Rashtreeya Sikshana Samithi Trust

R.V.COLLEGE OF ENGINEERING

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Bachelor of Engineering (B.E)

Scheme and Syllabus

Department of Biotechnology

(2016 Scheme)

VISION

A Premier Department in Biotechnology Education, Research and Innovation with a Focus on Sustainable Technologies for the Benefit of Society and Environment.

MISSION

- Create state-of-the-art infrastructure for research and training in Biotechnology
- Develop graduates who are ethically and socially concerned
- Promoting collaboration with academia, industries and research organizations at national and international level
- Contribute to socioeconomic development through sustainable and inclusive technologies

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO	Description
PEO1	Have a strong foundation in scientific and engineering principles, develop oral and written communication skills and team work that prepare them for a successful career in Biotechnology and allied industries.
PEO2	Function at a technically competent level in formulating and solving problems in Biotechnology and to develop an outlook for higher education and lifelong learning.
PEO3	Organize and utilize the knowledge to develop biological processes and products, exhibit professionalism, ethical attitude to become an entrepreneur.

PROGRAM OUTCOMES (POs):

The Graduates of Biotechnology will

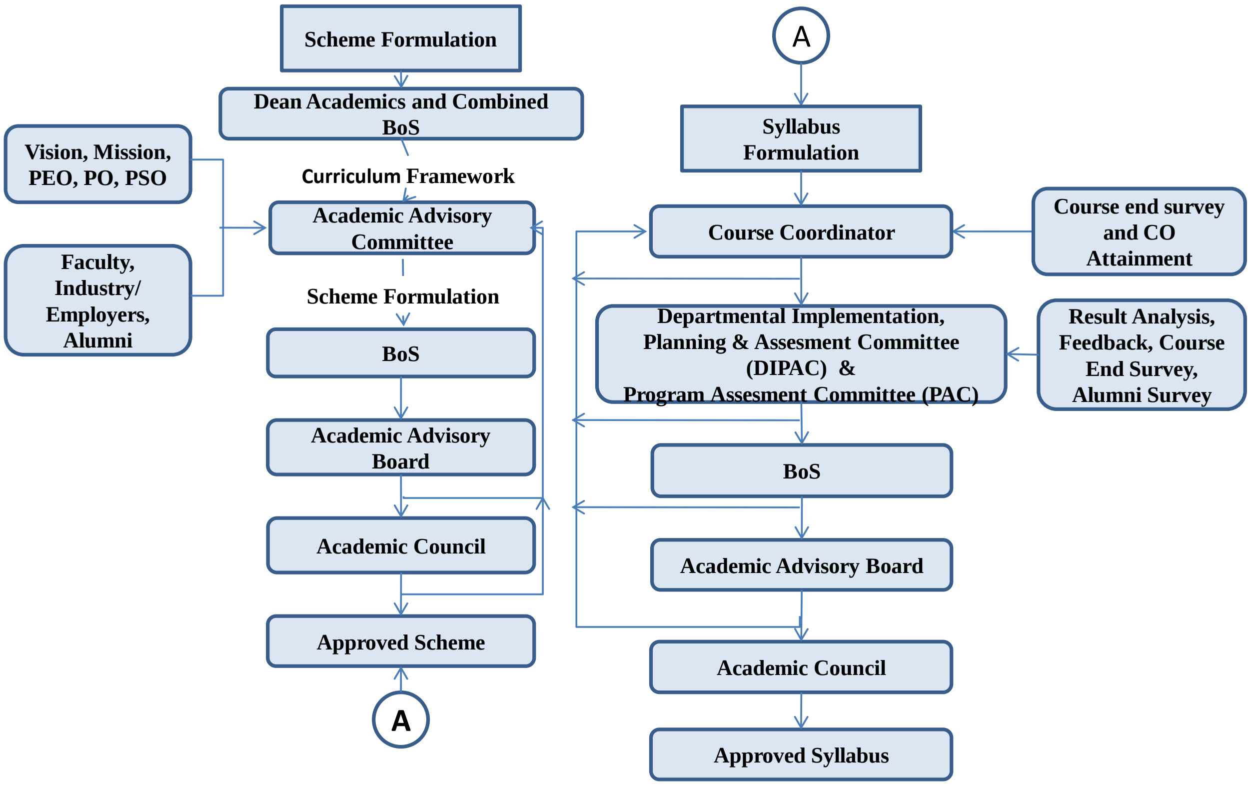
1. **Engineering Knowledge:** Gain knowledge of Biotechnology and apply Science & Engineering concepts to solve problems related to field of Biotechnology.
2. **Problem Analysis:** Identify, analyze and understand problems related to biotechnology and finding valid conclusions with basic knowledge in Engineering.
3. **Design / Development of solution:** Able to design and develop solution to Biotechnology Engineering problems by applying appropriate tools while keeping in mind safety factor for environment & society.
4. **Conduct investigations of complex problems:** Able to design, perform experiments, analyze and interpret data for investigating complex problems in biotechnology Engineering and related fields.
5. **Modern tool usage:** Able to decide and apply appropriate tools and techniques in biotechnological manipulations.
6. **The engineer and society:** Able to justify societal, health, safety and legal issues and understand his responsibilities in biotechnological engineering practices
7. **Environment and sustainability:** Able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.
8. **Ethics:** Have knowledge and understanding of related norms and ethics in Biotechnology Engineering product/technique development.
9. **Individual and team work:** Able to undertake any responsibility as an individual and as a team in a multidisciplinary environment.
10. **Communication:** Develop oral and written communication skills.
11. **Project management and finance:** Able to demonstrate knowledge of project and finance management, property rights (IPR) when dealing with Biotechnology Engineering problems.
12. **Lifelong learning:** Have thorough knowledge in Biotechnology Engineering and will also be ready to engage themselves in lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

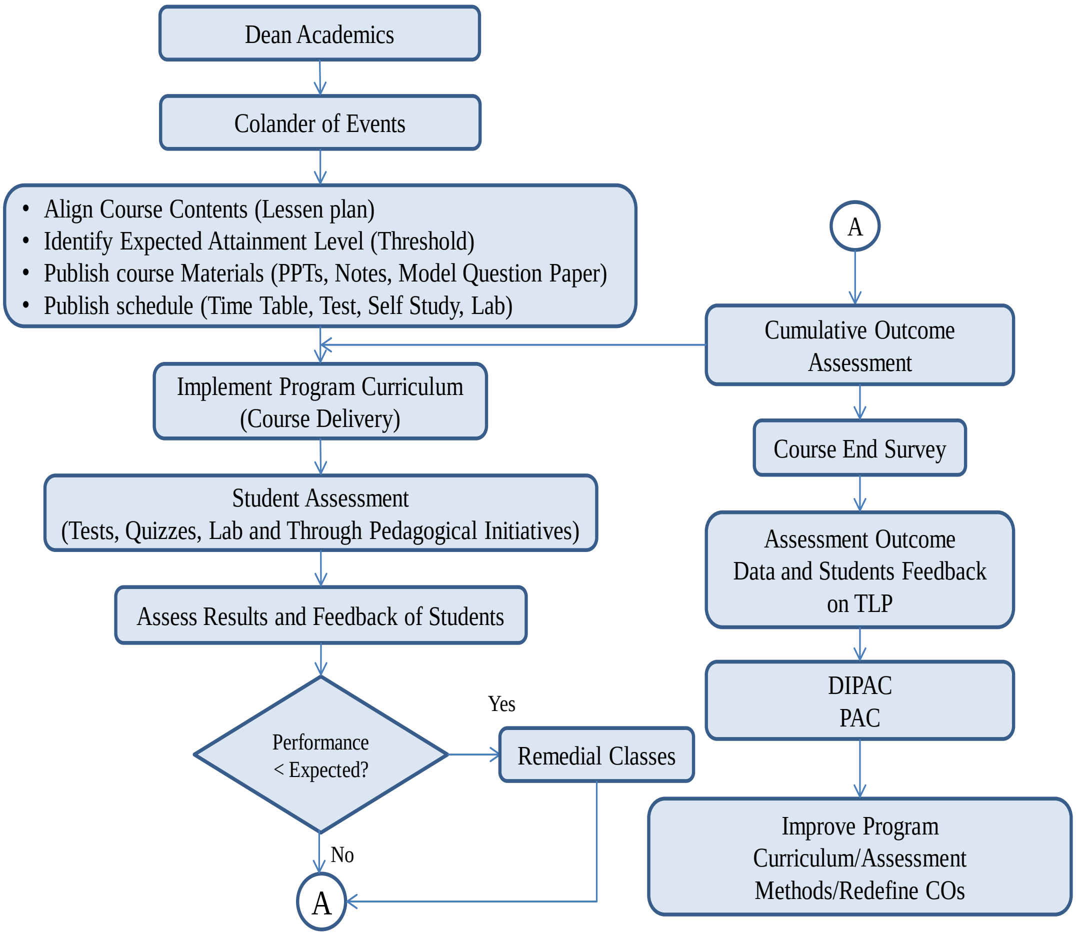
PSO	Description
PSO1	Acquire strong knowledge of mathematics and statistics to deal with engineering problems related to Biotechnology and Bioinformatics and will have enough basic knowledge of computer science and biology to deal with Bioinformatics problems related to Biotechnology.
PSO2	Acquire good knowledge to deal with Chemical Engineering and Biotechnology problems related to Upstream and Downstream process Technology through laboratory core and elective courses. Interdisciplinary knowledge is upgraded by attending global elective.
PSO3	Acquire technical knowledge and expertise by applying biotechnological tools to Agriculture Health sector and Fermentation Industry with emphasis on production, Management and Research.

