disciplinary domains interact and integrate in real life situations. It is very common that an expert in a particular domain models and designs systems or products is oblivious of the impact of other subsystems. This lack of multi-disciplinary thinking is very blatantly visible when the students take up their major project during their final year. This course aims to develop appropriate skills on systemic thinking on how to identify and formulate a problem, deconstruct the problem into smaller elements, conceptualise the design, evaluate the conceptual design by using scientific, engineering and managerial tools, select, analyze and interpret the data, consideration of safety, socio-politico-cultural, risks and hazards, disposal, regional and national laws, costing and financial model and undertake documentation and finally presentation.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model	a	c	e	f	i	l	

2.	To rationalize a system architecture or product design problem by selecting appropriate design variables, parameters and constraints	a	c	e	f	i	l	
3.	To design for value and quantitatively assess the expected lifecycle cost of a new system or product	a	c	e	f	i	l	
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	a	c	e	f	i	l	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1	Introduction: Facilitating Multidisciplinary Projects		C,D,I,O	1,2,3,4	
2	Identifying and formulating a problem				
3	System Modelling				
4	Thinking perspectives: Decomposition–Composition Thinking Hierarchical Thinking, Organizational Thinking, Life-Cycle Thinking, Safety Thinking, Risk Thinking, Environment Thinking				
5	Decomposing a system – Identifying the major sub-systems				
6	Mathematical Modeling and Governing equations for each sub systems				
7	Objectives, Constraints and Design Variables				
8	Conceptual Design				
9	Collaborative Design – Disciplinary teams satisfy the local constraints while trying to match the global constraints set by the project coordinator.				
10	Tools for modeling, designing, analysis, data interpretation, decision making etc				
11	Design Analysis, evaluation and selection				
13	Documentation, Reviewing and Presentation				
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	To be decided by the students based on the choice of the problem, conceptualization of the design, the methodology, risks and hazards, disposal, regional and national laws (wherever applicable)..

Course nature		**Predominantly Practice Complemented by theory**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Review 1	Review 2	Review 3	Review 4	**Total**
	Weightage	**10%**	**25%**	**25%**	**40%**	**100%**
End semester examination Weightage :						**0%**

Pedagogy:
Theme or major/broad domains will be announced by the department every semester. Multi-disciplinary designs will be made by the students in groups (group size may be decided by the course coordinator), with the topic of interest falling within the theme or major/broad domains as announced by the department, applying any combinations of the Pharmaceutical, Medical, Plant, Environmental and Bioprocess disciplines in Bioengineering. In a combination of lecture and hands-on experiences, students must be exposed to understand and analyse socially relevant problems related to Biotechnology, design methodologies and anticipate a probable outcome. Guest lectures from industry experts from the sub-domains may be arranged to provide an outside perspective and show how the system design is being handled by the industry (wherever applicable). Periodic oral and written status reports are required. The course culminates in a comprehensive written report and oral presentation. The students should at the end of the course be able to Conceive, Design, and may implement the idea for his/her major project if approved by the Course Coordinator/ Department . This course is 100% internal continuous assessment.

15BT496L	Major Project	L	T	P	C
		0	0	24	12

Co-requisite:	NIL		
Prerequisite:	NIL		
Data Book / Codes/Standards	NIL		
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY
Course designed by	Department of Biotechnology		
Approval	32nd Academic Council Meeting July 23, 2016		

PURPOSE	The Major Project experience is the culminating academic endeavor of students who earn a degree in their Undergraduate Programs. The project provides students with the opportunity to explore a problem or issue of particular personal or professional interest and to address that problem or issue through focused study and applied research under the direction of a faculty member. The project demonstrates the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems. This final project affirms students' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	apply the knowledge and skills acquired in their courses to a specific problem or issue.	a	c		e	f		i
2.	extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.	a	c		e	f		i
3.	think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.	a	c		e	f	h	i
4.	refine research skills and demonstrate their proficiency in written and/or oral communication skills.	a	c		e	f	g	i
5.	face the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.			d			g	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	1. The Major project is a major component of our engineering curriculum: it is the culmination of the program of study enabling the students to showcase the knowledge and the skills they have acquired during the previous four years, design a product/service of significance, and solve an open-ended problem in engineering. 2. Each student must register to the project course related to his or her program 3. Major Project course consists of one semester and would be allowed to register only during the final year of study. 4. The Major Project may be initiated during the pre-final semester but will be assessed and credits transferred only during the last semester of study, upon completion of all other degree requirements. Generally the undergraduate major project is a team based one. 5. Each team in the major project course will consist of maximum of 5 students. 6. Each project will be assigned a faculty, who will act as the supervisor. 7. The project shall be driven by realistic constraints like that related to economic, environmental, social, political, ethical, health & safety, manufacturability and sustainability.		C,D,I,O	1,2,3,4, 5	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	8. Each group must document and implement a management structure. Group leadership roles must be clearly identified including who has responsibility for monitoring project deliverables and group coordination.				
2.	9. A group project may be interdisciplinary, with students enrolled in different engineering degrees, or in Engineering plus other faculties such as Management, Medical and Health Sciences, Science and Humanities. 10. Each student team is expected to maintain a log book that would normally be used to serve as a record of the way in which the project progressed during the course of the session. 11. Salient points discussed at meetings with the supervisor (i.e., suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work. 12. The logbook may be formally assessed; 13. The contribution of each individual team member will be clearly identified and the weightage of this component will be explicitly considered while assessing the work done. 14. A project report is to be submitted on the topic which will be evaluated during the final review. 15. Assessment components will be as spelt out in the regulations. 16. The department will announce a marking scheme for awarding marks for the different sections of the report. 17. The project report must possess substantial technical depth and require the students to exercise analytical, evaluation and design skills at the appropriate level.				
	Total contact hours				

Course nature		**Project – 100 % Internal continuous Assessment**			
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Review 1	Review 2	**Review 3**	**Total**
	Weightage	**10%**	**15%**	**20%**	**45%**
End semester examination	**Assessment Tool**	**Project Report**	**Viva Voce**		
	Weightage :	**25%**	**30%**		**55%**

15BT207E	**Developmental Biology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To understand the genetic and molecular bases of developmental stages of living organisms.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
4.	Gain knowledge related to basic concepts of development of living organisms	a						
5.	Understand the processes of gametogenesis and fertilization	a	c					

6.	Appreciate the genetic and molecular mechanisms underlying development	a	f					
7.	Correlate and comprehend the developmental changes of model organisms	a						
8.	Explore the relevance of concepts of developmental biology to mankind.	a	i					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: BASIC CONCEPTS OF DEVELOPMENT	**9**			
28.	Introduction and scope of Developmental biology	1		1-5	1
29.	Potency of embryonic cells, Commitment and Specification	1	C	1, 3	1
30.	Induction and Competence	1	C,D	1, 3	1
31.	Determination, Differentiation, Morphogenetic gradients	2	C,D	1, 3	1
32.	Cell fate and Cell lineages	2	C	1, 3	1
33.	Genomic equivalence and Cytoplasmic determinants	2	C	1, 3	1
	UNIT II: GAMETOGENESIS FERTILIZATION AND EARLY DEVELOPMENT	**9**			
34.	Spermatogenesis and Oogenesis	1	C	2	1
35.	Biochemical and Molecular aspects of Fertilization	1	C,D	2	1
36.	Mechanisms and significance of embryonic cleavage	2	C,D	2	1
37.	Parthenogenesis	1	C,D	2	1
38.	Teratogenesis, Gene –phene relationships, Teratogenic agents	2	C,D,	2	1
39.	Post embryonic development – growth –proliferation and death	2	C,D	2	1
	UNIT III: CELLULAR INTERACTIONS AND DIFFERENTIAL GENE EXPRESSION	**12**			
40.	Genetic Specificity of Induction – Paracrine factors - Hedgehog, Wnt family, TGF	3	C,D, I	3	1
41.	Surface receptors and Signal Transduction Pathways , Smad, Wnt, Hedgehog	3	C,D,I	3	1
42.	Cell survival signaling, Caspases, Cellular death receptors, Apoptosis	2	C,D,I	3	1
43.	Transcriptional and post-transcriptional control of gene expression	2	C,I, D	3	1
44.	Translational and post-translational control of gene expression	2	C,D, I	3	1
	UNIT IV: DEVELOPMENT OF MODEL ORGANISMS	**6**			
45.	Development and axis specification in *Caenorhabditis elegans*	2	C, D	4	1
46.	Development and axis specification in *Drosophila melanogaster*	2	C, D	4	1
47.	Development of *Arabidopsis thaliana*	2	C, D	4	1
	UNIT V: IMPLICATIONS OF DEVELOPMENTAL BIOLOGY	**9**			
48.	Assisted Reproductive Techniques	3	D,I	5	1
49.	Embryonic stem cells and Therapeutic cloning	2	D,I	5	1
50.	Multipotent adult stem cells and Transgenic stem cells	2	D, I	5	1
51.	Medical Advances in Regeneration	2	D, I	5	1
	Total contact hours	**45**			

LEARNING RESOURCES	
S. No.	**TEXT BOOKS**
8.	Scott F Gilbert.Developmental Biology 6 th Edition Sunderland (MA):2000.ISBN-10: 0-87893-243-7
9.	JMW Slack Essentials of Developmental Biology 2nd Edition BlackWell Publishing.
	REFERENCE BOOKS/OTHER READING MATERIAL
10.	Lewis Wolpert, Cheryll Tickle Principles of Development, 4th edition

Course Nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT208E	PERL Programming and Bio PERL	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	PERL is one of the important programming languages for Bioinformatics							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To understand the basic commands in Unix	a						
2.	Ability to write Programs using commands and functions	a	c					
3.	Control statements in PERL	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: UNIX OS AND EDITORS	**9**			
1.	Unix OS	1	C	1	1
2.	Working Environment in Unix	1	C	1	1
3.	Navigating in Unix	1	C	1	1
4.	Creating and manipulating sequence files in Unix	1	C	1	1
5.	emacs editor commands	2	C	1	1
6.	Vi editor commands	2	C	1	1
7.	FTP	1	C	1	1
	UNIT II: UNIX COMMANDS	**9**			
8.	Advanced Unix commands I : ls, cat, more,	2	C	1	1
9.	Moving, renaming and finding file with command	2	C	1	1
10.	Accessing and changing file permission	1	C	1	1
11.	Advanced Unix commands: uniq, sort and grep.	2	C	1	1
12.	grep command and file compression	2	C	1	1
	UNIT III: INTRODUCTION TO PERL	**9**			
13.	Introduction to Perl-scalars	1	C	2	1,2,3,4
14.	tr/ / / function and Formatting Numerical output with printf	1	C	2	1,2,3,4
15.	s/ / / Operator	2	C	2	1,2,3,4
16.	The Chop and chomp Operator	1	C	2	1,2,3,4
17.	Perl Arrays and manipulation of Arrays.	2		2	1,2,3,4
18.	Standard Perl modules	2	C	2	1,2,3,4
	UNIT IV: PERL REGULAR EXPRESSION, PERL ARRAY OPERATIONS AND CONTROL STATEMENTS	**9**			
19.	Introduction to Perl regular expression and Perl debugger	2	C	2,3	1,2,3,4
20.	Constructing Regexs in the Debugger and Debugger commands	2	C	2,3	1,2,3,4
21.	Regex Operators	2	C	2,3	1,2,3,4
22.	Perl control statements and FILE I/O	3	C	2,3	1,2,3,4
	UNIT V: PERL SUBROUTINES AND BIOPERL	**9**			
23.	Perl subroutines and Functions.	3	C	2,3	1,3,4
24.	Installation of Bioperl	1	C	2,3	1
25.	Retrieving sequence from the GenBank accessions using Bioperl	1	C	2,3	1
26.	Usage of Bioperl modules	4	C	2,3	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Harshawardhan P Bal, *Perl Programming for Bioinformatics*, Tata McGraw Hill, 2003.
2.	James Tisdall, *Mastering Perl for Bioinformatics*, O'Reilly, 2003
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	D. Curtis Jamison, *Perl Programming for Bioinformatics & Biologists*, John Wiley & Sons, INC., 2004
4.	Michael Moorhouse, Paul Barry, *Bioinformatics Biocomputing and Perl*, Wiley, 2004.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT209E	**Industrial Microbiology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To acquire the basics of industrial microorganisms, production of microbial products, strain improvement processes to improve the yield of the microbial metabolites.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the industrial microorganisms and their characteristics	a						
2.	Acquire knowledge about the metabolic pathways for the production of primary and secondary metabolites	a	b					
3.	Gain the knowledge on strain improvement for the production of industrially important metabolites	a	c	d				
4.	Acquire the knowledge on storage techniques, culture collection centers and IPR and copy rights	a	i					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I- INTRODUCTION: SCOPE OF BIOTECHNOLOGY AND INDUSTRIAL MICROBIOLOGY	**9**			
1.	Introduction -brief recap of Introduction to Industrial Microbiology - Overview of syllabus	1	C	1	
2.	Characteristics of Industrial Microbiology	1	C	1	1,5
3.	Multi-disciplinary or Team-work nature of industrial microbiology	1	C	1	1
4.	Organizational set-up in an industrial microbiology establishment,	1	C	1	1
5.	Upstream processing (USP) and downstream processing (DSP), unit downstream processing	2	C,O	1,2	1
6.	Industrial fermentation products and their producer microorganisms	2	C	1,2	1
7.	Obsolescence in industrial microbiology, Free communication of procedures in industrial microbiology	1	C	2	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT II -METABOLIC PATHWAYS FOR THE BIOSYNTHESIS OF INDUSTRIAL MICROBIOLOGY PRODUCTS	**9**			
8.	The Nature of Metabolic Pathways	1	C	2	1,2,4
9.	Industrial Microbiological Products as Primary and Secondary Metabolites	2	C	2	1,2,4
10.	Trophophase-idio phase Relationships in the Production of Secondary Products	2	C	2	1,2,4
11.	Role of Secondary Metabolites in the Physiology of Organisms Producing Them	2	C	2	1,2,4
12.	Pathways for the Synthesis of Primary and Secondary Metabolites of Industrial Importance -Catabolism of carbohydrates and Catabolism of hydrocarbons	2	C	2	1,2,4
	UNIT III- OVERPRODUCTION OF METABOLITES OF INDUSTRIAL MICROORGANISMS	**9**			
13.	Mechanisms Enabling Microorganisms to Avoid Overproduction of Primary Metabolic Products Through Enzyme Regulation	3	C	3	1,3
14.	Derangement or Bypassing of Regulatory Mechanisms forthe Over-production of Primary Metabolites	3	C	3	1,3
15.	Regulation of Overproduction in Secondary Metabolites	3	C	3	1,3
	UNIT IV-SCREENING FOR PRODUCTIVE STRAINS AND STRAIN IMPROVEMENT IN BIOTECHNOLOGICAL ORGANISMS	**9**			
16.	Isolation de novo of organisms producing metabolites of economic importance	1	C,O	3	1,3
17.	Strain Improvement	2	D,I, O	3	1,3
18.	- Selection from naturally occurring variants	2	C	3	1,3
19.	- Manipulation of the genome of industrial organisms in strain improvement	2	C	3	1,3
20.	Use of mutants / Genetically Modified Microorganisms (GMM) as against Wild type isolates for production.	2	D,O	3	1,3
	UNIT V-THE PRESERVATION OF THE GENE POOL IN INDUSTRIAL ORGANISMS: CULTURE COLLECTIONS	**9**			
21.	Isolation of suitable producer microorganisms from the environment	3	C	3,4	1,3,5
22.	Concept and examples of Microorganisms classified as Generally Regarded As Safe (GRAS)	2	C	4	1,3,5
23.	Methods of Preserving Microorganisms	2	C	4	1,3,5
24.	Culture Collections of industrially important microorganisms	2	C	4	1,3,5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Nduka Okafor, “Modern Industrial Microbiology and Biotechnology” Science Publishers, Enfield, NH, USA
2.	Industrial Microbiology (1999) by Casida. LE, New age International (P) Limited,Publishers.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heineman, Aditya Books (P) Ltd.
4.	Industrial Microbiology (2000) by A.H. Patel. Macmillan Publishers India
5.	A text book of Industrial Microbiology (1989) by Wulf Crueger and Anneliese Crueger, Panima Publishing Corporation

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT210E	**Enzyme Engineering and Technology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	The purpose of this course is to provide an opportunity to understand the theoretical concepts of enzyme engineering principles and applications.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to acquire knowledge on the rudiments of enzyme action and it will be helpful to work technologically								
1.	Familiarize with the basics of enzyme, properties, types and its mode of action	a						
2.	Expand knowledge on various kinetic mechanisms of enzyme action, deactivation and their regulation	a	c	e				
3.	Analyze the methods, kinetics characteristics and applications of immobilized enzymes	a	c					
4.	Expose to techniques of enzyme production , purification and analysis of characteristics of enzyme	a	c					
5.	Explore the industrial, analytical and diagnostic applications of enzymes	a	c	k				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: INTRODUCTION TO ENZYMES	**9**			
1.	Chemical Nature and Properties of Enzymes- Characteristics of enzymes	1	C	1-4	1,2,5
2.	Enzymes and Their Actions - Characteristics of enzymes - Structural Components of Enzymes	1	C	1	1,2,5
3.	specificity of enzyme action	1	C	1	1,2
4.	Classification of enzymes	2	C	1	1
5.	Factors affecting enzyme activity	1	C,D, I,O	1	1,2
6.	Enzyme substrate complex formation models	1	C	1	1,2
7.	Enzyme Catalysis- Mechanisms of enzyme catalysis	2	C	2	1,2
	UNIT II: ENZYME KINETICS	**12**			
8.	Kinetics of single substrate reactions- Michaelis–Menten Kinetics	2	C	2	1
9.	Evaluation of Michaelis –Menten parameters, Turnover number	2	D,I, O	2	1
10.	Types of Enzyme Inhibition and their Kinetics	6	C,D, I,O	2	1
11.	Enzyme Deactivation kinetics	1	C,D, I,O	2	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
12.	Allosteric enzymes	1	C	2	1
	UNIT III: IMMOBOLIZED ENZYME TECHNOLOGY	**10**			
13.	Methods of enzyme immobilization–Physical and Chemical Methods	1	C,D, I,O	3	4
14.	Advantages and Disadvantages	1	C	3	4
15.	Diffusion Mechanisms and Limitations in the Immobilized Enzyme Systems	3	C	2,3	2,3
16.	Porous and Non porous support matrices,	3	D,I, O	2.3	2,3
17.	Reactor configuration for Immobilized enzymes	2	C,D, I,O	3	2,4
	UNIT IV: PRODUCTION, PURIFICATION AND CHARACTERIZAION OF ENZYMES	**08**			
18.	Production of enzymes on a commercial scale	1	C,D, I,O	4	4
19.	Extraction from plant, animal and microbial sources	1	C,D, I,O	4	1
20.	Purification of intracellular and extracellular enzymes	3	C,D, I,O	4	1,2
21.	Analysis of yield, purity and activity of enzymes	1	C,D, I,O	4	1
22.	Determination of molecular weight of enzymes: ultracentrifugation, gel filtration, electrophoresis, and MALDI-TOF methods	2	C,D, I,O	1,4	1
	UNIT V: APPLICATIONS OF ENZYMES	**06**			
23.	Application of enzymes in industries – Food and Beverage	2	C,I	1,5	1
24.	Leather, Detergent, Textile, Pulp and paper Industries	1	C,I	1,5	1
25.	Pharmaceuticals and Medicines	1	C,I	1,5	1
26.	Analytical and diagnostic applications of enzymes	2	C,I	1,5	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Trevor Palmer and Philip L Bonner. "*Enzymes: Biochemistry, Biotechnology, Clinical Chemistry*", East-West Press, 2004.
2.	Syed Tanveer Ahmed Inamdar. *"Biochemical Engineering : Principles and Concepts"* Third Edition, PHI Learning Pvt. Ltd., 2012
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Doran. P. M., "*Bioprocess Engineering Principles*", Academic press, 1995.
4.	Shuler. M.L., Kargi. F., "*Bioprocess Engineering: Basic Concepts*", 2nd Edition. Pearson, 2002.
5.	Nicholas.C, Price and Lewis Stevens, "*Fundamentals of Enzymology*", OxfordUniversity Press, 1982.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT211E	Cellular and Molecular Neuroscience	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To provide basic and applied knowledge of neuroscience at the cellular and molecular levels							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Student will understand fundamental concepts in neuroscience	a						
2.	Understand the neuro-anatomical and -physiological basis of various body functions	a						
3.	Student will learn about relevance of basic concepts in neurodegenerative diseases.	a	c	f				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: OVERVIEW OF THE NERVOUS SYSTEM	**9**			
1.	Genetics, Genomics, and Brain	1	C	1	1, 2
2.	Development of the nervous system	2	C	1	1, 2
3.	Cellular Components of the Nervous system	1	C	1	1, 2
4.	Neurons and Glia	2	C	1, 2	1, 2
5.	Neural Circuits	1	C	1, 2	1, 2
6.	Organization of the Nervous system	1	C	1, 2	1, 2
7.	Structural and Functional analysis of the Nervous system	1	C	1, 2	1, 2
	UNIT II: NEURAL SIGANLING AND NEUROCHEMICALS	**9**			
8.	Electrical signals: Voltage-dependent membrane permeability	1	C	1, 2	1, 2
9.	Ion channels and transporters	2	C	1, 2	1, 2
10.	Synaptic transmission-Neurotransmitters and their receptors	1	C	1, 2	1, 2
11.	Molecular signaling in neurons	1	C	1, 2	1, 2
12.	Synaptic plasticity	1	C	1, 2	1, 2
13.	Electrical signals: Voltage-dependent membrane permeability	1	C	1, 2	1, 2
14.	Ion channels and transporters	1	C	1, 2	1, 2
15.	Synaptic transmission-Neurotransmitters and their receptors	1	C	1, 2	1, 2
	UNIT III: SENSORY AND MOTOR SYSTEMS	**8**			
16.	Somatic sensory system-Pain	2	C	1,2	1, 2
17.	Visual and Vestibular pathways	2	C	1,2	1, 2
18.	Motor neuron circuits-Motor neuron control by the CNS	2	C	1, 2	1, 2
19.	Construction and modification of neural circuits	2	C	1, 2	1, 2
20.	Repair and Regeneration in nervous system		C	1,2	1, 2
	UNIT IV: BRAIN FUNCTIONS	**10**			
21.	Cognition-Speech and Language	2	C	1,2	1, 2
22.	Sleep and Wakefulness	2	C	1,2	1, 2
23.	Emotions-Memory	2	C	1,2	1, 2
24.	Sex and Sexuality	1	C	1,2	1, 2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
25.	Neuroanatomical basis for brain functions-Interactions between neuroendocrine system and immune system-its role in health and disease	3	C	1,2	1, 2, 3
	UNIT V: NEURODEGENERATIVE DISEASES	**9**			
26.	Diseases and injuries of the nervous system-Alzheimer's disease, Huntington's disease	3	C	2,3	1,2.3
27.	Diseases of injuries of the nervous system: Neuromuscular disorders, Basal ganglia disorders, Spinal cord injury	3	C	2,3	1, 2. 3
28.	Traumatic brain injury, Stroke, Dementia	3	C	2,3	1, 2, 3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel LaMantia, Leonard E. White, "*Neuroscience*," Sinauer Associates, Inc., 5th Edition, 2012.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, "*Principles of Neural Science*," McGraw-Hill, 5th Edition, 2012.
3.	Robert Ader, "*Psychoneuroimmunology*," Academic Press; 4th edition, 2006

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT212E	**Vaccine Biotechnology**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	Clark's Table, IS : 456-2000						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To understand the conventional strategies in vaccine production and to keep in pace with the emerging trends in the field of vaccine biotechnology							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Acquire theoretical knowledge on conventional to recent technology of vaccine production	a						
2.	To learn the types of vaccine, immunological effects and regulatory guidelines	a	f					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I- HISTORICAL DEVELOPMENTS OF VACCINE	**9**			
1.	History of vaccine development -Conventional strategies for vaccine improvement; Current development in vaccines	2	C	1	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
2.	Live, attenuated, subunit, peptide and killed vaccines	3	C	1,2	
3.	Types of adjuvants	2	C	1	
4.	Quality control, preservation and monitoring of microorganisms in seed lot systems	2	C	1	
	UNIT II -BETTER PRODUCTION	**8**			
5.	Technology related to monitoring -temperature, sterilization, environment, quality assurance and related areas	3	C	1	2
6.	Production techniques-growing the microorganisms in maximum titre	3	C,D	1	
7.	Preservation techniques, freeze drying	2	C	1	
	UNIT III-TYPES, METHODS AND APPLICATION	**10**			
8.	Vaccine efficacy, types of vaccines- Inactivated toxins, Inactivated whole bacteria or viruses, Live attenuated bacteria or viruses	2	C	1,2	1
9.	Subunit vaccines, Polysaccharide vaccines, Conjugated vaccines	3	C	1,2	
10.	Recombinant DNA vaccines, Edible vaccines, Virus like particles	3	C	1,2	
11.	Uses of nanoparticles in vaccine application- Nanoparticles in vaccine delivery, Induction of immune responses by nanoparticle based vaccine	2	C,D	1,2	
	UNIT IV-DELIVERY METHODS	**9**			
12.	Immunomodulators-Innovative methods of delivering immunogens ; liposomes-role of liposomes in delivering vaccines-Mechanism of liposome formation	3	C,D	2	1,3
13.	Microspheres-Types of microspheres, Preparation methods	3	C,D	2	
14.	**ISCOMS**-Properties of ISCOM based vaccines, Types, components of ISCOM	3	D,I	2	
	UNIT V-GUIDELINES FOR THE MANAGEMENT	**9**			
15.	**Regulatory issues**- Regulatory bodies, Environmental effects of recombinant vaccines	2	C	2	1
16.	Disease security and biosecurity principles; OIE guidelines for vaccine seed lot management	2	C,I	2	1
17.	OIE guidelines for the method of vaccine production ,OIE guidelines for production facility	2	C,I	2	1
18.	**In process control and batch control**-organization and responsibilities, documentation and evaluation of data**Test on final products**-Overview, General manufacturing recommendations, Final product release tests	3	C,I	2	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ronald W. Ellis, “New Vaccine Technologies”, Landes Bioscience, 2001.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Noel Mowat, “Vaccine manual: The production and quality control of veterinary vaccines for use in developing countries”, Daya books, 1999.
3.	Cheryl Barton, “Advances in Vaccine Technology and Delivery”, Espicom Business Intelligence, 2009.