Lead Society: American Society of Agricultural and Biological Engineers

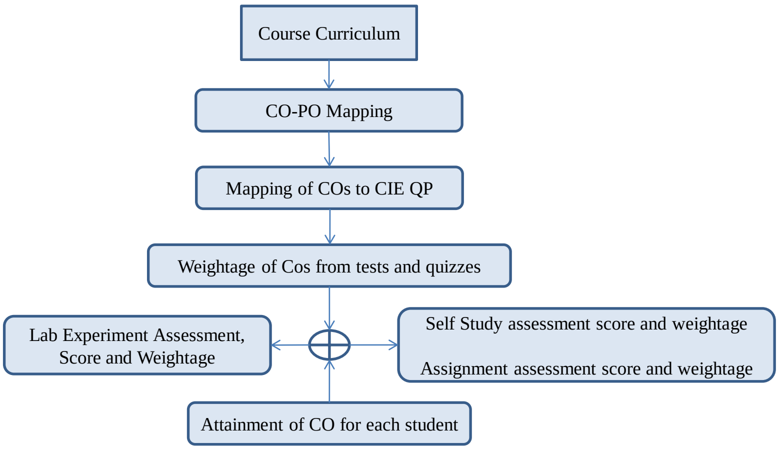
Curriculum Design Process



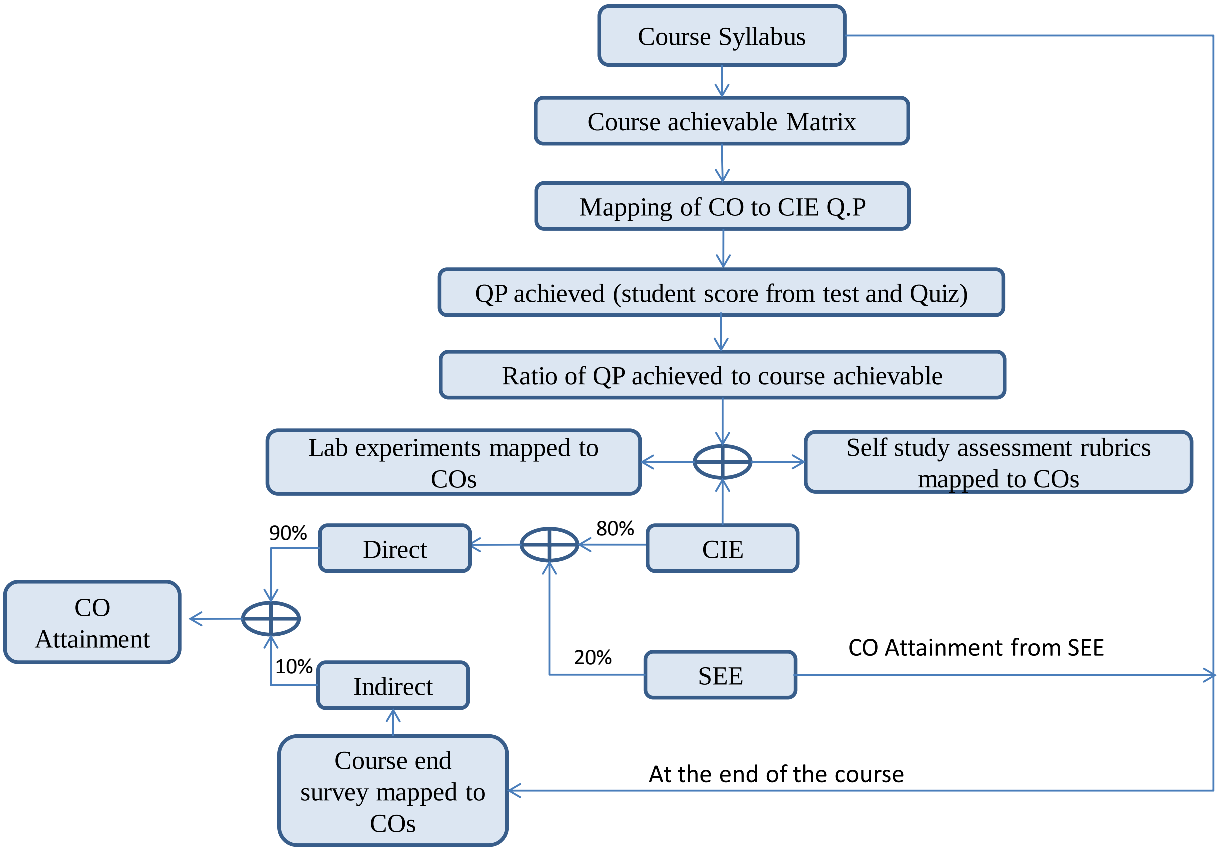
Academic Planning and Implementation

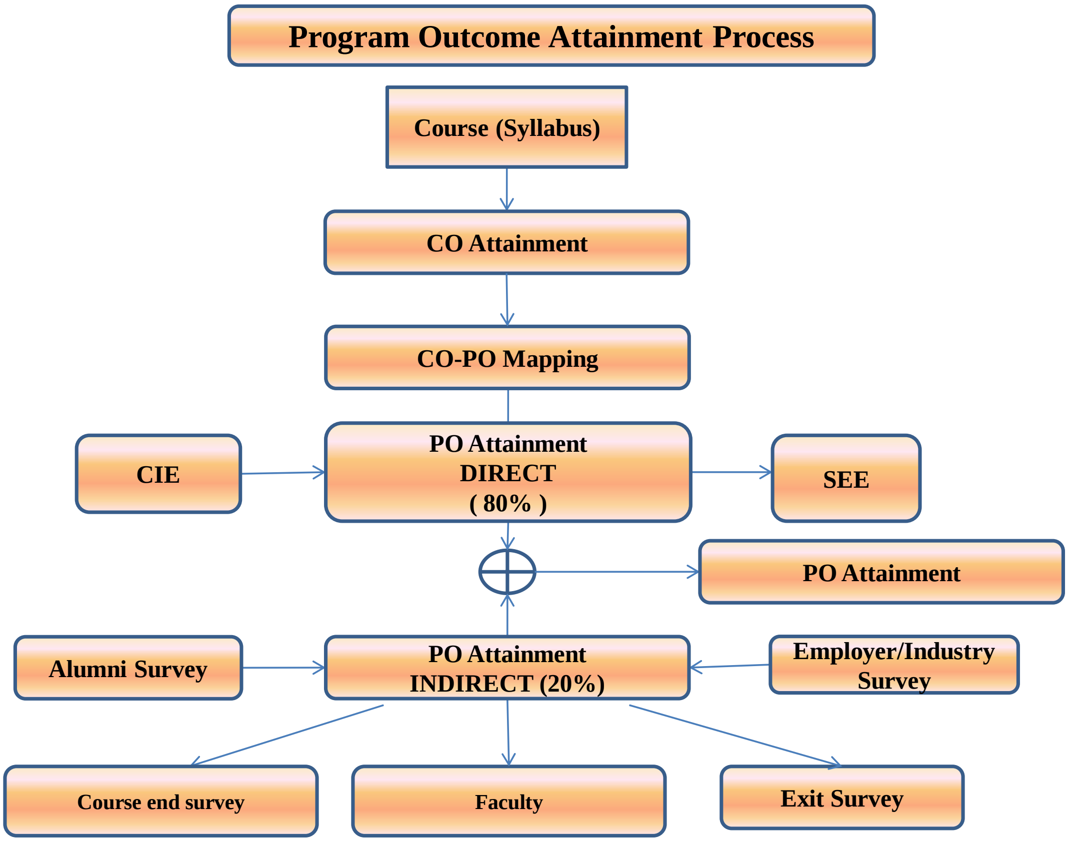


Process for Course Outcome Attainment



Final Course Outcome Attainment Process





Guidelines for Fixing Targets

- The target may be fixed based on last 3 years' average attainment

Credits Distribution as per UGC/VTU

Sl. No.	Category	Percentage (%)	Minimum No. of credits	2016 scheme	
				Without Mini Project	With Mini Project
1	Humanities	5-10	10	9+2	9+2
2	Basic Science	15-20	30	30	30
3	Engineering Science	15-20	30	30	30
4	Professional Core Courses (PC)	30-40	60	78+3=81 (3 credits core in place of Minor project in 7th semester)	81-3=78 (3 Credits for minor project in 7th semester)
5	Professional Elective Courses	10-15	20	20	20
6	Other Electives	5-10	10	10	10
7	Project Work	10-15	20	16+2 Major project +Tech. Seminar	16+2+3 Major project +Tech. Seminar +Mini Project
				200	200

R.V. College of Engineering, Bengaluru- 560059
(Autonomous Institution Affiliated to VTU, Belagavi)
THIRD SEMESTER CREDIT SCHEME

Sl. No	Course Code	Course Title	BoS	CREDIT ALLOCATION				Total Credits
				Lecture	Tutorial	Practical	SS (EL)	
1	16MA31C	Applied Mathematics - III	Maths	3	1	0	0	4
2	16EB32	Biology for Engineers	ME/ BT	2	0	0	0	2
3	16BT33	Biochemistry	BT	3	0	1	1*	5
4	16BT34	Cell and Microbiology	BT	3	0	1	1*	5
5	16BT35	Unit Operations	BT	3	0	1	1*	5
6	16BT36	Thermodynamics	BT	3	1	0	0	4
7	16DMA37 /16DCS 37	Bridge Course Mathematics /Bridge Course C Programming	Maths /CSE	2**	0	0	0	0
		Total No. of Credits		17	02	03	03	25
		No. Of Hrs.		17+2**	04	06	12***	30

***Self study attached to Lab ** Mandatory audit course for lateral entry diploma students. *** Non contact hours**

R.V. College of Engineering, Bengaluru- 560059
(Autonomous Institution Affiliated to VTU, Belagavi)
FOURTH SEMESTER CREDIT SCHEME

Sl.No	Course Code	Course Title	BoS	CREDIT ALLOCATION				Total Credits
				Lecture	Tutorial	Practical	SS (EL)	
1.	16BT41	Biostatistics	BT	3	1	0	0	4
2.	16ET42	Environmental Technology	BT	2	0	0	0	2
3.	16BT43	Biophysics. & Instrumentation techniques	BT	3	0	1	1*	5
4.	16BT44	Basics of Computer applications	BT	3	0	1	1*	5
5.	16BT45	Process Principles and Calculations	BT	3	0	0	1*	4
6.	16BT46	Molecular Biology	BT	3	1	0	0	4
7.	16HS47	Professional Practice – II (Teamwork & Professional ethics)$	HSS					1
8.	16DMA48 /16DCS48	Bridge Course Mathematics /Bridge Course C programming	Maths	2**	0	0	0	0
		Total No. of Credits		17	02	02	03	25
		No. Of Hrs.		17+2**	04	04	12***	27

***Self study attached to Lab ** Mandatory audit course for lateral entry diploma students. *** Non contact hours**

$ 3 days (18hrs) in 3rd semester and 3 days (18 Hrs) in 4th semester

R.V. College of Engineering, Bengaluru- 560059
(Autonomous Institution Affiliated to VTU, Belagavi)
FIFTH SEMESTER CREDIT SCHEME

Sl. No	Course Code	Course Title	BoS	CREDIT ALLOCATION				Total Credits
				Lecture	Tutorial	Practical	SS (EL)	
1	16HSI51	IPR & Entrepreneurship	HSS	3	0	0	0	3
2	16BT52	Bioinformatics	BT	3	0	1	1*	5
3	16BT53	Genetic Engineering	BT	3	0	1	1*	5
4	16BT54	Reaction Engineering	BT	3	1	0	0	4
5	16BT55	Immunotechnology	BT	3	0	0	0	3
6	16BT5AX	Elective A (PE)	BT	3	0	0	1*	4
7	16GE5BXX	Elective B (OE) Bioinformatics	BT	4	0	0	0	4
		Total No. of Credits		22	01	02	03	28
		No. Of Hrs.		22	02	04	12**	28

*** Self study attached to Lab   ** Non contact hours**

R.V. College of Engineering, Bengaluru- 560059
(Autonomous Institution Affiliated to VTU, Belagavi)
SIXTH SEMESTER CREDIT SCHEME

Sl.No	Course Code	Course Title	BoS	CREDIT ALLOCATION				Total Credits
				Lecture	Tutorial	Practical	SS (EL)	
1	16HEM61	Foundations of Management And Economics	HSS	2	0	0	0	2
2	16BT62	Microbial Biotechnology	BT	3	0	1	1*	5
3	16BT63	Process Dynamics & Control	BT/CH	3	0	1	1*	5
4	16BT64	Genomics & Proteomics	BT	3	1	0	0	4
5	16BT6CX	Elective C (PE)	BT	3	0	0	1*	4
6	16BT6DX	Elective D (PE)	BT	4	0	0	0	4
7	16GE6XX	Elective E (OE) Bioinspired Engineering	BT	3	0	0	0	3
8	16HS68	Professional Practice III (Employability skills & Professional Development of Engineers)	HSS	1	0	0	0	1
		Total No. of Credits		22	01	02	03	28
		No. Of Hrs.		22	02	04	12**	28

*** Self study attached to Lab   ** Non contact hours**

R.V. College of Engineering, Bengaluru- 560059 (Autonomous Institution Affiliated to VTU, Belagavi) SEVENTH SEMESTER CREDIT SCHEME								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**				**Total credits**
				Lecture	**Tutorial**	**Practical**	**SS**	
1	**16BT71**	**Plant Biotechnology**	**BT**	**4**	**0**	**1**	**0**	**5**
2	**16BT72**	**Downstream Processing**	**BT**	**4**	**0**	**1**	**0**	**5**
3	**16BT73**	**Animal Biotechnology**	**BT**	**3**	**0**	**0**	**0**	**3**
4	**16XX7FX**	**Elective F (PE)**	**BT**	**4**	**0**	**0**	**0**	**4**
5	**16XX7GX**	**Elective G (PE)**	**BT**	**4**	**0**	**0**	**0**	**4**
6	**16GH7XX**	**Elective H (OE)** **Nanotechnology**	**BT**	**3**	**0**	**0**	**0**	**3**
		Total Credits		**22**	**00**	**02**	**00**	**24**
		No. Of Hrs.		**22**	**00**	**04**	**00**	**26**

1Hr. Theory= 1 credit **2Hrs. Practical=1credit** **2Hrs. Tutorial=1 credit** **4Hrs. SS (EL) = 1 Credit**

R.V. College of Engineering, Bengaluru- 560059 (Autonomous Institution Affiliated to VTU, Belagavi) EIGHTH SEMESTER CREDIT SCHEME								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**				**Total Credits**
				Lecture	**Tutorial**	**Practical**	**SS**	
1	**16BTP81**	**Major Project**	**BT**	**0**	**0**	**16**	**0**	**16**
2	**16BTS82**	**Technical Seminar**	**BT**	**0**	**0**	**2**	**0**	**2**
3	**16HSS83**	**Innovation and Social Skills**	**HSS**	**0**	**0**	**2**	**0**	**2**
		Total Credit				**20**		**20**
		No. Of Hrs.		**0**	**0**	**40**	**0**	**40**

List of Professional Electives

	I	II	III	IV
	Health & Pharmaceuticals	**Food & Agricultural Biotechnology**	**Industrial Biotechnology**	**Informatics**
Professional elective A	**Pharmaceuticals**	**Agricultural Biotechnology**	**Process Engineering**	**Data Structure**
Professional elective C	**Clinical Technology**	**Food Engineering**	**Fermentation Technology**	**Java and J2EE**
Professional elective D	**Medical Instrumentation**	**Food & Diary Biotechnology**	**Plant Design & Economics**	**Systems Biology**
Professional elective F	**Nanobiotechnology**	**Plant - Based Vaccines**	**Equipment Design & Drawing**	**MAT LAB**
Professional elective G	**Vaccine Technology**	**Nutraceuticals**	**GMP, GLP, Biosafety and Biobusiness**	**HPC and Big data analysis**

APPLIED MATHEMATICS – III (ASE,BT,CH,CV,IEM,ME)		
Course Code: 16MA31C		**CIE Marks:** 100
Hrs/Week: L:T:P:S: 3:1:0:0		**SEE Marks:** 100
Credits: 04		**SEE Duration:** 3Hrs

Course Learning Objectives:

1. Identify and solve initial value problems, physically interpret the solution, using Laplace Transforms and Inverse Laplace transforms.
2. Evaluate extremal of integrals involving functional with applications to physical situations.
3. Understand the basics of Matrix theory, Eigenvalues and Eigenvectors, solution of system of linear equations.
4. Analyze the given set of experimental data and fit suitable approximating curves.

Unit-I	09 Hrs

LAPLACE TRANSFORM: Existence and uniqueness of Laplace Transform (LT), Transform of elementary functions, RoC. Properties of LT: Linearity, change of scale and first shifting. Transform of function multiplied by t^n, division by t, derivatives and integral. LT of periodic function, Heaviside unit step function, Unit impulse function. Heaviside shift (second shift) theorem.

Unit – II	09 Hrs

INVERSE LAPLACE TRANSFORM: Definition, properties of inverse Laplace transform, evaluation using different methods. Convolution theorem, problems. Application to solve ordinary linear differential equations and simultaneous differential equation

Unit -III	09 Hrs

CALCULUS OF VARIATION: Introduction of variation of functions, extremal of a functional, Euler's equation-special cases-problems. Geodesics-problems, Hanging cable problem, Brachistochrome problem.

Unit -IV	09 Hrs

LINEAR ALGEBRA: Rank of matrices-rank of matrix by Echelon form, consistency of system of linear equations- homogeneous and non-homogeneous equations, Gauss elimination, Gauss Jordan, Gauss Seidel methods, Eigen values and Eigen vectors-properties, largest Eigen value by Power method.

Unit -V	09 Hrs

STATISTICS: Curve fitting by method of least squares, fitting of curves-linear, parabolic, exponential, power functions. Correlation and Regression analysis – problems.

Course outcomes: On completion of the course, the student should have acquired the ability to

CO1	Understand the fundamental concepts of - Laplace and inverse Laplace transforms variation of functions, elementary transformation of matrices and method of least squares.
CO2	Demonstrate - the properties of Laplace and inverse Laplace transforms knowledge of extremal of functional, Eigen values, Eigen vectors and correlation.
CO3	Apply - Laplace and inverse Laplace transform technique to solve differential equations, Euler's equation to solve variational problems, matrix methods to solve system of linear

	equations, regression analysis for curve fitting.
CO4	Analyze and interpret- solution of IVP and BVP, solution of functional, solution of linear systems, statistical data occurring in Engineering problems.

Text Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 40^{th} Edition, 2007, ISBN: 81-7409-195-5.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2008, ISBN: 13-978-07-063419-0; ISBN: 10-0-07-063419-X.

Reference Books

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9^{th} Edition, 2007, ISBN: 978-81-265-3135-6.
2. Introduction to Probability and Statistics by Lipshutz and Schiller (Schaum's outline series), ISBN:0-07-038084-8

Continuous Internal Evaluation (CIE) (Theory – 100 Marks)	
Evaluation method	Course with Assignment/ Self-study
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Self-study (EL)	10
Total	100

Semester End Evaluation Theory (100)	
Part- –A Objective type questions	**20**
Part –B 1. There should be five questions from five units. Each question should be for maximum of 16 Marks. 2. The UNIT-1, UNIT-4 and UNIT-5 should not have any choice. 3. The UNIT-2 and UNIT-3 should have an internal choice. 4. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**80**
Total	**100**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**H**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**L**
CO2	**H**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**L**
CO3	**L**	**M**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**L**
CO4	**-**	**L**	**L**	**H**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**L**

High-3 : Medium-2 : Low-1

Note: The faculty teaching the course may adapt additional methods for evaluation within the total maximum marks.

BIOLOGY FOR ENGINEERS
(Theory)

Course Code:16EB32		**CIE Marks: 50**
Hrs/Week: L:T:P:S: 2:0:0:0		**SEE Marks: 50**
Credits: 02		**SEE Duration (Theory) : 90 minutes**

Course Learning Objectives:

1. To familiarize engineering students with basic biological concepts
2. To involve students in an interdisciplinary vision of biology and engineering
3. To gain an understanding that the design principles from nature can be translated into novel devices and structures
4. To gain an appreciation for how biological systems can be designed and engineered to substitute natural systems

UNIT-I	**06 Hrs**

Cells and Biomolecules: Structure and function of plant, animal and microbial cell. Stem cells: types and applications. Biomolecules: Carbohydrates, lipids, Proteins, Nucleic acids, Enzymes, Hormones, Vitamins.

UNIT II	**05 Hrs**

Human physiology: Digestive, Blood circulatory, Respiratory, Excretory and Nervous system. Structure and Function of sense organs- Skin, Ear, Eye, Tongue and Nose.

UNIT III	**04 Hrs**

Photosynthesis: Chloroplasts, Light reaction and Dark reaction. Plants as Bioinspirations: Bionic leaf and Photovoltaic cells.