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT213E	**Industrial Fermentation Technology**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	This course provides an opportunity to learn the importance of the industrial fermentation processes and production of various valuable bio products through fermentation.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Enable the students to understand the basics of industrial fermentation process in prokaryotic and eukaryotic systems.	a	c	d				
2.	Gain knowledge about the fermentation department and product development in industries	a	c	d				
3.	Expand the knowledge about the use of organisms to produce primary and secondary microbial metabolite son an industrial scale.	a	c		f			
4.	Learn about the production process of nutraceuticals and functional foods.	a	c		f			
5.	Enable the students to use organisms to produce valuable pharmaceutically important bio products on an industrial scale.	a	c		f			

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I :BASICS OF INDUSTRIAL FERMENTATION	**10**			
1.	Introduction to industrial fermentations	3	C	1	1, 3, 4, 5, 6
2.	Microbial fermentation	3	C	1	2
3.	Mammalian cell culture system	2	C, D	1	2
4.	Plant cell tissue and organ cultures	2	C, D	1	2
	UNIT II :INDUSTRIAL FERMENTATION DESIGN	**8**			
5.	Fermentation department, equipment and space requirements	3	C, D	2	2
6.	The design of large fermenters (based on aeration)	2	D	2	2
7.	Product development: regulation and safety - use of process flowcharts and block diagrams	3	D, I	2	1 – 6
	UNIT III :PRODUCTION OF PRIMARY AND SECONDARY METABOLITES	**10**			
8.	Organic acids fermentation	3	C-D-I-O	2,3	1,3,4,5
9.	Solvents fermentation	2	C-D-I-O	2,3	1,3
10.	Antibiotic production: Classification	1	C	2,3	1, 3, 4, 5
11.	Carbohydrate containing antibiotic production	2	C-D-I-O	2,3	1,2,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
12.	Peptide antibiotic production	1	C-D-I-O	2,3	1, 3, 4
13.	Vitamins fermentation	1	C-D-I-O	2,3	1, 3, 4
	UNIT IV :FOOD FERMENTATION	**6**			
14.	Food fermentations	1	C	2,4	1, 4, 6
15.	Food flavouring agents and preservative production	3	C-D-I-O	2,4	1, 4, 6
16.	Food colorants fermentation	1	C-D-I-O	2,4	1, 4, 6
17.	Production of single cell protein	1	C-D-I-O	2,4	1, 4, 6
	UNIT V: PRODUCTION OF OTHER COMMERCIAL PRODUCTS	**11**			
18.	Recombinant protein production	4	C-D-I-O	2,5	1, 5, 7
19.	Production of nucleosides and nucleotides	2	C-D-I-O	2,5	1, 5, 7
20.	Biopolymers production	2	C-D-I-O	2,5	1, 5, 7
21.	Bioinsecticide production	1	C-D-I-O	2,5	1, 5, 7
22.	Wine and Cider production	2	C-D-I-O	2,5	1, 4, 6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Cruger. W., Cruger. A., "*Biotechnology: A Textbook of Industrial Microbiology*", Panima Publishing ,2000
2.	Vogel. H.C., Todaro. C.L., "*Fermentation and Biochemical Engineering Handbook - Principles, Process design, and Equipment*", Noyes Publications,1997.

	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Lee. Y.K., "*Microbial Biotechnology: Principles and Applications*", World Scientific Publishing, 2006.
4.	Prescott. S.C., Dunn. C.G., Reed. G., "*Prescott & Dunn's Industrial Microbiology*", CBS Publishers, 1983.
5.	Peppler. H. J., Perlman. D., "*Microbial Technology: Microbial processes*", Volume I, Academic Press, 1979.
6.	Frazier. W.C., Westhoff. D.C., "*Food Microbiology*", 4th Edition., Mcgraw-Hill Book Co.,New York, 1988.
7.	Okafor. N., "*Modern Industrial Microbiology and Biotechnology*", Taylor and Francis Publishers, 2007.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15BT214E	Phytochemical Techniques	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	The course is designed to provide an understanding of the range of metabolites synthesized by plants and the varied applications of these metabolites. The student will gain an understanding of theoretical principles related to the metabolic pathways leading to the synthesis of these metabolites in vivo and various modern techniques for the purification and identification.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To explore the structural complexity and diversity of pharmaceutically relevant plant metabolites.	a	b					
2.	To impart knowledge in principles underlying plant secondary metabolism	a	b					
3.	To present an overview of different classes of metabolites present in plants	a	b					
4.	To understand the technologies underlying the isolation, purification, quantification and identification of plant metabolites	a	b					
5.	To appreciate the diversity of plant metabolites and their utility	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - OVERVIEW OF PLANT SECONDARY METABOLITES	**9**	**C**	1,2,3,5	
1.	Drugs from plants - Insecticides and rodenticides- Fibers & Fiber Plants	2	**C**	1,2,3,5	1,2
2.	Industrially important Plant products Essential Oils, Fatty Oils & Waxes,	2	**C**	1,2,3,5	1,2
3.	Forest Products: Wood and Cork, Forest Resources, Gums & Resins.	3	**C**	1,2,3,5	1,2,4
4.	Rubber and Other Latex Products, Tanning, Dye & Processing Materials..	2	**C**	1,2,3,5	1,2,4
	UNIT II: METABOLITES DERIVED FROM THE SHIKMATE CHORISMATE PATHWAY	**9**			
5.	Plant acids, fatty acids and lipids, alkanes and related hydrocarbons.	2	**C**	1,2,3,5	1,2,3
6.	polyacetylenes, sulphur compounds. nitrogen compounds-amino acids, amines,	3	**C**	1,2,3,5	1,2,3
7.	alkaloids, cyanogenic glycosides, inoles, purines, pyrimidines	3	**C**	1,2,3,5	1,2,3
8.	cytokinins, chlorophylls.	1	**C**	1,2,3,5	1,2,3
	UNIT III:- METABOLITES DERIVED FROM THE MALONIC AND MEVALONIC ACID PATHWAYS	**9**			
9.	Phenols and Phenolic acids, phenylpropanoids	2	**C**	1,2,3,5	1,3
10.	Flavanoid pigments, Anthocyanins, Flavaonols and flavones, Tannins, Quinones.	4	**C**	1,2,3,5	1,3
11.	Essential oils, Diterpenoids and Gibberlins, Triterpenoids, Steroids and Carotenoids	3	**C**	1,2,3,5	1,3
	UNIT IV: CONVENTIONAL METHODS IN PLANT ANALYSES	**9**			
12.	Introduction, selection of plant and plant products.	3	**C**	1,2,3,5	1,5
13.	Method of extraction and isolation, Methods of separation.	3	**C**	1,2,3,5	1,5
14.	Methods of identification, Analysis of result and application	3	**C**	1,2,3,5	1,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V: ADVANCES IN PLANT ANALYTICAL TECHNIQUES	**9**			
15.	GC-HPLC-HPTLC	2	**C**	3,4,5	5
16.	OPLC-NMR- MS Microarray	3	**C**	3,4,5	5
17.	RT PCR- RNA SEQ- fluorescence and confocal microscopy.	4	**C**	3,4,5	5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Harbone J. B., "Phytochemical Method-- A guide to modern techniques of plant analysis," Chapman and Hall Third edition. 2005.
	REFERENCE BOOKS
2.	Sarker, S. D., Latif, Z. and Gray,A.I. "Methods in Biotechnology -Natural Product Isolation" Second Edition, Humana Press 2006
3.	Raman N. "Phytochemical Techniques" – New India Publishing agency First Edition, 2006.
4.	Coppen J.J.W., "Gums, resins and latexes of plant origin", Food and Agriculture organization of the United Nations, 1995.
5.	Wilson K., "Principles and Techniques of Biochemistry and Molecular Biology", Seventh edition, 2010.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT307E	**Marine Biotechnology**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	E	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To provide an adequate knowledge of the wealth and commercialization of marine and aquaculture resources. In addition to know the techniques on the resource management.			
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**		
At the end of the course, student will be able to				
1.	To understand the economically important marine resources and their wealth.	b		
2.	To acquire knowledge on the potency of natural toxins and drugs.	b		
3.	To learn the knowledge on the degradation process for discharged wastes.	c	e	
4.	To know the diseases of cultivable animals and its controlling measures.		c	h

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - ECONOMICAL IMPORTANCE OF MARINE RESOURCES	**9**			
1.	Wealth of the sea	2	C	1	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
2.	Economically important marine animals	1	C	1	1
3.	Commercially important finfishes	2	C	1	1
4.	Penaeid and non-penaeid shrimps	1	C	1	1
5.	Marine crabs	1	C	1	1
6.	Edible oysters	1	C	1	1
7.	Economically important pearl oysters	1	C	1	1
	UNIT II - TOXINS AND THEIR ACTION	**9**			
8.	Marine toxins from animals	2	C	2	2,5
9.	Sources of toxins	1	C	2	2,5
10.	Pharmacological potential of toxins	2	C	2	2,5
11.	Tetrodotoxins	2	C	2	2,5
12.	Conotoxins	1	C	2	2,5
13.	Ciguateratoxins	1	C	2	2,5
	UNIT III - POTENTIAL BIOACTIVE COMPOUNDS	**10**			
14.	Bioactive compounds from the sea	1	C	2	2,5
15.	Source and benefits of bioactive compounds	1	C	2	2
16.	Antioxidants	1	C	2	2
17.	Collagen, gelatin	2	C	2	2
18.	Heparin, chitosan	2	C	2	2
19.	Omega 3 fatty acids and carotinoids	3	C	2	2
	UNIT IV - OIL AND SOLID WASTE DEGRADATION	**8**			
20.	Oil spillage – methods of degradation in coastal waters	2	C	3	3,4
21.	Algal blooms	1	C	3	3,4
22.	Biodegradation of pesticides	1	C	3	3,4
23.	Heavy metals discharged in coastal waters	2	C	3	3,4
24.	Solid wastes disposed into coastal waters	1	C	3	3,4
25.	Management of solid waste disposal	1	C	3	3,4
	UNIT V - DISEASES AND WATER QUALITY MANAGEMENT	**9**			
26.	Diseases associated with cultured shrimps and management	2	C	4	1,6
27.	Fine fish diseases and management	2	C	4	1,6
28.	Antibiotics used in culture	1	C	4	1,6
29.	Immunostimulants	1	C	4	1,6
30.	Diagnostic kits	1	C	4	1,6
31.	Water quality management in hatcheries and grow out ponds	2	C	4	1,6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Milton Fingerman and Rachakonda Nagabhushanam, "*Recent Advances in Marine Biotechnology* (Series) *Biomaterials and Bioprocessing*", Science Publishers, 2009.
2.	Proksch and Werner E.G.Muller, "*Frontiers in Marine Biotechnology*", Horizon Bioscience, 2006.
3.	Le Gal, Y., Ulber, R, "*Marine Biotechnology I: Advances in Biochemical Engineering/Biotechnology*", (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 96, 2005.
4.	Le Gal, Y., Ulber, R "*Marine Biotechnology II: Advances in Biochemical engineering/Biotechnology*", (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 97, 2005.
	REFERENCE BOOKS/OTHER READING MATERIAL
5.	Attaway D.H. and Zaborsky O.R., (eds). "*Marine Biotechnology: Volume I, Pharmaceuticals and Bioactive Natural Products*", New York: Plenum. 1993.
6.	Powers D.A., "*New frontiers in marine biotechnology: Opportunities for the 21st century*", In: Marine Biotechnology in the Asian Pacific Region (eds). C. G. Lundin and R. A. Zilinskas. Stockholm. 1995.