UNIT IV	**05 Hrs**

Bioinspired Engineering: Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Echolocation of bats and whales (Ultrasonography), Human brain (Artificial neural networks), Natural recognition receptors (Biosensors), Silk from insects and spiders (High performance fibers and flexible medical tapes), Plant burrs (Velcro).

UNIT V	**03 Hrs**

Biomimetics: Medical implants: Orthopaedic, Dental, Cardiovascular, Optical and Auditory. Artificial senses: Electronic Nose and Electronic Tongue.

Course Outcomes: After completing the course, the students will be able to

CO1	Remember and explain the fundamentals of biology
CO2	Describe the basic principles of design in biological systems.
CO3	Comprehend how biological principles have served as a source of inspiring innovation
CO4	Address the problems associated with the interaction between living and non-living materials and systems

Text Books

1. Donald Voet,Charlotte W. Pratt, Judith G. Voet.," Principles of Biochemistry: International Student Version". Wiley John and Sons, 2012. ISBN:1118092449.
2. Yoseph Bar-Cohen, Biomimetics: Biologically Inspired technologies, 2005, CRC press, ISBN: 9780849331633
3. Yoseph Bar-Cohen, Biomimetics-Nature Based Innovation, 2011, CRC press, ISBN: 9781439834763

Reference Books

1. Jenkins, C.H. Bioinspired Engineering, NY: Momentum press, 2012 ISBN: 97816066502259

2. C.C.Chatterjee, Human Physiology Volume 1 (11th Edition), 2016, ISBN 10: 8123928726 / ISBN 13: 9788123928722.

Continuous Internal Evaluation (CIE)	
Evaluation method	Course with assignment
Quiz-1	05
Test-1	15
Quiz-2	05
Quiz-3	05
Test-2	15
Assignment	05
Total	50

Semester End Evaluation (SEE) **Theory (50 marks)**	
Part – A	10
Objective type questions	
Part – B	40
There should be five questions from five units. Each question should be for maximum of 8 marks. The UNIT-1, UNIT-4 and UNIT-5 should not have any choice. The UNIT-2 and UNIT-3 should have an internal choice. Both the questions should be of the same complexity in terms of Course outcomes and Bloom's taxonomy levels.	
Total	**50**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	-	-	L	-		L	M	-	L
CO2	L	L	M	L	-	L	-	-	L	M	-	L
CO3	L	M	M	L	-	L	-	-	L	M	-	L
CO4	M	H	H	L	M	M	L	-	L	M	-	M

High-3 : Medium-2 : Low-1

BIOCHEMISTRY (Theory and Practice)		
Course Code:16BT33		**CIE Marks:100+50=150**
Hrs/Week: L:T:P:S: 3:0:2:4		**SEE Marks:100+50=150**
Credits:05		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will

1. Get an overview of the main aspects of biochemistry by relating molecular interactions to their effects on the organism as a whole, especially as related to human biology.
2. Be able to understand the organization of macromolecules through a discussion of their hierarchical structure and study their assembly into complexes responsible for specific biological processes.
3. Explore the topics addressing protein function that includes enzyme kinetics, enzyme purification and characterization , and their industrial applications
4. Understand the different metabolic pathways and their interconnection into tightly regulated networks

UNIT-I	**06 Hrs**

Chemical foundations of Biology: Types of chemical bonds: covalent, coordinate, electrostatic, hydrogen and van der walls interactions. Types of chemical reactions. Water as solvent for biochemical reaction-physical and chemical properties of water. Concentration of solutions, pH, buffers. Buffering against pH changes in biological systems.

UNIT II	**07 Hrs**

Carbohydrates and Lipids: Carbohydrates: Structure and function of monosaccharide, disaccharide and polysaccharide. Carbohydrate metabolism: Aerobic and anaerobic glycolysis, tricarboxylic acid cycle, gluconeogenesis and pentose phosphate pathway. Lipids: Classification and function. Lipid metabolism: Biosynthesis and biodegradation of fatty acids. Biochemical functions of fatty acids, triacylglycerols, phospholipids, glycolipids, lipoproteins and steroids.

UNIT III	**07 Hrs**

Proteins and Nucleic acids: Amino Acids: Classification, structure and properties of amino acids. Proteins: primary, secondary, tertiary and quaternary structures of proteins. Nucleic acids: Structure, properties and functions of nucleotides. Types, structure and function of DNA and RNA. Amino acid metabolism: Biodegradation of amino acids- deamination, transamination and urea cycle.

UNIT IV	**06 Hrs**

Enzymes and Enzyme Kinetics: Enzyme classification. Enzyme catalyzed reactions, factors affecting enzyme activity, co-factors and co-enzymes. Extraction, purification and characterization of enzymes. Determination of molecular mass of enzymes. Enzyme assays. Enzyme kinetics and mechanism of enzyme action. Enzyme Inhibition: Competitive, uncompetitive and non-competitive.

UNIT V	**06 Hrs**

Vitamins and Hormones: Classification and biochemical functions of Vitamins. Fat soluble Vitamins: Vitamin A, D, E and K. Water Soluble Vitamins: Vitamin B and C. Classification and functions of hormones. Metabolic Disorders: Diabetes Mellitus, atherosclerosis, gout, phenyl ketoneuria.

LAB EXPERIMENTS

1. Qualitative tests for amino acids and proteins.
2. Qualitative tests for carbohydrates
3. Qualitative tests for lipids and steroids.
4. Estimation of reducing sugars by DNS method
5. Estimation of total sugars by anthrone method.
6. Estimation of total proteins by Lowry’s method.
7. Estimation of Protein by Bradford method.
8. Estimation of enzyme activity.
9. Calculation of Km & Vmax for an enzyme catalyzed reaction
10. Effect of Temperature on enzyme activity

Students should perform all the experiments in a semester

Self study: Students will perform experiments related to

1. Extraction and purification of proteins/enzymes.
2. Characterization of proteins/enzymes.

Course Outcomes: After completing the course, the students will be able to

CO1	Remember and explain the fundamentals of biochemistry such as structures, functions and interactions of biologically important molecules and theirfunctions.
CO2	Understand complex biochemical pathways within living cells and the associated metabolic disorders
CO3	Comprehend biochemical principles and apply them to biological systems/samples
CO4	Design basic biochemical experiments, analyze, interpret and present the data.

Text Books

1. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, W H Freeman & Co, 5th ed. 2008. ISBN: 139780716771081.
2. Donald Voet, Charlotte W. Pratt, Judith G. Voet., "Principles of Biochemistry: International Student Version". Wiley John and Sons, 2012. ISBN: 1118092449.

Reference Books

1. Satyanarayana U, "Biochemistry" , Books and Allied (P) Ltd, Kolkata, 2008, ISBN: 8187134801
2. Denise Ferrier, "Biochemistry", Lippincott Williams & Wilkins, 2017, ISBN: 149636354X, 9781496363541

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)		(Laboratory- 50 Marks)		Total (150)
Evaluation method	**Course with assignment**			
Quiz -1	10	Performance of the student inthe laboratory, every week	40	
Test -1	25			
Quiz -2	10	Test at the end of the semester	10	
Quiz -3	10			
Test -2	25			
Self study	20			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)

Theory (100 Marks)		Laboratory(50 Marks)		Total (150)
Part- –A **Objective type questions**	**20**	**Experiment Conduction with proper results**	40	
Part –B There should be five questions from	**80**	**Viva**	10	**150**

	five units.Each question should be for maximum of 16 marks The UNIT**-1, UNIT-4 and UNIT-5** should nothave any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.					
	Total	**100**	**Total**	**50**		

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**H**	**L**	**-**	**L**	**L**	**L**	**-**	**-**	**-**	**-**	**-**	**L**
CO2	**H**	**L**	**-**	**L**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**L**
CO3	**H**	**M**	**M**	**H**	**M**	**M**	**M**	**L**	**L**	**M**	**-**	**M**
CO4	**H**	**H**	**H**	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**-**	**M**

High-3 : Medium-2 : Low-1

CELL AND MICROBIOLOGY (Theory and practice)		
Course Code:16BT34		**CIE Marks:100+50=150**
Hrs/Week: L:T:P:S: 3:0:2:4		**SEE Marks:100+50=150**
Credits:05		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to

1. Acquire a basic knowledge of structure and functions of the cell, and also study genetics and gene interaction mechanism in plants and animals.
2. Understand the various physiological processes of human and plants.
3. Know various techniques for isolation, culture and control of microorganisms.
4. Study genetics of microorganisms and acquire basic knowledge of beneficial and pathogenic microorganisms.

UNIT-I	**9hrs**

Cell Structure and Cell signaling: Eukaryotic and prokaryotic cells, plant and animal cells, nucleus, mitochondria, ribosomes, golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, chloroplast, vacuoles. Specialized cell: Stem Cells and Neurons. Cell Membrane: Sanger and Nicholas model. Cell cycle and Cell division. Cell signaling: Mechanism of reception, transduction and response, and Programmed cell death.

UNIT II	**9hrs**

Genetics: Chromosomes, nucleosomes, euchromatin andheterochromatin. Giant chromosome: salivary gland chromosome of Drosophila. Mendelian laws of inheritance: Monohybrid and dihybrid inheritance (laws of segregation and independent assortment) Gene Interaction: Multiple alleles. Supplementary and complementary genes, epistasis. Linkage and crossing over, sex-linked inheritance.

UNIT III	**9hrs**

Human Physiology: The processes/ mechanism of Food ingestion, digestion, absorption, circulation, detoxification and excretion. Plant Physiology: Photosynthesis, Respiration and Photorespiration, Physiological function and molecular mechanism of action of Plant Growth Regulators: auxins, Gibberellins, Abscisic acid, Cytokinins and Ethylene.

UNIT IV	**9hrs**

Introduction to Microbiology: Morphology and fine structure of bacteria, fungi, protozoa, algae and viruses. Isolation of microbes from soil, water and air. Pure culture techniques: streak and spread plate. Classification, characterization and identification of Microorganism: Bacteria, Fungi, Protozoa, Algae and Viruses. Staining techniques: simple & differential, Growth and measurement of Bacteria, Preservation of Microbes. Control of Micro-organisms: Physical and chemical methods. Antibiotics: classification and mechanism of action.

UNIT V	**9hrs**

Microbial Genetics: DNA as the Genetic Material: Griffith/Hershey-Chase experiments, Horizontal genetic transfer in bacteria: conjugation, transformation and transduction. Mutation: types and mutagenic agents, Isolation of auxotrophic mutants using replica plating technique. Plasmids, episomes and transposons, Hfr strains. Pathogenic Microorganisms: Human diseases of bacterial, fungal, protozoan and viral origin with examples. Beneficial Microorganisms: Beneficial microflora for humans, general applications of microbes in agriculture, environment and industry.

LAB EXPERIMENTS	

1. Use of compound microscope and Micrometry.
2. Preparation of culture media (solid & broth). Aseptic techniques.
3. Isolation of microorganisms by serial dilution, pour plate, spread plate and streak plate methods. Colony characteristics.
4. Staining of microorganisms– simple (fungi) and differential (bacteria).

5. Study of bacterial growth curve.
6. Isolation of antibiotic producing organisms.
7. Identification of bacteria by biochemical tests (IMViC, Starch Hydrolysis, Oxidase, Catalase, Gelatin Hydrolysis tests).
8. Antibiotic sensitivity testing of bacteria.
9. Study of divisional stages of Mitosis in plants (preparation of slides from root tips of onion).
10. Study of divisional stages of Meiosis in plants (preparation of slides from flowers buds of onion).

Note: Each student has to perform all theexperiments in a semester.

Course Outcomes: After completing the course, the students will be able to

CO1	Define the structure and function of cell, and inheritance pattern in living system.
CO2	Explain the structure and functions of cell, inheritance pattern and physiological processes of living system.
CO3	Apply the techniques for isolation and culture of microbes, control of microbes, illustrate various processes, and discuss the role of stem cells and plant growth regulators in modern biology.
CO4	Compare and contrast between various cells, physiological processes, inheritance pattern, techniques and interpret the results.

Text Books

1. Enger E, Concepts in Biology. McGraw Hill Education, 14 edition, 2014, ISBN-10: 9339204352
2. Elrod SL, Stansfield WD, Bhowmik G, Genetics. Tata McGraw-Hill, 4th edition, 2009, ISBN-13: 9780070139190

Reference Books:

1. Pollard TD, Earnshaw WC, Lippincott-Schwartz J, Johnson GT, Cell Biology, Elsevier, 3rd edition, 2016, ISBN-9780323341264
2. Taiz L and Zeiger E, Plant physiology. Sinauer Associates, 5th edition, 2010, ISBN-10: 0878935118.
3. E.C.S. Chan, Michael J. Pelczar, Noel R. Krieg. Microbiology – an Application Based Approach, Tata McGraw Hill publications, 2010, ISBN 0070151474.
4. Karp G, Cell Biology, Wiley, 7th edition, 2013, ISBN-9781118318744
5. Willey J, Sherwood L and Woolverton CJ, Prescott's Microbiology, McGraw Hill Education, 10th edition, 2017, ISBN-9781259657573.

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)		**(Laboratory- 50 Marks)**		**Total**
Evaluation method	**Course with assignment**			
Quiz -1	10	Performance of the student in the laboratory, every week	40	
Test -1	25			
Quiz -2	10	Test at the end of the semester	10	
Quiz -3	10			
Test -2	25			
Self study	20			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)

Theory (100 Marks)		**Laboratory(50 Marks)**		**Total**
				(150)

Part- –A		**Experiment Conduction with proper results**	40	
Objective type questions	**20**			
Part –B				
• There should be five questions from five units. Each question should be for maximum of 16Marks. • The **UNIT-1, UNIT-4 and UNIT-5** should nothave any choice. • The **UNIT-2 and UNIT-3** should have an internalchoice. • Both the questions should be of the samecomplexity in terms of COs and Bloom'staxonomy level.	**80**	**Viva**	10	
Total	**100**	**Total**	**50**	**150**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	-	-	-	-	-	-	L	M	-
CO2	H	M	-	-	-	-	-	-	-	M	M	-
CO3	M	M	L	M	-	-	-	M	M	M	M	-
CO4	M	M	L	-	-	-	-	-	-	M	M	-

High-3 : Medium-2 : Low-1

UNIT OPERATIONS (Theory and Practice)		
Course Code:16BT35		**CIE Marks:100+50=150**
Hrs/Week: L:T:P:S: 3:0:2:4		**SEE Marks:100+50=150**
Credits:05		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to

1. Understand the importance of fluid flow in biological systems and interpret the behaviour of fluids.
2. Learn the various separation techniques useful to separate the biological compounds.
3. Interpret the behaviour of heat transfer in biological systems.
4. Apply principles of Unit operations in biological systems

UNIT-I	07 Hrs

Dimensional Analysis: Units, Dimensions, Basic and Derived Units, Dimensional homogeneity, Dimensionless numbers, Rayleigh's method, Buckingham's pi theorem.

Introduction to Fluid Mechanics:

Fluid: Definition. Fluid Statics- Hydrostatic equilibrium, Barometric equation, Pressure measurements-Manometers-U tube, Inclined tube and inverted U tube.. Fluid dynamics - Shear stress, Shear strain, Newton's law of viscosity, Newtonian and Non Newtonian fluids. Fluid flow**:** Continuity equation, Bernoulli's equation, Hagen-Poiseulle's equation, simple numerical.