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15BT308E	**Food Process Technology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
NIL	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	Psychrometry chart				
Course Category	P PROFESSIONAL ELECTIVE BIOTECHNOLOGY				
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To understand the principles of Food Process Technology							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the equipments and their preliminary operations in food processing	a	f					
2.	Understand the physical principles involved in the food processing techniques and the equipments used.	a	f					
3.	Equip themselves to trouble shoot the problems arises in drying process to preserve the foods	a	c	f				
4.	Familiarize with preservation of foods at low temperature	a	c	f				
5.	Know the unit operations involved in processing of solid and liquid foods	a	f					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I – INTRODUCTION	**9**			
1.	Scope and importance of Food Process Engineering	2	C	1	1,2
2.	Preliminary operations – cleaning, grading, sorting, washing, cutting	4	C	1,2	3,4
3.	Equipments used	3	C-D	2	3,4
	UNIT II-PROCESSING METHODS	**9**			
4.	Concepts and equipment used in processing methods	3	C-D	2	3,4
5.	Concepts and equipment used in blanching- pasteurization – sterilization	3	C-D	2,3	3,4
6.	Concepts and equipment used in extrusion cooking- micro wave processing	3	C-D	2,3	3,4
	UNIT III-PRESERVATION BY DRYING	**9**			
7.	Moisture content- definition, methods of determination	1	C	1,2	5
8.	Problems on moisture removal	1	C	3	5
9.	Equilibrium moisture content- methods	2	C	2,3	5
10.	Hysterises effect. Psychrometry chart	1	C	2,3	5
11.	Drying-mechanisms-constant rate period and falling rate period- methods and equipment used	2	C	2,3	5
12.	Water activity – concepts and importance	1	C	1,2	5
	UNIT IV-PRESERVATION BY LOW TEMPERATURE	**9**			
13.	Refrigeration	1	C	1,4	4
14.	Freezing-Theory, freezing time calculation	2	C	2,4	4
15.	Methods of freezing, freezing equipments	3	C-D	2,4	4
16.	Freeze drying, freeze concentration, thawing	3	C	3,4	4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V-FOOD CONVERSIONOPERATION	**9**			
17.	Size reduction	2	C	1,5	4
18.	Solid foods and liquid foods	2	C	5	4
19.	Theory and equipments used	3	C-D	2,5	3
20.	Problems on energy requirement	2	C	3,5	3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Paul Singh R. and Dennis R Heldman, "Introduction to Food Engineering'' Third edition. Academic press, London, 2004. 36 FP-2013 SRM(E&T)
2.	Fellows, P.J, "Food processing Technology: Principles and practice". Second edition, Woodhead Publishing limited, Cambridge,2005.
3.	Sahay, K.M. and K.K. Singh, "UNIT Operations in Agricultural Processing". Vikas Publishing House Pvt. Ltd., New Delhi, 2003.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Dennis, R.H, "Food Process Engineering''Academic Publishing andPress, King Saud University, 1981.
5.	Rao, M.A. Syed S.H. Rizvi, and Ashim K. Datta, "Engineering properties of foods"CRC Press2010.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT309E	**Regulation of Gene Expression in Plants**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	The course is designed to provide an understanding of the molecular concepts related to the control of plant growth and development. The student will gain an understanding of theoretical principles related to gene expression which in turn can be applied for genetic manipulation of plants. The course will be relevant for students who wish an insight of molecular switches that regulate plant growth and development and who wish to explore these principles for improvement of plant production.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To explore the complexity of plant genome	a	c	e	h	k		
2.	To appreciate the tolerance ranges in plants to abiotic stress factors and apply the principles for manipulation of plants to improve tolerance	a	c	e	h	k		
3.	To understand and apply various strategies for increasing resistance in plants to biotic stress	a	c	e	h	k		
4.	To explore applications of various chemical and environmental signals involved in plant development	a	c	e	h	k		
5.	To understand the applications of various plant derived control systems for crop improvement	a	c	e	h	k		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ORGANIZATION OF PLANT GENOME	**9**			
1.	Introduction-, genome size and organization - the chloroplast genome -organization, inheritance and expression.	2	C	1-5	1,2,3
2.	Mitochondria genome - organization -expression - male sterility - gene structure and gene expression - regulation,	2	C	2-5	1,2,3
3.	Implication for plant transformation - protein targeting, heterologous promoters	2	C	2-5	1,2,3
4.	Transposons - Ac and Ds transposable elements in maize, transposon tagging and retrotransposons- Arabidopsis	3	C,D	2-5	1,2,3
	UNIT II: TRANSGENIC TECHNOLOGIES FOR COMBATING ABIOTIC	**9**			
5.	Herbicide resistance- Use of herbicides in modern agriculture	2	C	1-5	1,2
6.	Strategies for engineering herbicide resistance	2	C	2-5	1,2,5
7.	Environmental impact- abiotic stress	2	C,D	2-5	1,2,5
8.	Water deficit stress	1	C,D	1-5	1,2,5
9.	ROS -various approaches for engineering tolerance	2	C,D		1,2,3
	UNIT III: TRANSGENIC TECHNOLOGIES FOR COMBATING BIOTIC STRESS	**9**			
10.	Pest resistance-nature and scale of insect / pest damage to crop - GM strategies	2	C	1-5	1,2,4
11.	Bt approach to insect resistance-copy nature strategy - insect resistant crops and food safety	2	C,D	2-5	1,2,5
12.	Plant-pathogen interactions - natural disease resistance pathways	2	C	2-5	1,2,4
13.	Biotechnological – Genetic manipulation based approaches to disease resistance -plant viruses - transgenic approach-PDR	3	C,D	1-5	1,2,4,5
	UNIT IV: PROMOTER SYSTEMS BASED ON CHEMICAL AND ENVIRONMENTAL SIGNALS	**9**			
14.	Tn10 encoded Tet repressor - ecdysteroid agonist inducible control of gene expression in plants - regulatory mechanism of the GR, GVG system construction, induction experiments, characteristics and prospects of steroid inducible system	2	C,D	1-5	1,2,5
15.	Copper controllable expression system - basis and functioning,modifications to overcome background expression in roots, vectors for CC gene expression - tissue specific antisense experiments- conditional lethal genes and practical uses	3	C,D	2-5	1,2,5
16.	Organization and types of heat shock promoters- heat shock transcription factors, heat shock promoter in transgenic plants	2	C	2-5	1,2,5
17.	Nitrate inducibility- gene expression using nitrite reeducates gene promoter	2	C,D	1-5	1,2,5
	UNIT V: PROMOTER SYSTEMS BASED ON PLANT DEVELOPMENTAL PROCESSES	**9**			
18.	Wound inducible genes and hormone responsive elements-Introduction – Multiple phases of wound response, Mechanism of wound induction	3	C	1-5	1,2,5
19.	Additional hormone factors. Hormone responsive elements-ocs/as-1 AuxRE, natural composite AuxREs, Synthetic composite and simple AuxREs	3	C,D	2-5	1,2,5
20.	Abscisic acid inducible promoters - developmental targeting of gene expression by senescence specific promoter.	3	C,D	1-5	1,2,5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Adrian Slater, Nigel W. Scott and Mark R.Fowler. "*Plant Biotechnology-The genetic manipulation of plants*", Oxford university press 2008.
2.	Reynolds P. H. S. (ed.) "*Inducible Gene Expression in Plants*", CAB International First Edition 1999.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Carole L. Bassett, "*Regulation of gene expression in plants - The role of transcript structure and processing*". Springer, First Edition 2007.
4.	Filipowicz and Horn, "*Post transcriptional control of gene expression in plants*", Springer, First Edition 1996.
5.	Balbas and Lorence "*Recombinant gene expression - Reviews and protocols*", Springer Second Edition 2004.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT310E	**Industrial Waste Management**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To acquire the basics of industrial wastes, treatment technologies and environmental regulations and regulatory concerns to control the environmental pollution.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the industrial processes and wastes generation	a	c					
2.	Toxicity of various pollutants and various biological and chemical treatment technologies	a	f	h				
3.	Understand the basic technologies to design the wastewater treatment plant	a	c	d				
4.	Acquire the knowledge on Environmental regulations	a	i					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I -INTRODUCTION	**9**			
1.	Introduction -brief recap of Industrial wastes and Environmental Pollution- overview of syllabus	1	C	1	1
2.	Industrial scenario in India	2	C	1	1,4,5
3.	Industrial waste generation, disposal and environmental impacts	3	C	1,2	1,4,5
4.	Toxicity of industrial effluents and Bioassay tests	1	C	2	1,4,5
5.	Brief introduction about Regulatory requirements and pollution control boards.	2	C	4	1,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT II- STANDARDS FOR WASTE DISPOSAL & METHODS OF WASTE REDUCTION	**9**			
6.	Standards for disposal of treated industrial wastewaters, solid wastes and gaseous emission	2	C	1,4	2,4
7.	Characteristics of industrial wastewater	2	C,O	2	2
8.	Individual and Common Effluent Treatment Plants.	1	D,I	3	3
9.	Waste management approach, source reduction, Waste audit	2	C	3	1,4
10.	Volume and strength reduction–Material and process modifications – Recycle, reuse and by-product recovery, Zero discharge processes	3	C,O	3	3,5
	UNIT III-TREATMENT AND DISPOSAL OF INDUSTRIAL EFFLUENTS	**10**			
11.	Equalization – Neutralization – Precipitation – Heavy metal Removal	2	C,D	1,2,3	1,2
12.	Aerobic and anaerobic biological treatments – High Rate reactors, Sequencing batch reactors, Membrane bioreactor	2	C,D, I	1,2,3	2
13.	Advanced oxidation processes	2	C,O	1,2,3	2
14.	Evaporation (Stripping) processes –adsorption processes (Ion exchange, Activated carbon, membrane filter)	2	C,I, O	1,2,3	2,4
15.	Electrolysis–Immobilized cell and enzyme based treatment processes	2	C,O	1,2,3	2,4
	UNIT IV-POLLUTION FROM MAJOR INDUSTRIES AND BIODEGRADATION/ RECYCLING OF INDUSTRIAL WASTES	**9**			
16.	Recycling of leather and chemical wastes	2	C,I, O	1,2	1,2
17.	Recycling of pharmaceutical and paper wastes	2	C,I, O	1,2	1,2
18.	Recycling of textile and oil refineries wastes	2	C,I, O	1,2	1,2
19.	Recycling of pesticides industrial wastes	1	C,I, O	1,2	1,2
20.	Recycling of Biomedical wastes, Radioactive wastes and Electronic wastes	2	C,I, O	1,2	1,2
	UNIT V-ENVIRONMENTAL CONCERNS, LEGISLATIONS AND ENVIRONMENTAL IMPACT ASSESSMENT	**8**			
21.	Environmental Assessment and Management Systems Applicable federal and provincial environmental regulations.	2	C	4	1,4
22.	Environmental impact assessment (EIA) legislation and regulatory framework.	2	C	4	1,4
23.	EIA applied to solid and liquid waste management, effluent control, air pollution control and urban development	2	C	4	1,4
24.	Environmental auditing- OSHA	2	C	4	1,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Eckenfelder, W.W., (1999) " Industrial Water Pollution Control ", Mc-Graw Hill.
2.	Clair N. Sawyer, Perry L. McCarty, “Chemistry for Environmental Engineering and Science” McGraw-Hill, 1978
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Nelson, L. Nemerow(2000)”Liquid waste of Industry, Theories, Practice and Treatment,Addison-Wesley Publishing Company, London.

4.	World Bank Group (1998) " Pollution Prevention and Abatement Handbook – Towards Cleaner Production ", World Bank and UNEP, Washington D.C.
5.	R.L Stephenson & J.B.Blackburn (1998) "Industrial Wastewater Systems Handbook, Lewis Publishers, New Yark.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT311E	**Bioinformatics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting 23 July , 2016				