UNIT II	07 Hrs

Flow metering and measurement: Construction and working of Centrifugal pump, reciprocating pump, characteristics of centrifugal pumps, cavitation, NPSH. Applications of Bernoullis equation-Venturimeter, Orifice meter, Pitot tube, Rotameter.

Introduction to Heat transfer: Modes of heat transfer. Steady state conductions through single-layer, composite-layer, slabs, cylinders, spheres with constant thermal conductivity. simple problems. Natural and forced convection. Correlation equations for natural and forced convection. Film co- efficient, overall Heat transfer co-efficient. Log mean temperature difference (LMTD), simple problems

UNIT III	07 Hrs

Heat Exchange Equipment: Construction and elementary design of double pipe pipe heat exchanger, shell and tube heat exchanger. Simple numerical to calculate heat transfer area in heat exchangers.

Evaporation: Introduction, Single effect and multiple effect evaporators, vapour recompression. Capacity and economy, types of feeding arrangements in multiple effect evaporators.

UNIT IV	09 Hrs

Particle Size Analysis: Sieves, differential and cumulative screen analysis. Screens- Ideal and actual screens. Size reduction- Laws of Size reduction, Work Index, Equipment for size reduction- Ballmill.

Settling: Drag, drag coefficient. Types of settling: Free and hindered settling. Terminal velocity, equation for one dimensional motion of particle through a fluid in gravitational field. Motion of particles in Stoke's, Newton's and intermediate, centrifugal settling process.

UNIT V	07 Hrs

Filtration: Introduction, Classification of filtration, types, Kozeny-Carman equation. Characteristics of filter media and filter aids, Industrial filters- rotary drum filter, leaf filter and plate and frame filter press.

Distillation: Types of distillation: simple, flash, steam distillation Azeotropic and extractive distillation. Distillation with and without reflux, types of feed line, reflux ratio, minimum reflux ratio, optimum reflux ratio, total reflux ratio. McCabe Thiele Method to find number of plates.

Self Study: 1. Chemicals and liquid fuels from biomass 2. Biosynthesis of nanomaterials and its application in biotechnology	**1 Credit** **4 Hrs/Week**

LAB EXPERIMENTS

1. Determine the discharge co-efficient (Cd) of Orificemeter.
2. Determine the discharge co-efficient (Cd) of Venturimeter.
3. Determination of the friction factor for the flow of water through a packed bed using Ergun's equation.
4. Determination of specific cake resistance 'α 'and filter medium resistance 'Rm' using a leaf filter.
5. Verification of Rayleigh's equation for simple distillation.
6. Determination of the effectiveness factor of screens
7. Determine the isotherms of Freundlich equation for adsorption of adsorbate on adsorbent
8. Determine the friction factor for the flow of water in the pipes
9. Determine the heat transfer coefficient in shell and tube heat exchanger
10. Determine the heat transfer coefficient in double pipe heat exchanger
11. Determine the emmisivity of a cylinder and sphere

Note: Each student has to perform 12 experiments in semester.10 Experiments are guided experiments, 02 experiments are involving experiential learning.

Course Outcomes: After completing the course, the students will be able to

CO1	Understand the basic fluid flow principles and its applications to biochemical process industries including pipe flow, fluid machinery and azitation and mixing.
CO2	Knowledge of fluid particle systems and equipments
CO3	Apply the principles of conservation of mass and energy to calculate flow rates, head loss, pumping and power requirements in closed conduits.
CO4	Develop the momentum and energy equations to calculate pressure variations in accelerating fluids and evaluate head loss in pipes and conduits.

Text Books

1. W. L. McCabe, J. C. Smith and P. Harriott, Unit Operations in Chemical Engineering, McGraw- Hill, New York, 7thEdition, 2005, ISBN2005978-0071247108.
2. R. K. Bansal, Fluid Mechanics and Hydraulics of Machines, Laxmi Publications, New Delhi, 9thEdition. 2010. ISBN:978-81-318-0815-3.

Reference Books

1. J.M.Coulson and J.F.Richardson: Chemical Engineering VoI 1. Fluid flow, Heat Transfer an Mass Transfer. Butterworth-Heinemann, an imprint of Elservier, 6 th Edition, Indian Reprint,2006. ISBN: 13:978-0387-25116-5.
2. C. J. Geankoplis, Transport processes and Unit Operations, Prentice Hall India, 3rdEdition, 2007, ISBN-0205059392,9780205059393.

Continuous Internal Evaluation (CIE)				
(Theory – 100 Marks)		**(Laboratory- 50 Marks)**		**Total**
Evaluation method	**Course with self study**			
Quiz -1	**10**	**Performance of the student in the laboratory, every week**	**40**	
Test -1	**25**			
Quiz -2	**10**			
Quiz -3	**10**			
Test -2	**25**	**Test at the end of the semester**	**10**	
Self study	**20**			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory (50 Marks)**		**Total (150)**
Part- –A	**20**	Experiment Conduction with proper results	40	
Objective type questions				
Part –B	**80**			
There should be five questions from five units.		Viva	10	
Each question should be for maximum of 16 Marks.				
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.				
The **UNIT-2 and UNIT-3** should have an internal choice.				
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.				
Total	**100**	**Total**	**50**	**150**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**M**	**L**				**M**	**M**	**L**	**L**			**M**
CO2	**M**	**M**				**L**			**L**			**L**
CO3	**M**	**M**	**L**			**M**	**M**		**L**			**M**
CO4	**M**		**L**			**M**			**-**			**L**

High-3 : Medium-2 : Low-1

THERMODYNAMICS (Theory)		
Course Code:16BT36		**CIE Marks:100**
Hrs/Week: L:T:P:S: 3:2:0:0		**SEE Marks:100**
Credits:04		**SEE Duration (Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. Acquire a basic knowledge the thermodynamics properties of fluids, Chemical potential, fugacity, Phase Equilibrium etc.,
2. Analyze typical devices and Units (engines, pumps, nozzles etc.,) using thermodynamics principles
3. Apply fundamentals of thermodynamics in Unit operations
4. Perform feasibility studies on chemical engineering processes

UNIT-I	07 Hrs

Introduction: The Scope of Thermodynamics, Dimensions and Units, Measures of amount size, force, temperature, pressure, work, energy and heat.
The First Law and other Basic Concepts: Joules experiments, Internal energy, The first law of thermodynamics, energy balance for closed systems, Thermodynamic state and state functions, Equilibrium, the phase rule, the reversible process, constant –V and constant-P Processes, Enthalpy, Heat capacity, mass and energy balance for open systems.

UNIT II	07 Hrs

The Second Law of Thermodynamics: Statement, heat engines, heat pumps, Thermodynamic temperature scales, Entropy, entropy changes for ideal gas, mathematical statement for second law: Clausius and Kelvins inequality, Entropy balances for open systems, Calculation of ideal work, lost work, The third law of thermodynamics.
Thermodynamic Properties of Fluids: Property relations, residual properties, residual properties by equations of state, two phase systems, thermodynamic diagrams.

UNIT III	08 Hrs

Vapor/Liquid Equilibrium: Introduction, The nature of equilibrium, The phase rule, Duhem's theorem, Simple models for vapor liquid equilibrium, VLE by modified Raoult's Law.
Solution Thermodynamics: Fundamental property relation, The chemical potential and phase equilibria, partial properties, fugacity and fugacity coefficient: Pure species, species in solution, generalized correlation for the fugacity coefficient, Ideal solution model, excess properties.

UNIT IV	07 Hrs

Heat Effects: Sensible heat effects, latent heat of pure substances, standard heat of reaction, standard heat of formation, standard heat of combustion, temperature dependence of ΔH.
Solution Thermodynamics:
Applications, Liquid phase properties from VLE data, Models for excess Gibbs energy, consistency test for VLE data, Property changes of mixing, Heat effects of mixing.

UNIT V	07 Hrs

Chemical Reaction Equilibria: The reaction coordinate, application of equilibrium criteria to chemical reactions, The standard Gibbs-Energy Change and the Equilibrium constant, Effect of temperature on the equilibrium constant, evaluation of equilibrium constants, Relation of equilibrium constants to composition, equilibrium conversions for single reactions.
Biochemical Thermodynamics: Acidity of solutions, solubility's of weak acids and weak bases. Protein concentration in an ultracentrifuge, Gibbs Donnan equilibrium and membrane potentials, Thermodynamic analysis of fermenters.

Course Outcomes: After completing the course, the students will be able to	
CO1	Recall the Laws of thermodynamics and explain heat, work, entropy, internal energy and determine changes of all these in cyclic and non-cyclic processes
CO2	Calculate the thermodynamic properties of pure substances, solutions (two phase) and mixtures involving reactions
CO3	Evaluate heat, work involved in processes and estimate heat –work inter-Conversions
CO4	Formulate thermodynamic properties for equipment design.

Text Books

1. M. Smith, H. C. Van Ness, M. M. Abbott. Introduction to Chemical Engineering, Thermodynamics, McGraw Hill Publication, 7th, Edition. 2009, ISBN- 97-800-7310-445.
2. K.V. Narayanan, Chemical Engineering Thermodynamics, Prentice Hall of India, New Delhi, 1st Edition, 2004, ISBN-81-203-1732-7.

Reference Books

1. Y.V.C. Rao, Chemical Engineering Thermodynamics, New Age International Publication, Nagpur, 1st Edition, 2000, ISBN-81-737-1087.
2. Stanly I. Sandler, Chemical Biochemical and Engineering Thermodynamics, John Wiley,Publication, 4th Edition, 2006, ISBN-04-716-6174-0.

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)

Evaluation method	Course with assignment
Quiz -1	**10**
Test -1	**30**
Quiz -2	**10**
Quiz -3	**10**
Test -2	**30**
Assignments	**10**
Total	**100**

Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	**80**
There should be five questions from five units.	
Each question should be for maximum of 16 Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	
The **UNIT-2 and UNIT-3** should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**H**	**H**	**H**	**M**	**-**	**M**	**M**	**L**	**L**	**-**	**M**	**M**
CO2	**H**	**H**	**M**	**M**	**-**	**L**	**-**	**-**	**L**	**-**	**M**	**M**
CO3	**H**	**H**	**H**	**M**	**-**	**M**	**M**	**-**	**L**	**-**	**M**	**M**
CO4	**H**	**H**	**M**	**M**	**L**	**M**	**-**	**-**	**-**	**-**	**M**	**M**

High-3: Medium-2 : Low-1

Bridge Course mathematics I / II		
Course Code:16DMA37		**CIE Marks: 100**
Hrs/Week: L:T:P: S 2:0:0:0		**SEE Marks: 100**
Audit Course		**SEE : 3 Hrs**

Course Learning Objectives:	
1	Understand the existence of polar coordinates as possible 2-D geometry, approximate a function of single variable in terms of infinite series.
2	Gain knowledge of multivariate functions, types of derivatives involved with these functions and their applications.
3	Recognize linear differential equations; apply analytical techniques to compute solutions.
4	Acquire concepts of vector functions, vector fields and differential calculus of vector functions in Cartesian coordinates.
5	Explore the possibility of finding approximate solutions using numerical methods in the absence of analytical solutions of various systems of equations.

Prerequisites: Hyperbolic functions, Trigonometric identities, methods of differentiation and basic techniques of integration, reduction formulae, vector algebra.

Unit – I	**06 Hrs**
DIFFERENTIAL CALCULUS: Taylor and Maclaurin's series for function of single variable.Partial derivatives – Introduction, simple problems. Total derivative, Composite functions, Jacobians- simple problems.	
Unit – II	**06 Hrs**
MULTIPLE INTEGRALS: Evaluation of double and triple integrals – direct problems, change of order in double integral, change of variables to polar, cylindrical and spherical coordinate systems.	
Unit – III	**06 Hrs**
DIFFERENTIAL EQUATIONS: Higher order linear differential equations with constant coefficients, Complementary function and Particular integral, problems. Equations with variable coefficients – Cauchy and Legendre differential equations, problems.	
Unit – IV	**06 Hrs**
VECTOR DIFFERENTIATION: Introduction, simple problems in terms of velocity and acceleration. Concepts of Gradient, Divergence- solenoidal vector function, Curl-irrotational vector function and Laplacian, simple problems.	
Unit – V	**06 Hrs**
NUMERICAL METHODS: Algebraic and transcendental equations – Regula-Falsi method, Newton-Raphson method. Ordinary Differential Equations – Taylor's, modified Euler's and 4th order Runge-Kutta methods. Numerical Integration – Simpson's 1/3rd, 3/8th and Weddle's rules.	

Course outcomes: On completion of the course, the student should have acquired the ability to	
1	Demonstrate the understanding of the basics of polar coordinates, partial differentiation, multiple integrals, vector differentiation, classification and types of solutions of higher order linear differential equations, requirement of numerical methods and few basic definitions.
2	Solve problems on total derivatives of implicit functions, double integrals by changing order of integration, homogeneous linear differential equations, velocity and acceleration vectors.
3	Apply acquired knowledge to find infinite series form of functions, multiple integrals by changing order, solution of non-homogeneous linear differential equations, and numerical solution of equations.
4	Evaluate multiple integrals by changing variables, different operations using del operator and numerical solutions of differential equations and numerical integration.

Text Book

1. B.S. Grewal; Higher Engineering Mathematics; Khanna Publishers; 40th Edition; 2007; ISBN: 81-7409-195-5.
2. R. K. Jain & S.R.K. Iyengar; Advanced Engineering Mathematics; Narosa Publishing House; 2002; 817319-420-3; Chapters: 1, 2, 8, 15;

Reference Books

1. N.P Bali & Manish Goyal; A Text Book of Engineering Mathematics; Lakshmi Publications; 7th Edition; 2010; ISBN: 978-81-7008-992-6; Chapters: 6, 18, 16, 8, 26;
2. Erwin Kreyszig; Advanced Engineering Mathematics; John Wiley & Sons; 9th Edition; 2007; ISBN: 978-81-265-3135-6; Chapters: 6, 10, 12.

Scheme of Continuous Internal Evaluation: CIE consists of Two Tests each for 50 marks (20 marks for Quiz + 30 marks for descriptive questions)

Scheme of Semester End Examination: The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions (descriptive, analytical, problems or/and design) carrying 16 marks each. All five questions from Part B will have internal choice and one of the two have to be answered compulsorily.

Course Title: BRIDGE COURSE C PROGRAMMING		
Course Code: 16DCS37		**CIE Marks: 100**
Hrs/Week: L:T:P:S : 2:0:0:0		**SEE Marks: 100**
Credits: 00		**SEE : 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Develop arithmetic reasoning and analytical skills to apply knowledge of basic concepts of programming in C.
2	Learn basic principles of problem solving through programming.
3	Write C programs using appropriate programming constructs adopted in programming.
4	Solve complex problems using C programming.

UNIT-I	
Introduction to Reasoning, Algorithms and Flowcharts Skill development – Examples related to Arithmetical Reasoning and Analytical Reasoning. Fundamentals of algorithms and flowcharts.	**02 Hrs**
Introduction to C programming Basic structure of C program, Features of C language, Character set, C tokens, Keywords and Identifiers, Constants, Variables, Data types.	**01 Hrs**
Handling Input and Output operations Reading a character, Writing a character, Formatted input/output functions, Unformatted input/output functions.	**02 Hrs**
UNIT-II	
Operators and Expressions Arithmetic operators, Relational operators, Logical Operators, Assignment operators, Increment and decrement operators, Conditional operators, Bit-wise operators, Arithmetic expressions, evaluation of expressions, Precedence of arithmetic operators, Type conversion in expressions, Operator precedence and associativity.	**02 Hrs**
Programming Constructs **Decision Making and Branching** Decision making with 'if' statement, Simple 'if' statement, the 'if…else' statement, nesting of 'if…else' statements, The 'else if' ladder, The 'switch' statement, The '*?:*' operator, The '*goto*' statement. **Decision making and looping** The while statement, the do statement, The 'for' statement, Jumps in loops.	**03 Hrs**
UNIT-III	
Arrays One dimensional arrays, Declaration of one dimensional arrays. Initialization of one dimensional arrays, Two dimensional arrays, Initializing two dimensional arrays.	**02 Hrs**
Character Arrays and Strings Declaring and Initializing String Variables, Reading Strings from Terminal, Writing strings to screen, Arithmetic Operations on characters, String operations using with and without String handling functions.	**02 Hrs**
UNIT-IV	
User-defined functions Need for User Defined Functions, Definition of functions, Return values and their types, Function calls, Function declaration, Category of functions, Nesting of	**03 Hrs**

functions, Functions with arrays, Storage classes.	
Structures and Unions Introduction, Structure definition, Declaring structure variables, Accessing structure members, Structure initialization, Copying and comparing structure variables, Arrays of structure, Arrays within structures, Structures and functions, Unions.	**03 Hrs**
UNIT – V	
Pointers Introduction , Accessing the address of a variable, Declaring and initializing of pointer variables, Accessing a variable using pointers, Chain of pointers, Pointer expressions, Pointer increments and scale factor, Pointers and arrays, Pointers and character strings.	**03 Hrs**
File Managements in C Basic concepts of files, Defining and opening a file, closing of a file, Input/Output operations on files.	**01 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand and explore the fundamental computer concepts and basic programming principles like data types, input/output functions, operators, programming constructs and user defined functions.
2	Analyze and Develop algorithmic solutions to problems.
3	Implement and Demonstrate capabilities of writing 'C' programs in optimized, robust and reusable code.
4	Apply appropriate concepts of data structures like arrays, structures, and files to implement programs for various applications.

Reference Books:	
1.	P. Dey, M. Ghosh, "Programming in C", Oxford University press, 1st Edition, 2007, ISBN -13: 9780195687910.
2.	Kernighan B.W and Dennis M. Ritchie, "The C Programming Language", 2nd Edition, Prentice Hall, 2005, ISBN -13: 9780131101630.
3.	H. Schildt, Turbo C: The Complete Reference, Mcgraw Hill Education, 4th Edition, 2000, ISBN-13: 9780070411838.
4.	Yashavant P. Kanetkar, "Understanding Pointers in C", BPB publications, 4th Edition, 2003,ISBN-13: 978-8176563581.

Continuous Internal Evaluation (CIE) (Theory – 100 Marks)	
Evaluation method	**Course with Assignment**
Quiz – 1	10
Test – 1	30
Quiz – 2	10
Quiz – 3	10
Test – 2	30
Assignments	10

Total	100

Semester End Evaluation Theory (100)	
Part- –A **Objective type questions**	**20**
Part –B There should be five questions from five units. Each question should be for maximum of 16 Marks. The **UNIT-1**, **UNIT-4** and **UNIT-5** should not have any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**80**
Total	**100**

Note: The faculty teaching the course may adapt additional methods for evaluation within the total maximum marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	M	M	M	L	-	-	-	-	M	-	L
CO2	H	M	M	M	M	-	-	-	M	L	-	L
CO3	H	M	M	M	M	L	L	-	M	M	L	M
CO4	H	H	H	M	M	L	L	-	M	M	L	M

Low-1 Medium-2 High-3

BIOSTATISTICS
(Theory)

Course Code:16BT41		**CIE Marks:100**
Hrs/Week: L:T:P:S: 3:2:0:0		**SEE Marks:100**
Credits:04		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. To make every engineering student understand the importance of applied mathematics, so that they can use their domain knowledge and apply to Biotechnology.
2. To understand and explain the importance of applied mathematics in Biotech industries
3. To be aware of understand and use the probability and statistics theory in applied mathematics.
4. To use these methods in the design and analysis of mathematical modeling in the field of Biotechnology

UNIT-I	**7hrs**

Introduction and Data presentation: Basic concepts, definitions, formulae, common terms in statistics. Types of numerical data - Nominal data, Ordinal data, Ranked data, Discrete data and Continuous data. Tables - Frequency distribution and Relative frequency, Graphs - Bar charts, Histograms and Polygons. Sampling Theory – Simple Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling.

UNIT II	**7hrs**

Measures of central tendency: Mean, Median and Mode. Measures of dispersion, grouped data. Measures of variation- Dispersion, Range, Mean deviation and Standard deviation. Analysis of variance (ANOVA): Basic concepts and principles. Mathematical modeling in Biotechnology – Lotka-Volterra Model of Predation, Mutation, Selection, Matrix Model of Base Substitution, mathematical model for Inheritance such as Genetic Inbreeding Model and Mendalian Model of Genetics. Growth equations of microbial populations.

UNIT III	**7hrs**

Probability and distributions: Theorems of probability, conditional probability, Bayes' theorem. Probability distributions- Discrete distribution (Binomial distribution, Poisson distribution) and Continuous distribution (Normal distribution).

UNIT IV	**7hrs**

Tests of statistical hypothesis: Statistical testing, Chi-square test, t-test, F-test and Z-test. Two sample hypothesis (testing difference between two means)

UNIT V	**7hrs**

Correlation and regression: The types of correlation – Perfect Positive Correlation, Perfect Negative Correlation, Moderately (Partial) Positive Correlation, Moderately (Partial) Negative Correlation and Absolutely No Correlation. Correlation coefficient - Pearson's correlation coefficient, Spearman's Rank correlation coefficient and their applications. Regression concepts, Types of regression - Simple Linear Regression, Multiple Regression.

Course Outcomes: After completing the course, the students will be able to

CO1	Understand and explain the fundamental concepts of statistics in applied mathematics
CO2	Organize Data, communicate essential features of data both numerically and graphically
CO3	Provide interpretations/conclusions of statistical problems as mathematical modeling.

CO4	Identify research questions that may be answered using statistical methods and to translate the questions into the appropriate analysis procedure.

Text Books

1. Dr.K S. Chandrashekar, Engineering Mathematics-IV, Sudha publications, 2011-12, ISBN:0007457SUDHAP

2. Pranab Kumar Banerjee, Introduction to Biostatistics, S. Chand & Co. Ltd, 2011, ISBN:9788121923293

Reference Books

3.Khan and Khanum, Fundamentals of Biostatistics, Ukaaz publications, 2009, ISBN:9788190044103.

4. Marcello Pagano and Kimberlee Gauvreau, Principle of Biostatistics, Thomson Asia Pvt., Ltd., 2nd ed. 2010, ISBN:100538733497.

(Theory – 100 Marks)	
Evaluation method	**Course with Assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units.	
Each question should be for maximum of 16	
Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not	**80**
have any choice.	
The **UNIT-2 and UNIT-3** should have an internal	
choice.	
Both the questions should be of the same	
complexity in terms of COs and Bloom's	
taxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	-	-	M	M	L	L	-	-	M
CO2	M	M	-	L	-	L	-	-	M	-	-	L
CO3	H	M	L	-	-	M	M	M	L	-	-	L
CO4	M	H	L	-	-	L	-	-	-	-	-	L

High-3 : Medium-2 : Low-1

ENVIRONMENTAL TECHNOLOGY (Theory)		
Course code:16ET32/42		**CIE Marks: 50**
Hrs/Week: L:T:P:S :2:0:0:0		**SEE Marks: 50**
Credits: 02		**SEE Duration (Theory): 90 min**

Course learning objectives: The student will be able to

1. Understand the various components of environment and the significance of the sustainability of healthy environment.
2. Recognize the implications of different types of the wastes produced by natural and anthropogenic activity.
3. Learn the strategies to recover the energy from the waste.
4. Design the models that help mitigate or prevent the negative impact of proposed activity on the environment.

Unit I	05 Hrs

Introduction: Ecosystem – Types and structure of ecosystem. Components of environment, Environmental education, Environmental act & regulations. Global environmental issues, ISO 14000, Environmental Impact Assessment and Challenges.

Unit II	05 Hrs

Environmental pollution: Causes, effects and control measures of Air, noise and land pollution. Air Pollution. Clean air act, Pollution standard index. Indoor air quality. Global atmospheric change - Global warming, Acid rain & Ozone depletion and their controlling measures.

Unit III	05 Hrs

Water pollution and management: Pollutants in surface & ground water, water borne diseases. Water purification systems: physical & chemical treatment - aeration, solids separation, settling operations, coagulation, softening, filtration, disinfection, The common technologies for purification of drinking water - Ultraviolet radiation treatment, Reverse Osmosis. Rain water harvesting, water recycling, STP plant.

Unit IV	05 Hrs

Renewable energy sources and technology for generation of energy:. Different types of energy, conventional sources & non conventional sources of energy, solar energy, wind energy, hydro electric energy, Geothermal Energy, Nuclear energy, Fossil Fuels & Biomass energy.

Unit V	05 Hrs

Solid waste management: Types, causes, control and processing. Typical generation rates, estimation of solid waste quantities, factors that affect generation rates. Management - On site handling, collection,

storage and processing techniques, ultimate disposal, landfills. Reduction and recycling of waste – waste to composite, energy.	
Course outcomes: After completing the course, the students will be able to	
CO1	Identify the components of environment and exemplify the detrimental impact of anthropogenic activities on the environment.
CO2	Differentiate the various types of wastes and suggest appropriate safe technological methods to manage the waste.
CO3	Aware of different renewable energy resources and can analyse the nature of waste and propose methods to extract clean energy.
CO4	Adopt the appropriate recovering methods to recover the essential resources from the wastes for reuse or recycling.
	Text Books
1.	Gilbert, M.M. Introduction to environmental engineering and science. Pearson Education. 2nd Edition, 2004, ISBN: 8129072770.
2.	Howard S. Peavy, Donald R. Rowe and George Tchobanoglous. Environmental Engineering, McGraw Hill Series in water resources and Environmental Engg. 2000.ISBN: 0070491348
	Reference Books
1.	G. Tyler Miller (Author), Scott Spoolman (Author), Environmental Science – 15th edition, Publisher: Brooks Cole, (2012), ISBN-13: 978-1305090446 ISBN-10: 130509044
2.	Vijay Kulkarni and T. V. Ramachandra 2009. Environment Management. TERI Press; ISBN: 8179931846, 9788179931844
3.	Sven Erik Jørgensen 2002. Integration of Ecosystem Theories: A Pattern Ecology & Environment; Edition 3, Springer; ISBN: 1402007558, 9781402007552
4.	Linvil Gene Rich 2003. Environmental Systems Engineering, McGraw-Hill; ISBN: 9780070522503

Continuous Internal Evaluation (CIE)

Evaluation method	Course with assignment
Quiz-1	05
Test-1	15
Quiz-2	05
Quiz-3	05
Test-2	15
Assignment	05
Total	50

Semester End Evaluation (SEE) **Theory (50 marks)**	
Part – A	10
Objective type questions	
Part – B	40
There should be five questions from five units. Each question should be for maximum of 8 marks. The UNIT-1, UNIT-4 and UNIT-5 should not have any6 choice. The UNIT-2 and UNIT-3 should have an internal choice. Both the questions should be of the same complexity in terms of Cos and Bloom's taxonomy level.	
Total	50

CO - PO mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**L**						**H**		**M**	**-**		**-**
CO2	**M**	**H**	**H**	**M**	**L**		**H**	**H**	**M**	**-**	**M**	**L**
CO3		**H**	**L**	**H**		**M**	**H**	**H**	**M**	**-**	**L**	**M**
CO4	**L**		**M**	**L**	**H**		**M**		**M**	**-**		**M**

High-3 : Medium-2 : Low-1

BIOPHYSICS AND INSTRUMENTATION TECHNIQUES (Theory and Practice)		
Course Code:16BT43		**CIE Marks:100+50=150**
Hrs/Week: L:T:P:S: 3:0:2:4		**SEE Marks:100+50=150**
Credits:05		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able

1. Explore the levels of molecular organization of biomolecules and their role in cell
2. Understand how to apply the principles of physics to biological system
3. Understand the interactions between the various systems of a cell, including the interactions between DNA, RNA and protein biosynthesis, as well as how these interactions are regulated.
4. To familiarize with the principles, instrumentation and application of nanomaterials, spectroscopic, chromatographic and electrophoretic techniques in the study of biotechnology

UNIT-I	07 Hrs

Nucleic acids: Bases, Sugars, Phosphate group, ribose-phosphate backbone. Principles of base-stacking and base pairing: The Watson and Crick hypothesis of DNA structure. Nucleic acid families: The A, B and C family. Nucleic acid interactions with proteins: electrostatic, hydrogen bonding and stacking interactions.

UNIT II	07 Hrs

Proteins: Structural organization: Primary, secondary, tertiary and quaternary structures. Globular and fibrous proteins. Dynamics of protein folding: Influence of solvent and side chains on protein folding, protein folding rules, protein taxonomy procedures (motifs and domains). Ramachandran plot. Protein-ligand interactions: Scatchard plot and Hill plot.

UNIT III	08 Hrs

Nanotechnology: Introduction & History of nanomaterials, structure and applications of nanomaterials: carbon based-Bucky ball, nanotubes, grapheme. Metal and hybrid nanostructures – Quntum dots and Nanoshells. Polymers – Dendrimers and Nanocarriers, Biological nanomaterials – niosomes, liposomes, proteins and nucleic acids

UNIT III	08 Hrs

Separation Techniques: Centrifugation: Principle and types of preparative, analytical and ultra-centrifugation. **Electrophoresis:** Principle, types and applications of agarose gel electrophoresis, native and sodium dodecyl sulphate polyacrylamide gel electrophoresis and two dimensional gel electrophoresis. **Chromatography:** Principle, instrumentation and biological applications of thin layer, gel permeation, ion exchange, affinity, gas liquid and high performance liquid chromatography.

UNIT V	06 Hrs

Spectroscopic Analytical techniques: Basic concepts and principles of spectroscopy, Absorption spectroscopy: UV-Visible, infrared and atomic absorption spectroscopy. Emission spectroscopy: fluorescence and luminescence. Scattering spectroscopy: Raman, nephelometry and turbidometry.

LAB EXPERIMENTS

1. Estimation of DNA concentration in a given sample using ultraviolet spectrophotometer.
2. Estimation of protein concentration in a given sample using visible spectrophotometer.
3. Estimation of sulphate using turbidometry
4. Determination of absorbance maxima of biologically important samples: Pigments/DNA/Protein
5. Analysis of sodium and potassium using flame photometer.

6. Analysis of biologically important metals using atomic absorption spectrometer.
7. Separation of amino acids/organic acids by thin layer chromatography.
8. Separation of ionic compounds by ion exchange chromatography.
9. Gel filtration chromatography.
10. Centrifugation techniques.
11. Gas liquid chromatography (demo).
12. High pressure liquid chromatography (demo).