PURPOSE	Aims at providing an elementary knowledge of bio informatics and its application							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Student will learn about the Scope of Bioinformatics	a						
2.	Get familiarized with various biological database and their uses.	a		c	f			
3.	Student will learn about the various sequence alignment methods and its applications.	a	b	c	f			
4.	Familiarize the protein analysis and DNA mapping using bio informatics tools.	a	b	c	f			
5.	Ability to write basic programs in PERL.	a		c				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: INTRODUCTION & APPLICATIONS OF BIOINFORMATICS	**9**			
1.	Introduction to Bioinformatics	1	C	1	1, 2
2.	Internet basics: Connecting to internet and internet protocols	2	C	1	1, 2
3.	Facilities on internet: Email, ftp, www.	1	C	1	1, 2
4.	The NCBI data model: Introduction	2	C	1, 2	1
5.	SEQ-Ids	1	C	1, 2	1
6.	BIOSEQs and BIOSEQ-SETs	1	C	1, 2	1
7.	SEQ-ANNOT and SEQ-DESCR	1	C	1, 2	1
	UNIT II: BIOLOGICAL DATABASES	**9**			
8.	Introduction on databases & biological databases	1	C	2	1, 2, 3
9.	Primary sequence databases	2	C	2	1, 2, 3
10.	Composite sequence databases	1	C	2	1, 2, 3
11.	Secondary databases	1	C	2	1, 2, 3
12.	Composite protein databases	1	C	2	1, 2, 3
13.	Structural databases	1	C	2	1, 2, 3
14.	Specialized genomic resources	1	C	2	1, 2, 3
15.	GRAIL and GENSCAN	1	C	4	2, 3
	UNIT III: ALIGNMENT TECHNIQUES	**9**			
16.	Global Pairwise Alignment Algorithm	1	C	2, 3	2, 3,4,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
17.	Local Pairwise Alignment Algorithm	1	C	2, 3	2, 3,4,5
18.	Database Searching Algorithms: FASTA and BLAST	2	C	2, 3	2, 3,4,5
19.	Multiple Sequence Alignment: Progressive and Iterative Alignment	2	C	2, 3	2, 3,4,5
20.	Application of Multiple Sequence Alignment	1	C	2, 3	2, 3,4,5
21.	Databases Of Multiple Alignment	1	C	2, 3	2, 3,4,5
22.	Secondary Database Searching	1	C	2, 3	2, 3,4,5
	UNIT IV:	**8**			
23.	Protein Identity Based on Composition	2	C	4	1
24.	Physical Properties Based on Sequence	2	C	4	1
25.	Motifs and Patterns prediction	1	C	4	1
26.	Secondary structure prediction	1	C	4	1
27.	Specialized secondary structure prediction	1	C	4	1
28.	Tertiary structure prediction	1	C	4	1
	UNIT V:	**9**			
29.	Introduction to Perl-scalars	1	C	5	1, 6
30.	Basic input & output	2	C	5	1, 6
31.	File handles	2	C	5	1, 6
32.	Conditional blocks & loops	2	C	5	1, 6
33.	Pattern matching,	1	C	5	1, 6
34.	Arrays and hashes	2	C	5	1, 6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Andreas D Baxevanis & B F Francis, "Bioinformatics- A practical guide to analysis of Genes & Proteins", John Wiley, 2002
2.	T K Attwood, D J Parry-Smith," Introduction to Bioinformatics", Pearson Education, 1st Edition, 11th Reprint 2005.
3.	Jin Xiong , " Essential Bioinformatics", Cambridge University Press, 2006
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	C S V Murthy,"Bioinformatics", Himalaya Publishing House, 1st Edition 2003.
5.	S.C.Rastogi & others, " Bioinformatics- Concepts, Skills, and Applications", CBS Publishing, 2003.
6.	Harshawardhan P Bal, *Perl Programming for Bioinformatics*, Tata McGraw Hill, 2003.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT312E	**Drug and Pharmaceutical Biotechnology**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	The course design is aimed at imparting basic knowledge and the requirements of Pharmaceutical Industry. The student will additionally gain specific knowledge on available drugs their mechanism of action and clinical uses.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	Understand the various dosage forms and the choice of dosage form based on the need.	a	c	f				
2.	Accumulate the parameters required in the drug discovery process and its formulation.	a	c	f				
3.	Understand the usage of drugs and their mechanism to treat certain ailments.	a	f					
4.	Realize the current and futuristic trends in Drug delivery systems.	a	f					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO DRUGS AND DOSAGE FORMS	**9**			
1.	Drug Discovery and Drug Design, Biologic Characterization, Early Formulation Studies, Investigational New Drug Application, New Drug application.	3	C	1, 2	1
2.	Different Dosage Forms – Tablets, Capsules, Lozenges, Ointments, Creams, Gels, Transdermal delivery system, Suppositories, Pesseries, Solutions, Suspensions, Emulsions, Syrups, Paints.	1	C, D	1	1
3.	**Dosage form Design:** Pharmaceutical and Formulation Considerations, Biopharmaceutical and Pharmacokinetic Considerations.	5	C, D	1,2	1
	UNIT II: LIQUID DOSAGE FORMS	**9**			
4.	**Solutions:** Solubility, Solvents used in preparations, Methods of preparations, Syrups, Elixirs, Tinctures, Topical solutions. Proper administration of Liquid Peroral dosage forms.	4	C, D	2	1
5.	**Parenterals:** Injections, Small Volume Parenterals, Large volume Parenterals, Implements or Implants. Special considerations associated with Parenteral therapy.	5	C, D	2	1
	UNIT III: PHARMACOLOGY – I	**10**			
6.	Structrue, Classification, Mechanism of action and uses of:Histamine and Anti-histaminicsProstaglandins, Leukotrienes and Platelet Activating FactorNon-steroidal Anti-inflammatory Drugs and Anti-Pyretic-Analgesics.Anti-Malarial DrugsDrugs affecting Renin-Angiotensin system.	10	C	3	2
	UNIT IV: PHARMACOLOGY – II	**10**			
7.	Classification, Mechanism of action and uses of :Anti-psychotic and Anti-anxiety drugs Anti-depressant and Anti-maniac drugs Anti-arrhythmic drugs Anti-hypertensive drugs	10	C	3	2
	UNIT V: NOVEL AND ADVANCED DRUG DELIVERY SYSTEMS	**7**			
8.	Radiopharmaceuticals, Drug antidote for radiation exposure, Non-radioactive Pharmaceutical use in Nuclear medicine	3	C	4	1
9.	Topical Administration – Iontophoresis and Phonophoresis	1	C	4	1
10.	Oral administration – Chewable Dispersible tablets, Mucoadhesive systems, Osmotic Pump, Oral inhalation	1	C	4	1
11.	Parenteral administration – Long acting Parenteral systems, Liposomes, Stealth liposomes	1	C	4	1
12.	Fusion Protein – Special Handling	1	C	4	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ansel. H. C, Allen. L. V, "*Pharmaceutical Dosage Forms and Drug Delivery Systems"*,Lippincott Williams & Wilkins, Indian Edition, 8th Edition.
2.	Tripathi.K.D, "*Essentials of Medical Pharmacology"*,Jaypee Brothers Medical Publishers, New Delhi, 7th Edition.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15BT313E	**Stem Cell Technology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To acquire knowledge in stem cell proliferation, differentiation and characterization to apply this concept on tissue engineering and organ regeneration							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Gain basic knowledge in stem cells and understand the importance of stem cell research	a	i					
2.	Acquire the essentials of culturing and differentiation of stem cells	a						
3.	Understand the role of signal pathways in cancer stem cell proliferation	a	c					
4.	Conceptualize the therapeutic applications of stem cells in tissue engineering and organ regeneration	a	f					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: STEM CELLS BASICS	**8**			
1.	Introduction to stem cells, Unique properties of stem cells, types of stem cells, ethical concerns	2	C	1	1
2.	Introduction to embryonic, adult and umbilical cord stem cells; Important sources of stem cells	2	C	1	1
3.	Similarities and differences between embryonic and adult stem cells	1	C	1	1
4.	Properties of stem cells with reference to potency; different types of potencies- Human embryonic development – totipotent, multipotent, pluripotent, induced pluripotent, oligopotent, unipotent	3	C	1	1
	UNIT II: ISOLATION, CHARACTERIZATION AND DIFFERENTIATION OF EMBRYONIC STEM CELLS	**10**			
5.	*In vitro* fertilization- collection and culturing of embryos	3	C	2	1,2
6.	Isolation of human embryonic stem cells (hES) from embryos	2	C	2	1,2
7.	Importance of blastocyst and inner cell mass ; Culturing, identification and characterization of hES cells	3	C	2	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
8.	Cloning and controlled differentiation of hES; Applications of ES cells	2	C,D	2	1,2
	UNIT III: Isolation, characterization and differentiation of adult stem cells	**9**			
9.	Different types of adult stem cells and its applications	1	C	2	1,2
10.	Haematopoeitic stem cells, Bone marrow stromal stem cells, Liver stem cells, Skeletal muscle stem cellsBone marrow derived stem cells	3	C	2	1,2
11.	Tests for identification of adult stem cells	2	C,D	2	1,2
12.	Trans differentiation: plasticity	1	C	2	1,2
13.	Differentiation of adult stem cells	2	C,D	2	1,2
	UNIT IV: Stem Cell Signaling	**10**			
14.	Tumor stem cells	2	C	3	2
15.	Common signaling pathways in cancer and ESCs	2	C	3	2,3
16.	Pathways involved in cancer & stem cell renewal	3	C	3	3
17.	Pathways involved in stem cell differentiation	3	C	3	3
	UNIT V: Stem Cells in Tissue Engineering and gene therapy	**8**			
18.	Introduction: Biomaterials – Cell and biomaterial interactions	2	C	4	1
19.	Therapeutic application of stem cells: hematopoietic stem cells and Leukemia, mesenchymal stem cells and bone tissue engineering	3	D,I	4	1
20.	Stem cells in gene therapy	1	D,I	4	1
21.	Regenerative medicine: Role of stem cells in Parkinson's diseaseOrgan development: cornea, wind pipe, pancreas	2	D,I	4	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ariff Bongso, Eng Hin Lee ,"Stem cells: from bench to bedside". World scientific, 2005.
2.	Potten. C.S., "Stem cells" Elsevier, 1996.
	OTHER READING MATERIAL
3.	Oliver Dreesen & Ali H. Brivanlou ,"Signaling Pathways in Cancer and Embryonic Stem Cells" . Stem cell rev , 2007 pp 1-11.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT314E	**Transgenic Animals**			**L**	**T**	**P**	**C**
				3	**0**	**0**	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To impart the fundamentals of transgenic animals and their potential therapeutic applications							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Develop the theoretical knowledge on basic concepts of transgenesis and the ethical concerns.	a		f	i			
2.	Emphasize the importance of animal model	a	c	f				
3.	Inculcate the importance of sources for transgenic animals and the valuable products	a	c	f				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I-HISTORICAL ASPECTS OF TRANSGENIC STUDY	**9**			
1.	Historical perspectives of transgenic technology	2	C	1	1,2
2.	Concepts of transgenic techniques of gene transfer	2	C	1	1,2
3.	Principles of animal cloning – Somatic Cell Nuclear Transfer (SCNT) method	2	C	1	2
4.	Social, Environmental concerns on transgenic animal technology – importance of transgenic animals on disease model, drug, environmental use, disease control and clone for food	1	C	1	3,4
5.	Ethical related to transgenic animal technology – CCAC guidelines for animal usage	1	C	1	3,4
6.	Religious and other regulatory issues – religious approach and approval bodies like FDA, FFDCA, INAD, NADA for transgenic animal production	1	C	1	3,4
	UNIT II-PROMOTORS AND VECTORS	**8**			
7.	Promoters – types, elements and transgene construct	3	C	1	1
8.	Eukaryotic expression vectors – P element, retro, lenti, adeno and adeno associated viral vectors	3	C	1	1
9.	Detection of transgenes by southern blot, PCR, QPCR, FISH methods	2	C	1	2
	UNIT III-METHODS OF TRANSGENESIS	**10**			
10.	Retroviral vector method for transgenic animal production	2	C,D	1	1
11.	DNA micro injection on pronuclei and cytoplasm, Embryonic stem cell mediated gene transfer	2	C,D, I	1	1
12.	Gene transfer in Oocyte and its limitations, Production of Dolly by nuclear transfer technique	2	C,D, I	1	1
13.	Transgenic Cattle, Goat production – super ovulation, AI, collection of ova, DNA construct, pronuclei injection, transfer of embryo	2	C,D, I	1	2
14.	Transgenic Pig and Rat production – hormonal induction, SCNT, microinjection, embryo transfer	2	C,D, I	1	2
	UNIT IV-DEVELOPMENT OF ANIMAL MODELS	**9**			
15.	Knock out and knock in technology – methods and advantages	2	C	2	1
16.	Animal models for human diseases – Sickle cell anemia, amylotrophic lateral sclerosis, chronic hypertension, retinal degeneration, osteogenesis imperfect, diabetes, neurodegenerative diseases, rhodopsin and retinitis pigmentation	3	C,D, I	2	1
17.	Cystic fibrosis – pigs and ferrets model	1	C,D, I	2	1
18.	Atherosclerosis – mice, rabbits, pigs and non-human primates model	1	C,D, I	2	1,5
19.	Obesity – agouti mouse mutation model	2	C,D, I	2	6

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V-PRODUCTS FROM TRANSGENIC SOURCES	**9**			
20.	Therapeutic proteins production : alpha- 1antitrypsin, protein C, fibrinogen, factor IX, human serum albumin	2	D,I	3	1,2
21.	Better nutrition – mutant models, carcass and meat improvement, modified milk, glycoconjugates	2	C,D	3	1,2
22.	Disease resistance models – knockout or replacement of susceptible or disease gene	2	C,D, I	3	1
23.	Xenotransplantation – kidney, liver, heart, pancreas transplantation from animal sources	2	C,D	3	1
24.	Bioindicator- transgenic Glofish development, types and applications	1	C,D, I	3	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Louis-Marie Houdebine, "Animal Transgenesis and Cloning". John Wiley and Sons Ltd., England, 2003.
2.	Ranga, M.M., "Animal Biotechnology". Third Revised Edition, Agrobios (India), Jodhpur, 2007.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Gary J. Curran and Yuri J. Koszarycz , "Animal Transgenesis and Cloning: Scientific, Religious and Ethical Considerations". Australian eJournal of Theology 3:1-10; 2004
4.	Kochhar, H.P.S.,Gifford,G.A.and Kahn,S. (Eds.)H. P. S. Makkar and G. J. Viljoen, "Applications of Gene -Based Technologies for Improving Animal Production and Health in Developing Countries".IAEA. Printed in the Netherlands, 479-498, 2005.
5.	Fatemeh Ramezani Kapourchali, Gangadaran Surendiran, Li Chen, Elisabeth Uitz, Babak Bahadori,Mohammed H Moghadasian , "Animal models of atherosclerosis".World J Clin Cases, 2(5): 126-132, 2014
6.	John Speakman, Catherine Hambly, Sharon Mitchell and Elżbieta Kro`l, "The contribution of animal models to the study of obesity" .Laboratory Animals, 42, 413–432, 2008.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT315E	**Bioreactor Design**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	The course provides exposure for the design and operation of various industrial bioreactors							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Strengthen the basic notions of bioreactor design	a	c					
2.	Accomplish knowledge on transport phenomena and scale up of bioreactors	a	c					

3.	Analyze the design and operation of air driven bioreactors	a	c	k				
4.	Expand knowledge on various modes of operation of industrial bioreactors for microbial, plant and animal cell culture systems	a	c	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : UNDERSTANDING BIOREACTOR DESIGN	**10**			
1.	Basics and importance of bioreactors	1	C	1	1,2
2.	Guidelines for bioreactor design	2	C	1	2,3
3.	Mechanical aspects of bioreactor design	1	C,D	1	2,3
4.	Requirements for construction of a bioreactor	2	C	1	2,3
5.	Development of bioreactors	1	C,D	1	2,3
6.	Instrumentation to control a bioreactor	1	C,I	1	2,3
7.	Common operations of bioreactor	2	C,O	1	
	UNIT II : TRANSPORT PHENOMENA AND SCALEUP OF BIOREACTORS	**10**			
8.	Transport phenomena in bioreactors	2	C	2	2
9.	Parameters influencing transfer operations	1	C	2	2
10.	Scale-up of bioreactors-Criteria of scale-up	2	C,D, I,O	2	1,2
11.	Scale-up methods	3	C,D, I,O	2	1,2
12.	Generalized approaches to scale-up in combination of methods	2		2	
	UNIT III :AIR-DRIVEN BIOREACTORS	**8**			
13.	Design and construction of Bubble column fermenter	2	C,D, I,O	3	1,2
14.	Airlift bioreactors: Design and construction of the airliftloop reactor	2	C,D, I,O	3	1,2
15.	Hydrodynamics – Three phase flow – Mixing – Oxygen transfer	2	D,I	3	1,2
16.	Design and operation of fluidized bed bioreactor	2	C,D, I,O	3	1,2
	UNIT IV :INDUSTRIAL BIOREACTOR DESIGN-I	**9**			
17.	Design and Operation of Sequence batch reactor	3	C,D, I,O	4	1,2
18.	Design and Operation of bioreactor with recycle	3	C,D, I,O	4	1,2
19.	Design of bioreactors for Solid-state fermentation	3	C,D, I,O	4	4,5
	UNIT V : INDUSTRIAL BIOREACTOR DESIGN - II	**8**			
20.	Design and Operation of Membrane bioreactor	2	C,D ,I,O	4	6,7
21.	Design and Operation of Immobilized enzyme bioreactor	2	C,D, I,O	4	6,7
22.	Design and Operation of Hollow fiber bioreactor	2	C,D, I,O	4	6,7
23.	Design and Operation of Plant cell bioreactor design	2	C,D, I,O	4	6,7
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Scragg. H., "*Bioreactors in Biotechnology*", Ellis Horwood series, 1991.
2.	Panda. T., "*Bioreactors: Analysis and Design*", McGraw Hill Education (India) Private Limited, 2011
3.	Riet. K. V., Tramper. J., "*Basic Bioreactor Design*", 2nd ed., Marcel Dekker, Inc., New York, 1991.