Students should perform all the experiments in a given semester

Self study:

1. Extraction/Isolation of biomolecules by applying biophysical principles
2. Characterization of biomolecules using different instrumentation techniques

Course Outcomes: After completing the course, the students will be able to

CO1	Students will have a solid foundation of the molecular organization, structures and functions of Nanomaterials, biomolecules such as proteins, lipids carbohydrates and nucleic acids and the instrumentation techniques used to analyze them
CO2	Understand the interactions between the various systems of a cell, including the interactions between DNA, RNA and protein, and the tools required to monitor/detect them
CO3	Apply the biophysical principles to solve biological problems and to analyze biological systems/samples
CO4	Design simple experiments to isolate and characterize biomolecules

Text Books

1. Keith M. Wilson, John M. Walker. "Principles and Techniques of Biochemistry and Molecular Biology". Cambridge University Press, Copyright. 2010. ISBN: 052151635
2. Donald Voet, Charlotte W. Pratt, Judith G. Voet. "Principles of Biochemistry: International Student Version". Wiley John and Sons, 2012. ISBN: 1118092449

Reference Books

1. James M. Miller, "Chromatography: Concepts and Contrasts", John Wiley& Sons, 2005, ISBN: 0471980595
2. Narayanan P, "Essentials of Biophysics", New Age International Pvt Ltd Publishers, 2008, ISBN: 9788122420807

Continuous Internal Evaluation (CIE)				
(Theory – 100 Marks)		**(Laboratory- 50 Marks)**		**Total (150)**
Evaluation method	**Course with assignment**			
Quiz -1	10	Performance of the student inthe laboratory, every week	40	
Test -1	25			
Quiz -2	10	Test at the end of the semester	10	
Quiz -3	10			
Test -2	25			
Self study	20			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory(50 Marks)**		**Total (150)**
Part- –A **Objective type questions**	**20**	Experiment Conduction with proper results	40	
Part –B There should be five questions from five	**80**	**Viva**	10	**150**

units. Each question should be for maximum of 16 marks The UNIT**-1, UNIT-4 and UNIT-5** should nothave any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.				
Total	**100**	**Total**	**50**	

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**H**	**L**	**-**	**L**	**L**	**L**	**-**	**-**	**-**	**-**	**-**	**L**
CO2	**H**	**L**	**-**	**L**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**L**
CO3	**H**	**M**	**M**	**H**	**M**	**M**	**M**	**L**	**L**	**M**	**-**	**M**
CO4	**H**	**H**	**H**	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**-**	**M**

High-3 : Medium-2 : Low-1

BASICS OF COMPUTER APPLICATIONS (Theory and Practice)		
Course Code:16BT44		**CIE Marks:100+50=150**
Hrs/Week: L:T:P:S: 3:0:2:4		**SEE Marks:100+50=150**
Credits:05		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to

1. Explore the knowledge of the fundamental areas of computer science such as Shell Programming, SQL, Biological databases and study the role of computer science in life sciences
2. Study the Data warehousing and mining technologies for the Biological data generated from the various domains of the Life Sciences
3. Acquire knowledge of the Object Oriented Programming and Database programming in C++ along with generic types and Exception handling
4. Demonstrate the Shell and C++ programming skills to work with text processing, database connection, access and control of backend database along with the problem solving techniques

UNIT-I	09 Hrs

Linux and Shell Programming: Introduction to Linux, basic commands, installing and uninstalling programs. Working with basic editors, pipes and wildcards. Working with processes; checking processes and killing processes. Working with files. Basic regular expressions. Introduction to Shell scripting/programming, Variables, Special Variables, Operators, Arrays, and Statements.

UNIT II	09 Hrs

Basics of Databases: Introduction to flat files, DBMS (Database Management System), RDBMS (Relational DBMS). Introduction to SQL and basic SQL commands - creating and modifying tables, joining tables, simple queries using SQL, inner join, outer joins, data sorting and filtration. Biological databases - Introduction to Biological databases, types of databases – Databases of Nucleic acid and Protein sequence, structure databases, protein profile, metabolic pathways and genome databases.

UNIT III	09 Hrs

Introduction to C++: Introduction, Object Oriented Programming concepts, data types, static data members, operators, statements, variables, arrays, pointers, structures, objects and classes, Constructors and Destructors, Parameterized constructors, copy constructors, functions – virtual functions, friend's functions. Encapsulation, Polymorphism and Inheritance.

UNIT IV	09 Hrs

Templates, Database connectivity and Exception handling: Introduction to Templates and Generic types, Class Templates, Function Templates, Member Function Templates. Basics of Exception Handling, Types of exceptions, mechanism of Exception Handing. Exception Throwing and Catching Mechanism. Re-throwing an Exception, Specifying Exceptions. Introduction to ODBC, Connecting front end to Back end database, querying and accessing the result set and closing the connection.

UNIT V	09 Hrs

Problem solving techniques in sequence analysis: Overview of Programming in Life sciences. Applications – finding an optimum pH for maximum enzyme activity, optimal dilution rate for maximum cell productivity. Basic problem solving techniques for sequence analysis – Dynamic Programming algorithms for sequence analysis Smith and Waterman, Needleman and Wunch, Nussinov dynamic programming, Exon chaining. Clustering algorithms for sequences – Neighbor Joining, UPGMA and overview of 3D Dynamic Programming. Programs to implement Taylor's series expansion, Runge Kutta 2nd and 4th order method, and Euler's backward method.

Self-Study: 1. Sequence analysis 2. Molecular modeling and Simulation	
LAB EXPERIMENTS	
1. Write a Shell program that parse information on author, taxonomy and coding sequence of 100 GenBank sequence files. 2. Write shell program to parse fasta ids and the sequences from the BLAST output. 3. Write shell program to trim all sequence files in the current working directory. 4. Write shell program to strip HTML tags in the given file. 5. Write a shell program to parse atomic and hetero-atomic sections of PDB file and estimate the atomic frequencies. 6. Write and execute a C++ program that prints all real solutions to the quadratic equation ax2 + bx + c = 0. Read in a, b, c and use the quadratic formula. If the discriminant b2-4ac is negative, display a message stating that there are no real solutions. 7. Write a program to find total and average marks of each student in class. Create a student class with USN, Name, Biochem, Bioinfo, Microbio, MolBio, BCA as its members. Use friend class that access the details of student and calculates total, average marks and prints the result. 8. Design and implement a class to represent a Bank account, and show the usage of the class in the main body of the program. Data members:- i. Name of the depositor ii. Account number iii. Type of account iv. Balance amount in the account v. Rate of interest (static data) Provide a default constructor, a parameterized constructor and a copy constructor to this class. Also provide Member Functions:- i. To deposit amount ii. To withdraw amount after checking for minimum balance iii. To display all the details of an account holder iv. Display rate of interest (a static function) Illustrate all the constructors as well as all the methods by defining objects. 9. Write a template function to sort an array. Illustrate how you sort integer, character as well as double arrays using the same template function. 10. Throw multiple exceptions and define multiple catch statements to handle negative number and out of memory exception. Negative number exception thrown if given number is negative value and out of memory exception is thrown if the given number is greater than 20. 11. Design a base class called ***Student*** with the following 2 fields:- (i) Name (ii) Id. Derive 2 classes called ***Sports*** and ***Exam*** from the Student. Class Sports has a field called ***s_grade*** and class ***Exam*** has a field called ***e_grade*** which are integer types. Derive a class called ***Results*** which inherit from ***Sports*** and ***Exam***. This class has a character array or string field to represent the final result. Also it has a member function called ***display*** which can be used to display the final result. Illustrate the usage of these classes in main. 12. Design and Implement a C++ program to interact with backend Protein database via front end interface. Illustrate the design stepwise	

13. Write a C++ program to implement Needleman and Wunch Algorithm for sequence alignment.
14. Write C++ program to parse fasta ids from the sequence database.
15. Write a C++ program to perform sequential clustering data given in the Distance matrix.

Note: Each student has to perform 13 experiments in a semester.
10 Experiments are GUIDED experiments
03 Experiments involving experiential learning.

Course Outcomes: After completing the course, the students will be able to

CO1	Understand basic Unix/Linux commands, regular expressions along with shell programming concepts.
CO2	Explore programming applications of Shell and C++ along with the software resources to mine biological databases including Biological databases available online.
CO3	Apply the programming applications of Shell and Object Oriented Programming to solve the problems related to process modelling, simulation and process engineering in Life Sciences
CO4	Use Shell and C++ Programming skills to solve Numerical methods, Differential equations, and mind crunching algorithms such as Dynamic programming in the field of Biotechnology and chemical engineering.

Text Books

1. Richard Blum, Christine Bresnahan, Linux Command Line and Shell Scripting Bible, John Wiley & Sons,3rd Edition, 2015, ISBN - 9781118984192
2. GaryJ.Bronson, C++for Engineers and Scientists, Cengage Learning, 4^{th} Edition, 2012, ISBN- 978-1133187844.

Reference Books

1. Richard Petersen, Linux: The Complete Reference, McGraw-Hill Education, 6^{th}Edition; 2007, ISBN - 978-0071492478.
2. Balagurusamy, Object Oriented Programming with C++, Tata McGraw-Hill Education, 6th Edition, 2013, ISBN – 9781259029936
3. Karline Soetaert, Jeff Cash, Francesca Mazzia, Solving Differential Equations in R, Springer, 1^{st}Edition; 2012, ISBN - 978-3642280696.

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)		**(Laboratory- 50 Marks)**			**Total**
Evaluation method	**Course with assignment**				
Quiz -1	10	Performance of the student in			
Test -1	25	the laboratory, every week		40	
Quiz -2	10				
Quiz -3	10	Test at the end of the semester			
Test -2	25			10	
Assignments	20				
Total	**100**	**Total**		**50**	**150**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory (50 Marks)**		**Total (150)**
Part- –A	**20**	Experiment Conduction with proper results	40	
Objective type questions				
Part –B				
There should be five questions from five units. Each question should be for maximum of 16 Marks.		**Viva**	10	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	**80**			
The **UNIT-2 and UNIT-3** should have an internal choice.				
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.				
Total	**100**	**Total**	**50**	**150**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L	H	M	H	H			M	L	
CO2	H	H	M	M	H	L	M		M			
CO3	H	M	H	M	M	H	H				M	
CO4	L	H	H	H	H	M	L					

High-3 : Medium-2 : Low-1

PROCESS PRINCIPLES AND CALCULATIONS (Theory and Practice)		
Course Code: 16BT45		**CIE Marks: 100**
Hrs/Week: L:T:P:S 3:0:0:4		**SEE Marks: 100**
Credits: 04		**SEE Duration: 03 Hrs**

Course Learning Objectives: The students will be able to

1. Convert one system of Units to the other
2. Identify unit operations and their role in process industries
3. Calculate material and energy requirement for unit operations and process industries
4. Calculate energy released in reactions.

UNIT I	08 Hrs

Units and Dimensions: Fundamental and derived Units, inter conversion of Units from one system to another (FPS, CGS, MKS, SI). Conversion of equations. Basic Chemical Calculations: Concept of mole and molecule, composition of mixtures of solids, liquids and gases. Composition of mixtures and solutions- percentage by weight, mole and volume. Normality, molarity, molality and ppm.

UNIT II	08 Hrs

Material Balance: Introduction to material and energy balances, equations for material and energy balances. General material balance, techniques for material balance without reaction, problems on mixed acid, distillation, extraction and crystallization.

UNIT III	08 Hrs

Material Balance without Chemical Reactions: Material balance for evaporation, drying, absorption, leaching. Definitions of vapor pressure, partial pressure, relative saturation, percentage saturation, humidity, molal humidity, percentage humidity, psychrometry, simple problem solving using psychrometric charts.

UNIT IV	06 Hrs

Material Balance without Chemical Reactions: Material balance involving bypass, recycle and purge. Problems.

Material Balance Involving Chemical Reactions: Principle of stoichiometry, definitions of limiting and excess reactants, fractional and percentage conversion, yield, selectivity. Problems.

UNIT V	06 Hrs

Energy Balance: General energy balance equation for steady state. Thermophysics and thermochemistry, heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Standard heat of formation, standard heat of reaction, Standard heat of combustion and calorific value of fuels. Calculation of ΔH_R at elevated temperature. Adiabatic reaction temperature and adiabatic flame temperature and their calculations.

Self study topics 1. Emerging technologies for biomass conversion to fuels 2. Applications of computational fluid dynamics to unit operations	1 Credit: **4 Hrs**/Week

Course outcomes:

After going through this course the student will be able to

CO1	Define various methods of expressing composition and apply ideal gas law for gaseous mixtures
CO2	Draw flow sheet for the description of a given process and apply law of conservation of mass to solve problems in material balances without chemical reactions and simple systems involving recycle, bypass and purge operations
CO3	Analyze the problem and carry out material balance for systems involving material balance with chemical reactions
CO4	Apply principles of thermo-chemistry and thermo-physics to carry out energy balance for simple systems
Text books	
1.	Bhatt B. I. and Thakore S.B., Stoichiometry, McGraw Hill, New Delhi, 5th ed., 2010. ISBN 9780070681149.
2.	Himmelblau D.M. and J.B.Riggs, Basic Principles and Calculations in Chemical Engineering, Prentice Hall, New Delhi, 8th ed., 2012. ISBN13: 978-0132346603.
Reference Books	
1.	Hougen O. A., Waston K. M. and Ragatz R. A., Chemical Process Principles Part–I, Material and Energy Balances, CBS Publishers and Distributors, New Delhi, 2nd ed., 2004. ISBN-9798123909539.
2.	Felder R.M. and Rousseau R.W.,L.G.Bullard, Elementary Principles of Chemical Processes, Wiley, 4th ed., 2015. ISBN: 978-1-119-19023-.3
3.	K. A. Gavhane, Introduction to Process Calculations (Stoichiometry), NiraliPrakashan, Pune, 27th ed., 2012. ISBN13: 9788190639668
4.	P.M. Doran; Bioprocess Engineering Principles; Academic Press; 2nd ed., 2012. ISBN:978012220851.

Continuous Internal Evaluation (CIE)	
Theory (100 Marks)	
Evaluation method	**Course with Self study**
Quiz -1	10
Test -1	25
Quiz -2	10
Quiz -3	10
Test -2	25
Self study	20
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	**80**
The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**L**	**M**	**L**	**L**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**M**
CO2	**M**	**M**	**L**	**L**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**M**
CO3	**M**	**H**	**L**	**M**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**M**
CO4	**M**	**H**	**L**	**M**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**M**

High-3: Medium-2 : Low-1

MOLECULAR BIOLOGY (Theory)		
Course Code:16BT46		**CIE Marks:100**
Hrs/Week: L:T:P:S: 3:2:0:0		**SEE Marks:100**
Credits:04		**SEE Duration (Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. Understand the life processes at sub-cellular and molecular level.
2. To compare and contrast the molecular mechanism between prokaryotes and eukaryotes.
3. Interpret the various levels of gene regulation at genetic and epigenetic levels.
4. Demonstrate the ability to articulate the knowledge of Biology, Biological methods and Biological issues in context.

UNIT-I	08 Hrs

Macromolecular organization of Nucleic acids: Structure of Nitrogen bases (ATGCU), Structure of DNA - Double Helix, features of Watson and Crick model, Forms of DNA- A,B, Z. Types, structure and function of RNA. Chromatin structure.