	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Vogel. H.C., "*Fermentation and Biochemical Engineering Handbook: Principles, Process design, and Equipment*", Noyes Publications, 1983.
5.	Mitchell. D., Krieger. N., Berovic. M., "*Solid-State Fermentation Bioreactors: Fundamentals of design and Operation*", Springer-Verlag Berlin Heidelberg, 2006.
6.	Eibl. R., Eibl. D., Pörtner. R., "*Cell and Tissue Reaction Engineering: Principles and Practice*", Springer, 2008.
7.	Chattopadhyay. S.,Farkya. S., Srivastava A. K., BisariaV. S. "*Bioprocess Considerations for Production of Secondary Metabolites by Plant Cell Suspension Cultures*", Biotechnology and Bioprocess Engineering". 2002, 7: 138-149.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT316E	**Plant Hormones and Signal Transduction**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	The course is designed to provide an understanding of the regulation of various physiological and metabolic processes by signaling growth regulating substances. The student will gain an understanding of theoretical principles related to transduction of signals between different plant parts which in turn regulate plant growth and development.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To introduce basic concepts related to discovery and physiological effects of plant growth regulators	a	c	e	h	k		
2.	To impart an understanding of control of various physiological and developmental mechanisms by hormones	a	c	e	h	k		
3.	To give an insight into the cellular and molecular modes of action of phytohormones	a	c	e	h	k		
4.	To explore the nature of signaling molecules and receptors involved in plant development	a	c	e	h	k		
5.	To explore the prospects related to potential applications of principles underlying signal transduction mechanisms.	a	c	e	h	k		

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I: AUXINS	**9**			
1.	Introduction to plant hormones and signal transductions, receptors types, translocation, perception and activation of genes	1	C	1-4	1,2,3
2.	Introduction – The emergence of the auxin concept	2	C	2-4	1,2,3
3.	Biosynthesis and metabolism of auxin, auxin transport	3	C	2-4	1,2,3
4.	Physiological effects of auxin, developmental effects of auxin	2	C	2-4	1,2,3
5.	Auxin receptors and signal transduction pathways of auxin	1	C,D	1-4	1,2,3,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT II: CYTOKININS	**9**			
6.	The discovery, identification and properties	2	C	1-4	1,2
7.	Biosynthesis, metabolism and transport of cytokinins	3	C	2-4	1,2,5
8.	Biological roles of cytokinins	2	C	2-4	1,2,5
9.	Cellular and molecular modes of cytokinin action	2	C,D	1-4	1,2,5
	UNIT III: GIBBERELLINS	**9**			
10.	The discovery of the gibberellins, effects of gibberellin on growth and development	3	C	1-4	1,2,4
11.	Biosynthesis and metabolism of gibberellin	2	C	2-4	1,2,5
12.	Physiological mechanisms of gibberellin-induced growth	2	C	2-4	1,2,4
13.	Signal transduction -cereal aleuronic layers	2	C,D	1-4	1,2,4,5
	UNIT IV: ETHYLENE	**9**			
14.	Introduction and Structure of ethylene	2	C	1-4	1,2,5
15.	Biosynthesis and measurement of ethylene	2	C	2-4	1,2,5
16.	Developmental and physiological effects	2	C	1-4	1,2,5
17.	Cellular and molecular modes of ethylene action- Ethylene receptors	3	C,D		1,2,5
	UNIT V: ABSCISIC ACID	**9**			
18.	Occurrence, chemical structure and measurement of ABA	3	C	1-4	1,2,5
19.	Developmental and physiological effects of ABA	3	C	2-4	1,2,5
20.	ABA Receptors - cellular and molecular modes of ABA action	3	C,D	1-4	1,2,5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Lincoln Taiz and Eduardo Zeiger, "*Plant Physiology*", Third edition. Panima Publishing corporation, 2003.
2.	Davies, P. J., "*Plant Hormones - Biosynthesis, Signal Transduction, Action*", Third Edition, Springer 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Perrot-Rechenmann, C. and Hagen, G.,"*Auxin Molecular Biology*" , Springer 2002.
4.	Takahashi, N., Phinney, B., MacMillan, J., "*Gibberellins* " , Springer 1990.
5.	http://www.genome.jp/kegg-bin/show_pathway?map=ath04075&show_description=show

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT317E	**Bioremediation Technology**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	E	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	The Purpose of this course is to introduce the use of living organisms such as plants and microbes or their systems to the treat contaminants. In addition, the course is expected to develop an efficient, eco-friendly and economical novel alternative treatment technologies.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	To impart sufficient scientific understanding of the current environmental problems and global concern.	a	b					
2.	To focus the process of bioremediation, mechanisms, types, success Stories& monitoring strategies.	a	b					
3.	To focus the advance molecular techniques to facilitate bioremediation technology.	a	b					
4.	To focus on advanced nuclear remediation program.	a	b					
5.	To apply the concepts of bioremediation technology to the real time Problems.	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	I-O	Reference
	UNIT I - PRINCIPLES OF BIOREMEDIATION	**9**			
1.	Introduction to Bioremediation: Types of Bioremediation	1	C	1,,2	3,4
2.	Bioremediation Mechanisms, Microbes for Bioremediation	2	C	1,2	3,4
3.	Metabolic process involved in bioremediation	2	C	1,2	3,4
4.	Factors affecting bioremediation, metabolic process involved in bioremediation, Limitations of Bioremediations	2	C	1,2	3,4
5.	Mycoremediation, and phytoremediation technologies.	2	C	1,2	3,4
	UNIT II-BIOREMEDIATION TECHNOLOGIES	**9**			
6.	Bioremediation Techniques: bio stimulation & bio augmentation	1	C	1,2	3,4
7.	In situ and ex situ remediation technologies : (Bio) venting, (Bio)sparging, (Bio)stripping, (Bio)sorption barriers, Biofilters, Bioreactors	2	C	1,2	3,4
8.	Use of bioreactors for bioremediation	2	C	1,2	3,4
9.	Molecular techniques in bioremediation	2	C	1,2	3,4
10.	Application, specific advantages and disadvantages of bioremediation technologies, use of bioreactors for bioremediation.	2	C	1,2	3,4
	UNIT III- BIOREMEDIATION PROJECT MANAGEMENT	**9**			
11.	Defining the project and goals, Site characterization, Screening and selecting remediation alternatives, Process design.	1	C	3,4	3,4
12.	Remediation field activities- Aerobic Bioremediation: Bioremediation of Surface Soils: Fate and transport of contaminants in the Vadose zone	2	C	3,4	3,4
13.	Anoxic/Anaerobic Bioremediation: Anoxic/Anaerobic Environment	2	C	3,4	3,4
14.	Potential anaerobic Bioremediation – Anoxic/Anaerobic Processes – Fermentation	2	C	3,4	3,4
15.	Bioremediation in fresh water and marine systems; Natural Attenuation process	2	C	3,4	3,4
	UNIT IV - NUCLEAR WASTE BIOREMEDIATION	**9**			
16.	Radioactive Waste: Sources, half-life of radioactive elements, modes of decay	1	C	3,4	3,4
17.	Effects on Plants, Animal and Man. Low and High-level Radioactive Waste Management	2	C	3,4	3,4
18.	Current Regulations and programs of interest	2	C	3,4	3,4
19.	Spent fuel characterization, storage and disposal,Partitioning, transmutation and conditioning	2	C	3,4	3,4
20.	Actinide research	2	C	3,4	3,4

Session	Description of Topic	Contact hours	C-D-I-O	I-O	Reference
	UNIT V- HEAVY METAL BIOREMEDIATION	**9**			
21.	Heavy metal pollution & sources; Microbial interactions with heavy metals - resistance &tolerance; Microbial transformation; Accumulation and concentration of metals.	2	C	3,4,5	3,4
22.	Microbial biosorption; Mechanisms of biosorption& bioaccumulation	2	C	3,4,5	3,4
23.	Bio surfactants: Applications & Advantages of bio surfactants	2	C	3,4,5	3,4
24.	Biofilms: Applications & Advantages of Biofilms	2	C	3,4,5	3,4
25.	Nanotechnologies used for removal of contaminants	1	C	3,4,5	3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Bruce E. Rittmann, Perry L. McCarty, "Environmental Biotechnology:Principles and Applications" McGraw-Hill, 2001.
2.	Rajendran P., P. Guansekaran, "Microbial Bioremediation", Mjp Publishers,2011
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Agarwal S. K., "Environmental Biotechnology", APH Publishing, 2000
4.	Martin Alexander, "Biodegradation & Bioremediation", Academic press,1999.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT406E	**Cancer Biology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To provide knowledge about biological aspects of cancer							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Student will understand fundamental concepts cell biology, biochemistry, immunology, and physiology in development of cancer	a						
2.	Understand the various stages in carcinogenesis and the involvement of signaling cascades in cancer	a						
3.	Student will learn about the pathogenesis of cancer metastasis and probable treatment and diagnostic modalities	a	c	f				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: CANCER CELL BIOLOGY	**9**			
1.	Basic concepts of cancer: Risk factors, Pathogenesis, Treatment, and future prospects	1	C	1	1, 2
2.	The cell cycle: cyclin and cyclin dependent kinases, mechanisms of CdK regulation	1	C	1	1, 2
3.	pRb and control of cell cycle	1	C	1	1, 2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
4.	Role of myc oncoprotein in regulating pRb	1	C	1	1, 2
5.	TGF and pRb; pRb's role in cancer	1	C	1	1, 2
6.	Tumor suppressor genes	1	C	1	1, 2
7.	Cell cycle and cancer	1	C	1	1, 2
8.	Different forms of cancer	1	C	1	1, 2
9.	Diet and cancer	1	C	1	1,2
	UNIT II: CARCINOGENESIS	**9**			
10.	DNA structure and stability-Mutations versus Repair Cancer and Environment	2	C	2	1, 2, 3
11.	Causes of cancer and risk factors	2	C	2	1, 2, 3
12.	Classes and types of carcinogens	2	C	2	1, 2, 3
13.	Mechanisms of Chemical carcinogenesis	1	C	2	1, 2, 3
14.	Epigenetics, Ecogenetics and cancer risk; Cancer Prevention	2	C	2	1, 2, 3
	UNIT III: SIGNAL TRANSDUCTION: CELL DIVISION, DIFFERENTIATION, AND APOPTOSIS	**10**			
15.	Oncogenes, Growth factors, and growth factor receptors	1	C	1,2	1, 2
16.	Growth factors, receptors and Cancer Src protein, EGF receptor, Integrin receptors, Ras protein, Intracellular signaling pathways	2	C	1, 2	1,2
17.	Signal transduction through Protein Tyrosine Kinase receptors, Oncogenes and survival signaling,	2	C	1,2	1, 2
18.	Cytokine receptor signaling, T and B cell signaling, NF-kB signaling,	1	C	1, 2	1,2
19.	Neurotransmitters and GPCR signaling	1	C	1, 2	1,2
20.	Wnt signaling, Implications in cancer therapy	1	C	1,2	1,2
21.	Apoptosis and Cancer	2	C	1, 2	1, 2
	UNIT IV: METASTASIS AND ANGIOGENESIS	**10**			
22.	Stem Cells and Differentiation: Role in Cancer	3	C	1,2	1, 2
23.	Tumor microenvironment in cancer progression	2	C	1,2	1, 2,3
24.	Invasion and Metastasis	2	C	1,2	1, 2
25.	Angiogenesis	2	C	1,2	1, 2
26.	Cancer-related pain	1	C	1,2	1, 2
	UNIT V: CANCER THERAPY, PREVENTION AND DIAGNOSIS	**7**			
27.	Therapeutic strategies in Cancer	2	C	2,3	1,2.3
28.	Molecular basis of cancer therapy	3	C	2,3	1, 2. 3
29.	Cancer in the future: focus on diagnostics and immunotherapy	2	C	2,3	1, 2, 3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Lauren Pecorino, Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics, Oxford University Press; 3 edition, 2012
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Robert A. Weinberg, The Biology of Cancer Garland Science; 2nd edition , 2014
3.	John Mendelsohn, Peter M. Howley, Mark A. Israel, Joe W. Gray, Craig B. Thompson. The Molecular Basis of Cancer, Saunders; 4 edition, 2014

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT407E	**Metabolic Disorders**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Civil Engineering						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To acquire an understanding of metabolic basis of various metabolic defects in humans							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	understand the anomalies in metabolism	a	b					
2.	Appreciate the genetic and biochemical bases of metabolic disorders	a	b					
3.	Gain knowledge on the role of lifestyle in the development of metabolic disorders	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I PRINCIPLES OF METABOLIC REGULATION	**9**			
1.	Introduction to metabolic disorders	1	C	1,2,3	1, 5
2.	Principles of metabolic regulation- Garrod's hypothesis-	1	C	1,2,3	1,5
3.	Regulation of enzyme activity Covalent modifications and reversible modifications – phosphorylation, dephosphorylation, adenylation and disulphide reduction	3	C	1,2,3	1,5
4.	Overview of inherited metabolic disease processesAccumulation of substrate; Accumulation of minor metabolites	2	C	1,2,3	1,5
5.	Deficiency of product; Secondary metabolic phenomena	2	C	1,2,3	1,5
	UNIT II DEFECTIVE CARBOHYDRATE METABOLISM	**9**			
6.	Overview of Carbohydrate metabolic pathways	2	C	1,2,3	1,5
7.	Congenital disorders of Glycosylation Galactosaemia Fructosaemia	2	C	1,2,3	1,5
8.	Lactose intolerance	1	C	1,2,3	1,5
9.	Glycogen storage diseases	2	C	1,2,3	1,5
10.	Glucose homeostasis and Diabetes Mellitus	2	C	1,2,3	1,5
	UNIT III ERRORS IN NITROGEN METABOLISM	**10**			
11.	Overview of Nitrogen metabolism and its target organs	2	C	1,2,3	1,5
12.	Amino acid synthesis transport and storage Phenylketonuria, tyrosinemia, homocystinuria, maple syrup urine disease Alkaptonuria, Albinism	2	C, D	1,2,3	1,5
13.	Amino acid transport disorders: Cystinuria, Dicarboxylic aminoaciduria, Hartnup disease	2	C,D	1,2,3	1,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
14.	Inborn error of purine metabolism: adenylosuccinate lyase deficiency, adenosine monophosphate deaminase deficiency, Nucleotide salvage - Lesch-Nyhan syndrome, adenine phosphoribosyl transferase deficiency - Adenosine deaminase deficiency, Xanthinuria – Pyrimidine metabolism	2	C,D	1,2,3	1,5
15.	Inborn error of pyrimidine metabolism: Orotic aciduria, Miller syndrome, Dihydropyrimidine dehydrogenase deficiency	2	C,D	1,2,3	1,5
	UNIT IV DEFECTS IN LIPID METABOLOSM	**10**			
16.	Inborn error of lipid metabolism - Hyperlipidemia-Hypercholesterolemia and its associated disorders,	2	C	1,2,3	1,5
17.	Hypolipoproteinemia- Tangier disease, Lipodystrophy	2	C,D	1,2,3	1,5
18.	Lipid storage disorders: Sphingolipidoses: ganglioside-globoside- sphingomyelin- sphingosine- sulfatide-related diseases	3	C,D	1,2,3	1,5
19.	Fatty-acid metabolism disorders: biotinidase deficiency, malonic aciduria, Sjögren–Larsson syndrome.	3	C,D	1,2,3	1,5
	UNIT V DISREGULATION OF SMALL MOLECULES	**7**			
20.	Disorders of vitamins, coenzymes, and cofactors	1	C	1,2,3	1,5
21.	Biotinidase deficiency Holocarboxylase synthetase deficiency	2	C	1,2,3	1,5
22.	Pantothenate kinase-associated neurodegeneration,	2	C	1,2,3	1,5
23.	Methylmalonic academia, Familial isolated vitamin E deficiency	2	C	1,2,3	1,5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Harper's Illustrated Biochemistry 30th Edition, 2003
2.	Archibald E. Garrod Inborn Errors of Metabolism, Second Edition, London 1923
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	**John H. Walter** Inborn Metabolic Diseases: Diagnosis and Treatment 5th edition 2012
4.	Radiology and nuclear medicine 1989; 750 p; Medical Publishers; Chicago, IL (USA); ISBN 0-8151-8742-4;
5.	Lehninger, Principles of Biochemistry, 6e - WHFreeman