UNIT II	09 Hrs

DNA Replication Repair and Recombination: Replication in prokaryotes and eukaryotes, Plasmid replication.DNA damage and repair; Nucleotide excision repair, base excision repair, mismatch repair, photo-reactivation, recombination repair and SOS repair. Mutagenesis. Oncogenes, Tumour suppressor genes and their mechanism of action. DNA recombination; homologous and site-specific recombination, Transposons.

UNIT III	09 Hrs

Transcription and post transcriptional modifications: Mechanism of transcription in prokaryotes and eukaryotes.Transcription inhibitors. Reversal of Central Dogma.Post transcriptional processing of mRNA. RNA editing, mRNAsurveillance mechanism; NMD pathway.

UNIT IV	09 Hrs

Translation and post translational processing: Genetic code. Translation machinery in prokaryotic and eukaryotic systems, Post translational modifications. Protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast, and nucleus.

UNIT V	09 Hrs

Principles of gene regulation: Transcriptional and post transcriptional gene regulation-transcription factors. Regulation of gene expression in, prokaryotes (Operon-*lac* operon and trpoperon) and eukaryotes (Transcriptional, processing translational and posttranslational level), riboswitches. Gene silencing: chromatin remodeling, RNA interference; Types and its relevance. Epigenetic regulation. CpGislands, histone modification. Epigenetic changes in different diseases.

Course Outcomes: After completing the course, the students will be able to

CO1	Understand the fundamentals of molecular biology
CO2	Explain the relationship between genes, proteins and their functions
CO3	Compare and contrast between prokaryotic and eukaryotic molecular process.
CO4	Ability to think critically in reading and analyzing biological information from research journals.

Text Books

1. David P. Clark, Nanette J. Pazdernik., “Molecular Biology”, Academic Press, 2nd edition, 2013. ISBN: 9780123785947.
2. Lodish H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H, Matsudaira. Molecular Biology, Freeman, 7th edn, 2013. ISBN: 13:9781464109812.

Reference Books

1. Gerald Karp, Cell and Molecular Biology, Wiley, 7th edn , 2013, ISBN-13: 978-1118301791
2. Donald Voet, Charlotte W. Pratt, Judith G. Voet." Principles of Biochemistry: International Student Version". Wiley John and Sons, 2012. ISBN: 1118092449.

(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments/ seminars	10
Total	**100**

Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units. Each question should be for maximum of 1Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	
The **UNIT-2 and UNIT-3** should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**80**
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L	L	-	-	-	-	-	M	-	M
CO2	M	M	M	M	-	-	-	-	-	M	-	M
CO3	M	M	M	M	-	-	-	-	-	M	-	M
CO4	H	H	H	H	-	-	-	-	H	H	-	H

High-3 : Medium-2 : Low-1

Semester – V			
INTELLECTUAL PROPERTY RIGHTS & ENTREPRENEURSHIP			
Course Code: 16HSI51			**CIE Marks: 100**
Hrs/Week: L:T:P:S: 3:0:0:0			**SEE Marks: 100**
Credits: 03			**SEE Duration: 3Hrs**

Course Learning Objectives: The students will be able to	
1	To build awareness on the various forms of IPR and to educate on the link between technology innovation and IPR.
2	To promote linkages with industries and stimulate research through developing and utilizing novel technologies.
3	Assess their own strengths and identify gaps that need to be addressed to become a successful entrepreneur.
4	Acquire the skills and knowledge related to the various phases in the venture creation process such as creating a business model and building a prototype

UNIT-I	
Introduction: Types of Intellectual Property, WIPO, WTO, TRIPS. **Patents:** Introduction, Scope and salient features of patent; patentable and non patentable inventions, Patent Procedure – Overview, Transfer of Patent Rights; Biotechnology patents, protection of traditional knowledge, Infringement of patents and remedy, Case studies **Trade Secrets:** Definition, Significance, Tools to protect Trade secrets in India.	**07 Hrs**
UNIT-II	
Trade Marks: Concept, function and different kinds and forms of Trade marks, Registrable and non- registrable marks. Registration of trade mark; Deceptive similarity; Assignment and transmission; ECO Label, Passing off; Offences and penalties. Infringement of trade mark with Case studies	**04 Hrs**
UNIT-III	
Industrial Design: Introduction, Protection of Industrial Designs, Protection and Requirements for Industrial |Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies , Case studies **Copy Right:** Introduction, Nature and scope, Rights conferred by copy right, Copy right protection, transfer of copy rights, right of broad casting organizations and performer's rights, Case Studies. **Intellectual property and cyberspace:** Emergence of cyber-crime ; Grant in software patent and Copyright in software; Software piracy; Data protection in cyberspace	**09 Hrs**
UNIT-IV	
Introduction to Entrepreneurship – a. Meaning and Definition, E-Cell, Entrepreneurial DNA, Traits and Gap analysis, Entrepreneurial Success Stories, Creative and Design Thinking, Communication, **Personal Selling**: Show and Tell, Risk –taking and Resilience. Concept of prototyping, Idea Validation (Product-Market Fit), Early attempts to sell the product or service, **Understand customer perspective**: how the proposed product/solution will be used, value perception, Early insights on customer segmentation – primary customer segment, alternate customer segments, Early insights on pricing, cost and margins.	**08 Hrs**
UNIT-V	
Business Model and Plan: Develop and validate a business model, Visioning for venture, Marketing the Business, Establish the success and operational metrics , Minimum Viable Product and the lean method, **Managing start – up finance**, Customer Development and Experience, Early insights on cost of customer acquisition, Clarifying the value proposition. Legal and regulatory aspects for starting up specific to the venture. Enhancing the growth process and creating scalability ((customers, market share and/or sales).	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO 1.	Comprehend the applicable source, scope and limitations of Intellectual Property within the

BIOINFORMATICS **(Theory and practice)**

	purview of engineering domain.
CO 2.	Develop Knowledge and competence on various Legal issues pertaining to Intellectual Property Rights with the utility in engineering perspectives
CO 3.	Learn about opportunity discovery and evaluation of viable business ideas for new venture creation.

Reference Books	
1.	Wadehra B L Law Relating to Intellectual Property 5th Edition Publisher: Universal Law Pub Co. Ltd.-Delhi, ISBN: 9789350350300, 9350350300, 5th Edition, 2012
2.	Prabuddha Ganguly, “Intellectual Property Rights: Unleashing Knowledge Economy”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1st Edition, 2001. ISBN: 0074638602.
3.	Rodney Ryder – Intellectual Property and the Internet, Publisher Lexis Nexis U.K., 2002 ISBN: 8180380025, 9788180380020

Continuous Internal Evaluation (CIE) (Theory – 100 Marks)							
Evaluation method	Quiz -1	Test -1	Quiz -2	Test -2	Quiz -3	Assignment	Total
Course with Self-study	10	30	10	30	10	10	100

Semester End Evaluation Theory (100)	
Part –A **Objective type questions**	**20**
Part –B There should be five questions from five units. Each question should be for maximum of 16 Marks. The **UNIT-1**, **UNIT-4** and **UNIT-5** should not have any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of Cos and Bloom’s taxonomy level.	**80**
Total	**100**

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1			M			M	H	M	M	L	L	M
CO2						H	H	M	L	L	L	L
CO3						L	H	M	H	M	H	H

Low-1 Medium-2 High-3

Course Code:16BT52		**CIE Marks:100+50=150**
Hrs/Week: L:T:P:S: 3:0:2:4		**SEE Marks:100+50=150**
Credits:05		**SEE Duration (Theory) : 3 Hrs**
		SEE Duration (Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to

1. Acquire the knowledge of Biological database and its role in insilico research
2. Understand the essential algorithms behind the biological data analysis such as Dynamic programming, Dot plotting, Evolutionary and Clustering algorithms along with their implementation.
3. Use various tools and techniques for the prediction of linear & non-linear structures of both macro and micro molecules and study the dynamics of macromolecules and High Throughput Virtual Studies.
4. Perform annotation of unknown DNA and Protein sequences and explore the principles of molecular modeling and insilico drug design

UNIT-I	**9 Hrs**

Overview of bioinformatics and Biological Databases: Introduction to Bioinformatics, Goals, Scope, applications in biological science and medicine. **Biological databases:** Types of Sequence Databases - The nucleotide and protein sequence databases, Primary and secondary databases. Structure Databases - PDB and MMDB records, molecular modeling databases at NCBI. Special Databases - Genome, Microarray, metabolic pathway, domain databases. Sequence retrieval from the databases

UNIT- II	**9 Hrs**

Sequence analysis: Significance of **s**equence alignment methods, homology, similarity and identity patterns. Scoring matrices: BLOSSUM (BLOSSUM40, BLOSSUM60, BLOSSUM90), PAM (PAM120 and PAM250). Sequence alignment algorithms: Dot matrix, Dynamic programming and progressive alignment. Types of alignment: Global, Local, Pair wise & Multiple Sequence alignment, FASTA & BLAST for database searches. **Phylogenetic analysis:** Introduction to cladogram and phylogram, rooted and unrooted phylogenetic trees. Phylogenetic data analysis: building the data model (Multiple sequence alignment). Determining the substitution model. Phylogenetic tree building Methods. Methods of tree evaluation.

UNIT- III	**9Hrs**

Predictive and structural bioinformatics: Gene prediction programs – ab initio and homology based approaches. ORFs and HMM for gene prediction. Detection of functional sites and codon bias in the DNA. Predicting RNA secondary structure, Finding RNA genes. Protein structure basics, structure visualization, comparison and classification. Protein structure predictive methods using protein sequence, Protein identity based on composition. Structure prediction - Prediction of secondary structure, antigenic sites, Folding classes and Tertiary structures. Prediction of Promoters, Primers and Restriction mapping.

UNIT- IV	**9 Hrs**

Genome analysis: Genome mapping - sequencing, sequence assembly, annotation, comparative genomics. Functional genomics – sequence based approach, microarray based approach, comparison of SAGE and Microarray. Prediction of gene function based on composition. Computational analysis of alternative splicing and Human genetic linkage analysis. Expressed Sequence Tags: clustering and analysis.

UNIT- V	**7 Hrs**

Introduction to Molecular modeling and Drug designing: Introduction to molecular modeling, methods of molecular modeling. Drug designing process - deriving pharmacophore pattern, receptor mapping, estimating biological activities, ligand-receptor interactions and molecular docking. Drug designing methods such as Rational drug designing and QSAR.

LAB EXPERIMENTS	

1. Sequence retrieval from nucleic acid and protein databases and retrieving articles from PubMed.
2. Locating the chromosome of a Gene
3. Retrieving structural data of a protein using PDB database and Motif Information of a Protein Using Prosite
4. Visualization of the structure of a protein and finding the distance between the ligands and the amino acids.
5. Finding ORF of a Given Sequence.
6. Restriction mapping and Primer design
7. Global and local alignments.
8. Pairwise Sequence Alignment using BLAST and Multiple sequence alignment using CLUSTAL W.
9. Phylogenetic Analysis using PHYLIP - Rooted trees and unrooted trees.
10. Secondary structure analysis of a protein using SOPMA.
11. Retrieval of the attributes of a drug molecule, and converting chemical file formats.
12. Homology modeling using modeler.
13. Protein ligand interaction studies.

Note: Each student has to perform 13 experiments in a semester.
10 Experiments are GUIDED experiments
03 Experiments involving experiential learning.

Course Outcomes: After completing the course, the students will be able to

1	Demonstrate the knowledge of retrieval of the biological data in the essential formats. and its analysis.
2	Analyse the gene, protein and RNA data to find the degree of similarities and identifying the patterns
3	Apply the drug designing methods for screening and inventing the new targets and drugs
4	Predict the structure of a compound and design the molecule.

Text Books

1. Jin Xiong, Essential Bioinformatics, 2006, Cambridge University Press, ISBN: 9780521600828, Units III & IV
2. D.Andreas Baxevanis and B. F; Francis Ouellette. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins; Wiley-IEEE; 3rd edn; 2009; ISBN: 9788126521920; Units I & II

Reference Books

1. D W Mount; Bioinformatics: Sequence and Genome Analysis; CSHL Press; 2nd edn;2004; ISBN: 9780879697129 Units I & IV
2. A Kriete and R Eils; Computational Systems Biology; Academic Press; illustrated edn; 2006; ISBN: 9780120887866; Unit V.

Scheme of Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	Course with assignment
Quiz -1	15
Test -1	25
Quiz -2	15
Test -2	25
Quiz -3	15
Test-3	25
Self-Study	20
Total	**100**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory(50 Marks)**		**Total (150)**
Part- –A	**20**	**Experiment**		
Objective type questions		**Conduction with**	40	
Part –B		**proper results**		
There should be five questions from five units.		**Viva**	10	
Each question should be for maximum of 16				
Marks.				
The **UNIT-1, UNIT-4 and UNIT-5** should not	**80**			
have any choice.				
The **UNIT-2 and UNIT-3** should have an internal				
choice.				
Both the questions should be of the same				
complexity in terms of COs and Bloom's				
taxonomy level.				
Total	**100**	**Total**	**50**	**150**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	-	L	-	M	M	L	L	-	-	M
CO2	M	M	-	M	M	L	-	-	L	-	-	L
CO3	M	M	L	M	-	M	M	-	L	-	-	M
CO4	M	M	L	H	-	M	-	-	-	-	-	L

High-3 : Medium-2 : Low-1

GENETIC ENGINEERING (Theory and practice)		
Course Code: 12BT53		**CIE Marks:100+50=150**
Hrs/Week: L:P:T:S: 3:0:2:4		**SEE Marks:100+50=150**
Credits: 05		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to

1. Acquire the knowledge of the fundamentals of Genetic engineering
2. Explore different methods for the production and screening of recombinant proteins
3. Apply the technique for the production of recombinant proteins
4. Develop methodology for the isolation and screening of recombinants

UNIT-I	7 Hrs

Introduction to Genetic Engineering: Role of genes within cells, genetic elements that control gene expression, scope and applications of genetic engineering, Isolation and purification of genomic, plasmid DNA and mRNA. Method of creating recombinant DNA molecules.

UNIT II	7Hrs

Tools used in Genetic Engineering: Vectors: Types, biology and salient features of vectors in recombinant DNA technology: Plasmids, Phages, Cosmids, Phagemids, and Artificial chromosomes **Enzymes:** Types and classification: Nucleases, ligases, polymerases, topoisomerases, modifying enzymes, DNase, linkers and adaptors.

UNIT III	7Hrs

Gene transfer techniques: Biological, chemical and physical methods.

Transformation – Methods, Preparation of competent cells, Introduction of DNA into host cells techniques used for selection, screening and characterization of transformants: Introduction, selectable marker genes, reporter genes, screening of clones, nucleic acid blotting and hybridization.

UNIT IV	7Hrs

Construction and screening of DNA libraries, Polymerase chain reaction: Construction of genomic and cDNA libraries. Screening of DNA libraries for clone identification. Characterization of clones. Polymerase chain reaction (PCR) - techniques and requirements, types of PCR, applications. Blotting techniques (Southern, Northern), Radioactive and non-radioactive labelling of nucleic acids.

UNIT V	7Hrs

Applications and advance genome editing: Transgenic science in plant and animal improvement, Biopharming- Animals as bioreactor for recombinant protein, Antisense technology. Genome editing- (Zinc finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), CRISPR technology.