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT408E	**Computer Simulation and Drug Designing**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	This course provides the basic concepts of drug design processes and computational tools used in the drug designing.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	Understand basic concepts of drug design processes for a various number of drug development scenarios.	a		c				
2.	To highlight the different computational tools for drug designing and the computer software used in the drug designing.	a	b	c	d	f		
3.	Familiarize the basic concepts of Molecular mechanics and Quantum Mechanics in drug designing.	a		c				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: THE DRUG DESIGN PROCESS	**8**			
1.	Introduction to drug design process	1	C	1	1
2.	Compound Testing : Biochemical Assays, Cell-Based Assays, Animal Testing and Human Clinical Trials	2	C	1	1, 4
3.	Effect of Molecular Structure on Activity, Bioavailability, Drug Side Effects, Toxicity of the drug and Multiple Drug Interactions	2	C	1	1, 4
4.	Metrics for Drug-Likeness	2	C	1	1, 2, 4
5.	Exceptions to the Rules	1	C	1	1, 4
	UNIT II: TARGET IDENTIFICATION AND CHARACTERIZATION	**10**			
6.	Target Identification: Primary Sequence and Metabolic Pathway, Crystallography and 2D NMR, Homology Models, Protein Folding.	1	C	1	1, 4
7.	Analysis of Target Mechanism: Kinetics and Crystallography, Automated Crevice Detection, Transition Structures and Reaction Coordinates.	1	C	1	1, 6
8.	Molecular Dynamics Simulations	1	C	2	1 & 2
9.	Pharmacophore Identification	1	C	1	1 & 2
10.	Choosing an Inhibitor Mechanism	1	C	1	1
11.	The Drug Design Process for a Known Protein Target: The Structure-Based Design Process, Initial Hits and Compound Refinement, ADMET and Drug Resistance	2	C	1	1
12.	The Drug Design Process for an Unknown Target : The Ligand-Based Design Process, Initial Hits and Compound Refinement and ADMET	2	C	1	1
13.	Drug Design for Other Targets	1	C	1	1
	UNIT III: COMPUTATIONAL TOOLS AND TECHNIQUES	**9**			
14.	Homology Model Building – Introduction	1	C	2	1
15.	Steps for Building a Homology Model	2	C,I	2	1, 6
16.	Molecular Mechanics **:** Brief Introduction to Molecular Mechanics and Force Fields for Drug Design	2	C	2	1, 2
17.	Molecular Docking : introduction and Search Algorithms	1	C	2	1, 2
18.	The Docking Process: Protein Preparation, Building the Ligand, Setting the Bounding Box, Docking Options, Running the Docking Calculation, and Analysis of Results.	2	C,I	2	1, 2
19.	Docking software	1	C	2	1, 2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV: PHARMACOPHORE MODELS AND QSAR	**10**			
20.	Components of a Pharmacophore Model	1	C	2	1, 2, 5
21.	Creating a Pharmacophore Model from Active Compounds and from the Active Site	2	C	2	1, 2, 5
22.	Searching Compound Databases and Reliability of Results	1	C	2	1, 2, 5
23.	QSAR : Conventional QSAR versus 3D-QSAR	1	C	2	1, 2, 5
24.	The QSAR Process and Descriptors	1	C	2	1, 2, 5
25.	Automated QSAR Programs and QSAR versus Other Fitting Methods	1	C	2	1
26.	The 3D-QSAR Process	2	C	2	1, 2, 5
27.	3D-QSAR Software Packages	1	C	2	1, 2, 5
	UNIT V: QUANTUM MECHANICS AND ARTIFICIAL INTELLIGENCE IN DRUG DESIGN	**8**			
28.	Quantum Mechanics Algorithms and Software	2	C	3	1, 2
29.	Structure based De novo Ligand synthesis	2	C	2	1, 2
30.	Nonquantitative and Quantitative Predictions	1	C	3	1, 2
31.	Future Developments in Drug Design : Individual Patient Genome Sequencing and Analysis of the Entire Proteome	1	C	2	1
32.	Drugs Customized for Ethnic Group or Individual Patient	1	C	2	1
33.	Application of Genetic Manipulation, Cloning and Stem Cells in drug design	1	C	2	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Young, “Computational Drug Design: a Guide for Computational and Medicinal Chemists”, Wiley, 2009
2.	Andrew Leach, “Molecular Modeling: Principles and applications,” 2nd edition, Pearson Education.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Andrew Leach, “An introduction to Chemoinformatics,” Springer, 2007
4.	Rick NG, “Drugs: from Discovery to Approval,” John Wiley & sons, 2004.
5.	Paul S Charifson, “Practical Application of Computer-Aided Drug Design,” Informa Health Care, 1997.
6.	Moody PCE and Wilkinson AJ, “Protein Engineering,” IRL press oxford 1990

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT409E	**Animal Therapeutics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	To impart knowledge on various animal sources for the production of animal therapeutics							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the guidelines for the product development and drug testing	a		f				
2.	Discriminate the *in vitro* and *in vivo* sources of drugs and their applications	a	c	f				
3.	Validate the ethical concerns in animal study	a		i				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I-HISTORY AND GUIDELINES OF PRODUCT DEVELOPMENT	**9**			
1.	History of the product development for human	2	C	1	1
2.	Guidelines for the product industry for the uses of animal and human cells	2	C	1	1
3.	Guidelines for product development and drug testing	3	C,D	1	2
4.	Common product safety tests	2	C	1	1,2
	UNIT II-METHODS AND SOURCES OF PRODUCT STUDY	**8**			
5.	*In vitro* and *in vivo* method of products –selection and culture of cell lines	3	C,D	2	3,4
6.	Types of human and animal cell lines	2	C	2	
7.	History, assessment and types of animal models for the therapeutic products	3	C,D	2	
	UNIT III-COMPARATIVE MEASUREMENT OF PRODUCT SOURCES	**9**			
8.	Methods of production of therapeutics	3	C,D,I	2	1,232
9.	Comparative status of drugs from : natural and cell line or animal models	3	C	2	
10.	Animal models and their applications–Fruit fly and Zebra fish	3	C,D, I	2	
	UNIT IV-PRODUCTS AND THEIR SPECIFIC SOURCES	**10**			
11.	Production of medicinally important products from in vitro sources	3	C,D	2	2,3
12.	Production of Hormones, blood clotting factors, interferons from cell lines	4	D,I	2	2,3
13.	*In vitro* production of plasminogen activator, erythropoietin and antitrypsin	3	D,I	2	2,3
	UNIT V-ETHICAL ISSUES AND PATENT APPROVAL	**9**			
14.	Fundamental issues for cell-line banks in biotechnology and regulatory affairs	2	C	3	3
15.	Ethical issues on animal model research	2	C	3	1
16.	Patents in the drug industry: Legal and Ethical Issues	3	C	3	2,44
17.	Drug Approval in the European Union and the United States	2	C	3	4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Allan B. Haberman, “Animal Models for Therapeutic Strategies”, Cambridge Healthtech Institute, 2010.
2.	Walsh G,“Pharmaceutical Biotechnology: Concepts and Applications”, John Wiley & Sons Ltd, 2007.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Freshney R.I., “Culture of Animal cells”,5th Edition, Wiley Publications, 2010.
4.	Jim E. Riviere and Mark G. Papich (Eds), “Veterinary Pharmacology and Therapeutics,” Wiley-Blackwell, 9th Ed., 2009.

Course nature				Theory			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15BT410E	**Bioprocess Modelling and Simulation**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	To introduce the different aspects of modeling in bioprocess system and tofamiliarize the simulation of bioprocess modeling							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn about the principles of bioprocess modeling and simulation	a		d	k			
2.	Understand the mathematical models in biochemical engineeringsystems	a	b	d	k			
3.	Apply the SuperPro Designer for analysis of material and energy balance of biochemical reaction	a	b	d	k			
4.	Acquire the basics of MATLAB, data analysis and interpretation ofdata							
5.	Study the application of MATLAB and CFD in thebioprocess systems	a	b	d	k			

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	UNIT I :BASIC MODELLING PRINCIPLES	**12**			
1.	Basic modeling principles - uses of mathematical modeling -Classification of modeling techniques.	3	C, D	1	1
2.	Fundamental laws - energy equations– examples	3	C, D	1	1
3.	Continuity equation - equations of motion – examples	3	C,D	1	1
4.	Transport equations - equations of state – examples	2	C, D	1	1
5.	Equilibrium states and chemical kinetics-examples	1	C, D	1	1
	UNIT II :MATHEMATICAL MODELS FOR BIOCHEMICAL ENGINEERING SYSTEMS	**9**			
6.	Continuous flow tanks - mixing vessel - mixing vessel mixing with reaction - reversible reaction	4	C, D	2	1
7.	Steam jacketed vessel - boiling of single component liquid-open and closed vessel-continuous boiling system	3	C,D	2	1
8.	Batch distillation	2	C,D,I	2	1
	UNIT III :SUPERPRO DESIGNER	**6**			
9.	Introduction to SuperPro Designer	1	C	3	3
10.	SuperPro Designer for Material Balance with reaction.	2	C,D,I	3	3
11.	SuperPro Designer for Material Balance without reaction.	1	C,D, I	3	3
12.	SuperPro Designer for Energy Balance with reaction.	1	C, D, I	3	3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13.	SuperPro Designer for Energy Balance without reaction.	1	C,D,I	3	3
	UNIT IV :MATLAB BASICS AND DATA ANALYSIS	**9**			
14.	Basics-Data analysis-curve fittings	2	C, D, I, O	4	2
15.	Numerical integration	2	C, D,I, O	4	2
16.	Euler and fourth order rungekutta method	3	C, D, I, O	4	2
17.	Input and Output in MATLAB	2	C, D, I, O	4	2
	UNIT V: MATLAB AND SIMULINK: APPLICATION IN BIOPROCESS SYSTEMS	**9**			
18.	Solving problems using MATLAB by numerical integration	1	C, D, I, O	5	2
19.	Euler and fourth order RungeKutta methods	2	C, D, I, O	5	2
20.	Simulation of gravity flow tank	1	C, D,I, O	5	2
21.	Simulation of CSTR in series	1	C, D,I, O	5	2
22.	Simulation of batch reactor using MATLAB	2	C, D,I, O	5	2
23.	Computational fluid dynamics in bioprocess	3	C, D,I, O	5	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCE BOOKS/OTHER READING MATERIAL**
1.	Luben. W.L., "*Process Modelling Simulation and Control for Chemical Engineers*", McGrawHill, International New York, 1990.
2.	Beers. K.J., "*Numerical Methods for Chemical Engineering Applications in MATLAB®*", Massachusetts Institute of Technology, Cambridge University press 2007 edition.
3.	www. intelligen.com

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT411E	**Bioproduct Development**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	This course provides exposure to utilize the integrated bioprocess technologies for the development of various valuable bio products.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Enables to learn the various advanced technologies for bio products development	a	f					
2.	Advancement of integrated technologies for the production of lingo cellulosic derived biofuel	a	c	f				
3.	Understanding the commercialization of immobilized enzymes process for industrial biochemical products.	a	c	f				
4.	Gain the knowledge about the scientific development of emergingisoprenoid products.	a	c	f				
5.	Expose to different techniques used for the encapsulation of bio products and various packing methodologies.	a	f					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : ENABLING ADVANCE TECHNOLOGIES FOR BIOPRODUCT DEVELOPMENT	**9**			
1.	Metabolic engineering: Applications, methods, and challenges	2	C	1	1
2.	Directed evolution tools in bioproduct and bioprocess development	2	C, D	1	1
3.	Bioreactor engineering	3	C, D	1	1
4.	Membranes for bioseparation	2	C, D	1	1
	UNIT II : BIOREFINERIES	**9**			
5.	Integrated biochemical processes for liquid biofuels	2	C, D, I, O	2	3
6.	Consolidated bioprocessing for cellulosic ethanol production	3	C, D, I, O	2	3
7.	Consolidated bioprocessing for cellulosic butanol production	3	C, D, I, O	2	3
8.	Process economics and farm based biorefinery	1	C, D, I, O	2	3
	UNIT III : INDUSTRIAL USE OF IMMOBILIZED ENZYMES	**12**			
9.	High fructose corn syrup commercialization using immobilized glucose isomerase	3	C, D, I, O	3	5
10.	Biodiesel commercialization using immobilized lipase	2	C, D, I, O	3	5
11.	Debittering of fruit juices using immobilized naringinase	3	C, D, I, O	3	5
12.	Commercial development of enzymatic interesterification of food oils and fats	3	C, D, I, O	3	5
13.	Carbon capture using immobilized carbonic anhydrase	1	C, D, I, O	3	5
	UNIT IV : BIOTECHNOLOGY OF ISOPRENOIDS	**9**			
14.	Engineering of higher plants and algae for isoprenoids productions	2	C, D, I, O	4	4
15.	Microbial terepenoid biosynthesis	2	C, D, I, O	4	4
16.	Current and emerging options for taxol production	2	C, D, I, O	4	4
17.	Production of high-value added products by marine microalgae *thraustochytrids*	3	C, D, I, O	4	4
	UNIT V: MICRO ENCAPSULATION AND PACKAGING TECHNOLOGIES	**6**			
18.	Bioproducts formulation	2	C, D, I, O	5	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
19.	Nano-microencapsulation technology and applications in fortified and functional foods	2	C, D, I, O	5	2
20.	Packaging functional foods	2	C, D, I, O	5	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Yang. S., "*Bioprocessing for value added products from renewable resources – New technologies and applications*", ElsevierPublishers, 2007.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Qureshi. N., Hodge. D.B., Vertes.A.A., "*Functional food ingredients and nutraceuticals processing technologies*", CRC PressPublishing 2016.
3.	Waites. M. J., "*Biorefineries integrated biochemical processes for liquid biofuels*", ElsevierPublishers, 2014.
4.	Schrader. J., Bohlmann. J., "*Biotechnology of isoprenoids*", CBS Publishers, 1983.
5.	MessingR.A., "*Immobilized enzymes for industrial bioreactors*", Academic Press Publishers, 1975.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15BT412E	**Pathogenesis Related Proteins In Plants**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	BIOTECHNOLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	The course is designed to provide an understanding of the up-regulation of various proteins during pathogen infection and other related abiotic stress conditions. The student will gain an understanding of theoretical principles related to mechanisms of resistance to pathogens at molecular level which can beapplied for developing technologies to improve resistance in plants.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To presents an overview of the expression of proteins during biotic and abiotic stress conditions	a	c	e	h	k		
2.	To gain an understanding of mechanisms of disease resistance in plants	a	c	e	h	k		
3.	To give an insight into principles related to plant insect interactions	a	c	e	h	k		
4.	To project the application of the knowledge of PR proteins for geneticmanipulation of plants	a	c	e	h	k		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: PR PROTEINS AND THEIR FUNCTIONS	**7**			
1.	Introduction- induction of PR proteins	1	C	1-4	1,2,3
2.	Occurrence and properties of PRs	2	C	2-4	1,2,3
3.	PR like proteins	2	C	2-4	1,2,3
4.	Functions of PR proteins	2	C,D	2-4	1,2,3
	UNIT II: PR-1 AND PR-2 PROTIENS	**10**			
5.	PR-1-Introduction- Characterization-acidic, basic proteins, proteins from other organisms, functions	2	C	1-4	1,2
6.	Expression - pathogens/wounds, salicylic acid, ethylene and other hormones, UV light and developmental stimuli.	2	C	2-4	1,2,5
7.	PR-1 promoter analysis	2	C,D	2-4	1,2,5
8.	PR-2- Introduction- Structural classes of β-1,3-Glucanases and PR-2 Nomenclature,Biological functions of β-1,3-Glucanases	2	C	1-4	1,2,5
9.	Regulation of β-1,3-Glucanases expression	2	C,D		1,2,3
	UNIT III: PLANT CHITINASES AND PR-5 FAMILY	**10**			
10.	Introduction-PR-3, 4, 8, 11	2	C	1-4	1,2,4
11.	Structure of proteins, catalytic mechanisms andspecificities, structure and regulation of the genes, functions.	4	C,D	2-4	1,2,5
12.	PR-5-Occurrence, biological properties of TLPs	2	C	2-4	1,2,4
13.	Regulation of TLP expression, cDNAs and genes for TLPs	2	C,D	1-4	1,2,4,5
	UNIT IV: PATHOGEN INDUCED PR GENE EXPRESSION AND RIP	**9**			
14.	Introduction – Signals and putative receptors that activate PR gene expression	2	C,D	1-4	1,2,5
15.	PR gene activation by pathogens, transcriptional regulation and genetic studies of PR gene expression.	2	C,D	2-4	1,2,5
16.	Ribosome inactivating proteins – structure, function and engineering	2	C	1-4	1,2,5
17.	Pathogen induced gene expression PR-6- Occurrence and structure of plant proteinase inhibitors, Plant microbe interaction, Plant insect interaction and its regulation.	3	C,D		1,2,5
	UNIT V: PLANT DEFENSINS AND PR GENES IN TRANSGENIC PLANTS	**9**			
18.	Introduction – Protein structure, antimicrobial activities, structure activity relationships	3	C	1-4	1,2,5
19.	Mode of action, expression of plant defensin genes and its contribution for host defense	3	C	2-4	1,2,5
20.	Transgenic plants – over expression of PR proteins – antifungal and insecticidal proteins, PR proteins in Rice.	3	C,D	1-4	1,2,5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Swapan K. Datta and Muthukrishnan, "*Pathogenesis –Related Proteins in plant*s", CRC Press, 1999.
2.	www.crcpress.com/Pathogenesis-Related-Proteins-in-Plants/Datta-Muthukrishnan/9780849306976+&cd=7&hl=en&ct=clnk&gl=in
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	*Physiological and Molecular Plant Pathology* (1999) ***55***, 85-97 Article No. pmpp.1999.0213, www.idealibrary.com

4.	http://www.ncbi.nlm.nih.gov/pubmed/8286442
5.	http://www.genome.jp/kegg-bin/show_pathway?map=ath04075&show_description=show

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT413E	**Environmental Microbiology and Metagenomics**			**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	E	PROFESSIONAL ELECTIVE	BIOTECHNOLOGY				
Course designed by	Department of Biotechnology						
Approval	32nd Academic Council Meeting - July 23, 2016						

PURPOSE	The purpose of this course is to provide an understanding of fundamental concepts in biofuel/bioenergy for sustainable developments.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To apply the concepts of extremophiles and its taxonomic make up.	a	b					
2.	To understanding of the extremophiles and its uses in Biotechnology.	a	b					
3.	To use metagenomics data to describe the taxonomic make-up and ecological processes of microbial communities from a range of environments	a	b					
4.	To assemble and annotate genomes by identifying genes	a	b					
5.	To apply next generation sequencing technology.	a	b					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**I- O**	**Reference**
	UNIT I - MICROBIAL DIVERSITY	**9**			
1.	A).Classification of Bacteria, Yeasts, Moulds, Viruses, Protozoans, Lichens and Mycorrhiza, Viroids, Prions and their role in the biosphere.	3	C	1,2	1,2,3,4
2.	B). Anoxygenic photosynthetic microbes-General characteristic of purple and green sulphur bacteria.	3		1,2	1,2,3,4
3.	C). Oxygenic photosynthetic microbes- General characteristics of Cyanobacteria and Prochlorales; D).Methanogenic-General characteristics.	2	C	1,2	1,2,3,4
4.	Magneto tactic bacteria.	1	C	1,2	1,2,3,4
	UNIT II-ARCHAEBACTERIA	**9**			
5.	A). Archaebacteria - distinguishing features, Phylogenetic groups of Archaebacteria, Ecology and habitats of Archaebacteria, Physiology of Archaebacteria	1	C	1,2	1,3
6.	B). Extremophiles- Acidophilic, alkalophilic, psychrophilic, thermophilic, barophilic, osmophilic and halophilic microorganisms	2	C	1,2	1,3
7.	C). Genes, Proteinsand Enzymes in extremophiles	2	C	1,2	1,3
8.	D). Applications of Extremophiles	4	C	1,2	1,3
	UNIT III- – EXOBIOLOGY	**9**			
9.	A).Search for Extra-terrestrial Intelligence (SETI): Cosmology, Evolution, and Life; Planetary Conditions for Life	2	C	1,2	8
10.	B).Basic Research on Radiation, Microgravity, Cellular & Plant Effects	2	C	1,2	8

Session	Description of Topic	Contact hours	C-D-I-O	I- O	Reference
11.	C).Antarctica as a model for Mars. Search for life on Mars, Viking mission, Viking landers, and Biology box experiment	2	C	1,2	8
12.	D).Gas exchange, Label release and pyrolytic release experiments	2	C	1,2	8
13.	E).Monitoring of astronaut's microbial flora	1	C	1,2	8
	UNIT IV - - ENVIRONMENTAL META GENOMICS	**9**			3.6
14.	A).Molecular Diversity and Metagenomics: Concept of e-DNA (environmental DNA), Diversity of Microbes in different environments; Conventional methods to study diversity, Cultured and Uncultured Methods	1	C	4,5	3,4
15.	B). Partial community analysis methods: Genetic fingerprinting techniques such as ARDRA, SSCP, T-RFLP, DGGE, RISA, LH-PCR, RAPD & DNA microarrays	2	C	4,5	3,4
16.	C). Whole community analysis methods: DNA-DNA reassociation, G+C fractionation, Whole genome sequencing,	2	C	4,5	3,4
17.	D). DNA Microarray Technology	2	C	4,5	3,4
18.	E). Next Generation Technology	2	C	4,5	3,4
	UNIT V- ENVIRONMENTAL META PROTEOMICS	**9**			
19.	A). Gel-based proteomics: (2-DE), (DIGE), (BN-PAGE); Merits and demerits of gel-based proteomic techniques	1	C	4,5	3,4
20.	B). Gel-free proteomics: Isotope-coded affinity tag (ICAT); isobaric tagging for relative and absolute quantitation (iTRAQ); multidimensional protein identification technology (MudPIT; Merits and demerits of gel-free proteomic techniques; Application of gel-free techniques in biological systems	3	C	4,5	3,4
21.	protein microarrays: Isotope-Coded Protein Label (ICPL); COmbinedFRActionalDIagonal Chromatography (COFRADIC); Application of gel-free techniques in biological systems	3	C	4,5	3,4
22.	Mass Spectrometry; Matrix Assisted Laser Desorption and Ionization (MALDI) and Electrospray Ionization (ESI); Mass spectrometry data analysis – computational tools.	2	C	4,5	3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Michael J. Pelczar, "Microbiology," Tata McGraw-Hill, 1993.
2.	Joanne M Willey, Joanne Willey, "Prescott's Microbiology," 8th edition, 2009,
3.	Stephen P. Hunt and Frederick J. Livesey, " Functional Genomics"
4.	R. M. Twyman, " Principles of Proteomics"
5.	**REFERENCE BOOKS/OTHER READING MATERIAL**
6.	Diana Marco Universidad Nacional de Cordoba, Argentina "Metagenomics: Current Innovations and Future Trends", Caister Academic Press, 2011.
7.	Maier, R.M. Pepper, I.L and Gerba, "Environmental Microbiology," C.P. Academic press, 2000.
8.	Hans G. Schlegel, "General Microbiology," Seventh Edition, Cambridge University Press Publisher, 1993.
9.	Evolutionary Biology: Exobiology and Evolutionary Mechanisms

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15BT414E	Bioenergy	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E PROFESSIONAL ELECTIVE	BIOTECHN OLOGY			
Course designed by	Department of Biotechnology				
Approval	32nd Academic Council Meeting - July 23, 2016				

PURPOSE	The purpose of this course is to provide an understanding of fundamental concepts in biofuel/bioenergy for sustainable developments.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	To provide a thorough understanding of various renewable feedstock's of importance their availability and attributes for biofuels production	a	b					
2.	To provide a thorough understanding of the broad concept of second and third generation biofuel production from biomass and other low-cost agro residues and bio wastes.	a	b					
3.	To provide students with tools and knowledge necessary for biofuel facility Operations.	a	b					
4.	To teach our students to analyze and design processes for biofuel Production.	a	b					
5.	To teach sustainable applications in bioenergy fields.	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	I-O	Reference
	UNIT I – BIO ENERGY	**9**			
1.	Introduction; Renewable and non-renewableResources	2	C	1,2	1
2.	Bioenergy and environment	2	C	1,2	1,3,4,5
3.	Bioenergy economics	2		1,2	1,3,4,5
4.	Feedstock's: Structure, Selection, conversion, Pre-treatment, Enzymatic Saccharification, fermentation and products purification.	3	C	1,2	1,3,4,5
	UNIT II- First Generation Bioenergy	**9**			
5.	Feed Stocks: Wood (Sugar and Starch) (Fuel from food crops): Corn, soybeans, canola oil, fryer grease, and coconut oil	2	C	2,3,4	1,3,4,5
6.	Conversions Process: Thermal Chemical Vs. Biochemical route and Enzymatic Conversion.	2	C	2,3,4	1,3
7.	Enzyme Discovery and degradation pathway studies	2	C	2,3,4	1,3,
8.	Bio refinery demonstration projects of ethanol and Biodiesel.	3	C	2,3,4	
	UNIT III- Second & Third Generation Bioenergy	**9**			
9.	Feed stocks: Lignocellulose, Agriculture, Forest, New Biomass and Genetically modified Biomass	2	C	2,3,4	2,5
10.	Conversions Process: Thermal Chemical Vs. Biochemical route and Enzymatic Conversion.	2	C	2,3,4	2,5
11.	Enzyme Discovery, Pathways, Rational Design and Direct Evolution	2	C	2,3,4	2,5
12.	bio refinery demonstration projects of Bioethanol	2	C	2,3,4	1,2
13.	Biomethanation, Biological Processes for Hydrogen Production;	3	C	2,3,4	1,2
	UNIT IV - NEXT GENERATION BIOENERGY	**9**			
14.	Synthetic Biofuels: Pyrolysis diesel, Pyrolysis bio oil, Hydrogenated biodiesels; Dimethyl ether (DME), Bio-synthetic natural gas	4	C	2,3,4	3,4
15.	Biobutanols and hydrocarbon like molecules	3	C	2,3,4	3,4
16.	New energy research Projects	2	C	2,3,4	4,5

Session	Description of Topic	Contact hours	C-D-I-O	I-O	Reference
	UNIT V- POLICIES AND FUTURE R&D OF BIOFUELS & BIOENERGY	**9**			
17.	Policies and Future R&D of Biofuels & Bioenergy: Evaluation of current and future R&D needs;	3	C	4,5	3,4
18.	legal framework to support sustainable development and increased use of biofuels;	3	C	4,5	4
19.	Government policies and programs with regard to biofuels and investment opportunities worldwide.	3	C	4,5	2,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Samir K. Khanal, "Anaerobic Biotechnology for Bioenergy Production:Principles and Applications", Wiley-Blackwell Publishing, 2008.
2	Mousdale D M., "Biofuels:Biotechnology, Chemistry, &Sustainable Development "CRC Press, 2008.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Robert C. Brown, "Biorenewable Resources: Engineering New Products from Agriculture", Wiley-Blackwell Publishing, 2003.
4.	Pogaku, Ravindra; Sarbatly, RosalamHj. (Eds.), "Advances in Biofuels",Springer, 2013.
5.	Ralph Sims, Michael Taylor, " From First to Second Generation Biofuel Technologies" IEA Bioenergy

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**