Self Study:

1. Recent applications of Recombinant DNA technology
2. Demonstration of antigen and antibody reaction

LAB EXPERIMENTS
1. Isolation of plasmid DNA from E. coli 2. Isolation of genomic DNA (plant/ animal/ microbial sources) 3. Extraction of total RNA from E.coli cells 4. Agarose Gel Electrophoresis and quantification of nucleic acids 5. Restriction digestion of plasmid / genomic DNA 6. Preparation of competent cells (E.coli / Agrobacterium). 7. Genetic transformation of E.coli 8. Screening techniques to select recombinants. 9. Polymerase Chain Reaction (PCR). 10. Separation of Proteins - SDS-PAGE. 11. Agglutination Technique: Blood group identification. 12. Bacterial Agglutination technique - Widal test (Tube / Slide agglutination). 13. Ouchterlony Double Diffusion (ODD). 14. Rocket immunoelectrophoresis (RIEP). 15. Enzyme Linked Immunosorbent Assay (ELISA).
Note: Each student has to perform 12 experiments in semester.10 Experiments are guided experiments, 02 experiments are involving experiential learning.

Course Outcomes: After completing the course, the students will be able to	
1	Remember and reproduce the basic concepts in molecular Biology
2	Explain the manipulation, expression and regulation of genes
3	Apply the genetic manipulation techniques in living cells for the production of useful compounds.
4	Design and execute research/ commercial projects.

Text Books
1. T.A.Brown; Gene Cloning and DNA Analysis – An Introduction; Wiley-Blackwell Science; 6th edn; 2010; ISBN: 9781405181730
2. S.B. Primrose, R. M Twyman and R. W. Old (6th edition)., Principles of gene manipulation,2001;ISBN; 0-632-059540
Reference Books
1. B.Alberts, A.Johnson, J.Lewis M.Raff, K.Robert and P. Walter; Molecular Biology of the cell; Garland Science; 5th ed; 2008; ISBN:0815341059.
2. B.R. Glick, J.J.Pasternak and C.L Patten; Molecular Biotechnology – Principles and applications of recombinant DNA; ASM Press; 4th edn; 2010; ISBN: 9781555814984.
3. H Lodish, A Berk, CA Kaiser, M Krieger, MP Scott, A Bretscher, H Ploegh, Matsudaira; Molecular Biology; Freeman; 6th edn; 2008; ISBN: 9780716776017.

Scheme of Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	Course with assignment
Quiz -1	15
Test -1	25
Quiz -2	15
Test -2	25
Quiz -3	15
Test-3	25
Self-Study	20
Total	**100**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory(50 Marks)**		**Total (150)**
Part- –A	**20**	**Experiment Conduction with proper results**	40	
Objective type questions				
Part –B		**Viva**	10	
There should be five questions from five units. Each question should be for maximum of 16 Marks.				
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	**80**			
The **UNIT-2 and UNIT-3** should have an internal choice.				
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.				
Total	**100**	**Total**	**50**	**150**

CO-PO Mapping												
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12
CO1	L	H	L	-	-	M	-	-	-	-	-	-
CO2	H	H	H	-	L	-	-	-	-	-	-	-
CO3	H	H	M	M	-	-	--	-	-	-	-	-
CO4	H	H	H	M	M							

High-3 : Medium-2 : Low-1

REACTION ENGINEERING		
Course Code: 16BT54		**CIE Marks: 100**
Hrs/Week: L:T:P:S 3:2:0:0		**SEE Marks: 100**
Credits: 04		**SEE Duration: 03 Hrs**

Course Learning Objectives: The students will be able to

1. Develop the ability to analyze kinetic data and determine rate laws.
2. Explore the performance of reactors with multiple reactions.
3. Understand the non ideal flow conditions in reactors ,to develop the skill to utilize simple models to characterize the performance of such reactors
4. Learn the stoichiometry of cell growth and product formation and determine stoichiometric and yield coefficients

UNIT – I	10Hrs

Introduction: Classification of reactions, molecularity and order of reaction, rate equation and rate of reaction, elementary and nonelementary reactions, Arrhenius law (excluding mechanism of reactions). Analysis of experimental reactor data: Evaluation of rate equation. Integral and differential analysis for constant and variable volume system (zero, 1st and 2nd order irreversible reactions).numericals.

UNIT– II	10Hrs

Design of ideal reactors: Concept of ideality, development of design expressions for batch, tubular and stirred tank reactors for both constant and variable volume systems. Evaluation of rate equations, comparison of ideal reactors, multiple reactor system, numerical.

UNIT – III	08 Hrs

Non Ideal Flow: Interpretation of RTD curve: C, E and F curves, step and impulse input response for the non ideal reactors. Exit age distribution of fluid in reactors, RTD's for CSTR and PFR, calculation of conversion for first order reaction, numerical.

UNIT – IV	06Hrs

Kinetics of microbial growth and product formation: Phases of cell growth in batch cultures, simple unstructured kinetic models for microbial growth: Monod model, growth of filamentous organisms. Growth associated and non growth associated product formation kinetics, Leudeking – Piret models, substrate and product inhibition on cell growth and product formation, numerical.

UNIT – V	08Hrs

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

Course outcomes: After going through this course the student will be able to:	
1.	Understand the rate law and determine the parameters of rate expression for homogeneous reactions
2.	Apply design equations for the three ideal reactors (batch, CSTR and plug flow) for single reactions
3.	Analyze the RTD data, plot C,E,F curves and determine mean residence time, variance, skewness and conversion for ideal and real reactors
4.	Evaluate the stoichiometric coefficients, yield coefficients, respiratory and maintenance coefficients for problems of microbial growth
Text books	
1.	Octave Levenspiel; Chemical Reaction Engineering; John Wiley and Sons; 3rd edition; 3rd ed; 1999. ISBN: 0-471-25424-X
2.	M.Shuler and F. Kargi; Bioprocess Engineering: Basic Concepts; Prentice Hall; 2nd ed; 2002. ISBN:0130819085
Reference Books	
1.	H.S Fogler; Elements of Chemical Reaction Engineering; Prentice Hall; 4th ed; 2006. ISBN:0130473944
2.	P.M. Doran; Bioprocess Engineering Principles; Academic Press; 2nded; 2012. ISBN:978012220851
3.	M.E.Davis and R.E. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill Education, 1st ed., 2003.ISBN 0-07-119260-3
4.	K.A.Gavhane. Chemical Reaction Engineering-I, NiraliPrakashan, 15th ed., 2014. ISBN-13:9788185790879

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignment	10
Total	**100**

Semester End Evaluation (SEE) Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
UNIT-1, UNIT-4 and UNIT-5 should not have any choice.	**80**
The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L	L	L	-	-	-	-	-	-	M
CO2	L	H	H	M	L	-	-	-	M	-	-	M
CO3	L	M	L	M	L	-	-	-	M	-	-	M
CO4	L	M	L	L	L	-	-	-	-	-	-	M

High-3 : Medium-2 : Low-1

IMMUNOTECHNOLOGY		
Course Code:16BT55		**CIE Marks:100**
Hrs/Week: L:T:P:S: 3:0:0:0		**SEE Marks:100**
Credits:03		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1	Understand the mechanism of immune response and reactions
2	Utilise various components and assets required for immune reaction
3	Comprehend structure of immunoglobulin and antibody
4	Apply various techniques for understanding intricacies of immunology
5	Figure out various tools and mechanism for graft rejection reactions

UNIT-I	6 Hrs

Introduction to the immune system

Innate and acquired immunity, passive and adaptive immunization, cells and organs of the immune system; primary and secondary immune responses, humoral and cellular immunity, antigens: chemical and molecular nature, Hapten, adjuvant, Chemical Nature, Types of Antigenic determinants. Regulation of Immune response

UNIT II	7 Hrs

Immunoglobulins and MHC

Immunoglobulins- General Structure, Classes of Immunoglobulin and Isotypes, Functions, Lymphocytes: T-Cells- Classes, Structure and organization of TCRs, B-Cells- Cell surface Receptors. Activation and function of T and B cells, Organization and polymorphism of MHC complex, Role of antigen presenting cells (APC); Antigen processing and presentation in the human response.

UNIT III	5 Hrs

Immune effector mechanism

Cytokines; general properties and functional categories of cytokines, therapeutic and diagnostic exploitation of cytokines and cytokine receptors, Complement, Hypersenstivity; Cell-mediated effector responses-cytotoxicity, inflammation, Immunotolerance. Tumor immunology; Tumor antigen, categories of tumor antigen, tumor immunoprophylaxis.

UNIT IV	8 Hrs

Antibody engineering and applications

Monoclonal antibodies, Generation of Recombinant antibodies from hybridoma, Antibody labeling for imaging and immunotherapy; Catalytic antibodies; Targeting antibodies using aptamers. Overview of Auto immunity; criteria and causes of autoimmune diseases-Autoimmune hemolytic anemia, myasthenia gravis, systemic lupus erythematosus, multiple sclerosis, rheumatoid arthritis, transplantation and graft rejection; mechanism; allograft rejection, bone marrow and haematopoietic stem cell transplantation.

UNIT V	7 Hrs

Immunotechnology techniques: Antigen Antibody interactions; Precipitin & Agglutination reaction. Immunofluorescence, flow cytometry, Immuno double diffusion test Immunoelectrophoresis, Rocket Immuno electrophoresis, Radio immuno assay, ELISA technique for detection of diseases & Elispot assay. fluorescence activated cell sorting analysis and Chemiluminiscence.

Course Outcomes: After completing the course, the students will be able to

1	Apprehend the concepts of immunity and immune reactions.
2	Analyse the various types of immune responses
3	Apply the knowledge of immunology to identify various immunological reactions and interactions

4	Evaluate the significance and applications of various immunological techniques.

Text Books

1. Ashim K. Chakravarthy. Immunology and Immunotechnology Oxford University Press. 2006. ISBN-13: 978-0195676884
2. T. Kindt, R. Goldsby, B. A. Osborne, Kuby Immunology, W. H. Freeman, 6th edition, 2006. ISBN 13: 9781429202114
3. Benjamini E. and Leskowitz S. Immunology: A short course, Wiley Liss, NY. 2003. ISBN : 978-1-118-39690-2

Reference Books

4. Abbas A., Litchman A. H., and Pober J., "Cellular and Molecular Immunology" W B Saunders & Co.(2000), ISBN: 9780323222754
5. Ajoy Paul, “Textbook of Immunology”Books and Allied (P) Ltd. (2016), ISBN-13: 9789384294724
6. Sudha Gangal and Shubhangi Sontakke "Textbook of basic and clinical Immunology" Universities Press. (2013). ISBN 13: 9788173718298

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE) Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
UNIT-1, UNIT-4 and UNIT-5 should not have any choice.	**80**
The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom’s taxonomy level.	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	M	L	-	M	M	L	-	M
CO2	M	H	H	H	H	M	H	M	H	L	-	H
CO3	L	H	H	M	M	H	H	H	M	M	L	M
CO4	M	M	H	L	L	H	H	H	M	H	M	H

High-3 : Medium-2 : Low-1

Professional A

PHARMACEUTICALS (Theory)						
Course Code	**:**	**16BT5A1**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 3:0:0:4**		**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**03 hour**

Course Learning Objectives: The students will be able to

1.Evaluate the nature of drugs, their formations and accruing benefits to mankind.

2.Illustrate the steps involved in the manufacturing of drugs and pharmaceutics preparations.

3.Demonstrate the types of drugs and their sites of action.

4. Acquaint the awareness about natural and semisynthetic products.

Unit – I	**07 Hrs**

INTRODUCTION: Current status and prospects for the Indian and global pharmaceutical industry. Drug development – Pre-formulation: structure determination, analytical development, salt form, chemical stability, physical-chemical properties, chiral properties, biopharmaceutical properties and excipient stability. Types of formulation: Liquids, semi-solids, solids and novel forms. Packaging and labeling. Clinical trials and quality assurance, Regulatory authority.

Unit – II	**07 Hrs**

Manufacturing principles and formulations: Compressed tablets, wet and dry granulation, direct compression, tablet formulation and coating pills. Capsules formulation and manufacture. Drug delivery types, sustained action dosage formulations, parenteral preparations, oral liquids and topical ointments and balms. Application of recombinant proteins in pharmaceutical industry. Scale-up aspects. Concept of GMP and GLP- Clean room.

Unit – III	**07 Hrs**

Chemical conversion processes and Drug metabolism : Alkylation, condensation, cyclization, dehydration, etc. Drug metabolism, half-life of drugs, physico-chemical principles in drug metabolism, use of radio-active compounds, pharmaco-kinetics and pharmacodynamics. Bioavailability and Bioequivalence.

Unit – IV	**07.Hrs**

Pharmaceutical products and their action: Non-steroidal contraceptives, vitamins, gamma globulins, clinical dextran and absorbable haemostats. Nutraceuticals: Antioxidants, flavanoids, carotenoids, cholesterol lowering chemicals, nutritional importance and their functions, nutritional status evaluation

Unit – V	**07 Hrs**

Drugs and their sites of action: Drugs acting on the central nervous system, cardiovascular system, blood and blood-forming agents, diuretics, gastrointestinal system and respiratory system. Immunomodulatory agents. Related case studies.

Self-Study Topics

1	Approaches in drug discovery topics
2	Total quality control in pharmaceutical development process

Course Outcomes: After completing the course, the students will be able to

1	Conceptualize the role of pharmaceutical products and their significance in modern society.
2	Exercise better professionalism by incorporating manufacturing of pharmaceutical products and their uses
3	Describe types of diseases and their impact on human lives

4	Explain relationship between sprawling human population and related diseases.
Text Books	
1	Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications by Oliver Kayser, Heribert Warzecha, John Wiley & Sons, 2012, ISBN: 352765125X, 9783527651252
2	Goodman and Gilman's Manual of Pharmacology and Therapeutics by Laurence L. Brunton, Randa Hilal-Dandan. McGraw Hill Professional, 2013. ISBN: 007176917X, 9780071769174
Reference Books	
1	J.P. Griffin and J. O'Grady; The text book of Pharmaceuutical medicine; New Age International; 5th Ed; 2012; ISBN: 140518035
2	Laurence Brunton, Bruce Chabner, Bjorn Knollman; Goodman and Gilman's The Pharmacological Basis of Therapeutics, Twelfth Edition. McGraw Hill Professional, 2011. ISBN: 0071769390, 9780071769396
3	Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm Pharmaceutical Biotechnology: Fundamentals and Applications *SpringerLink : Bücher*. Springer Science & Business Media, 2013. ISBN: 1461464862, 9781461464860
4	Lanju Zhang. Nonclinical Statistics for Pharmaceutical and Biotechnology Industries *Statistics for Biology and Health*; Springer, 2016. ISBN: 3319235583, 9783319235585

Scheme of Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	Course with assignment
Quiz -1	15
Test -1	25
Quiz -2	15
Test -2	25
Quiz -3	15
Test-3	25
Self-Study	20
Total	**100**

Scheme of Semester End Examination (SEE):	
Theory (100 Marks)	
Part- –A	20
Objective type questions	
Part –B	80
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
The UNIT-1, UNIT-4 and UNIT-5 should not have any choice. The UNIT-2 and UNIT-3 should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	100

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12
CO1	M	L	-	L	M	H	L	H	-	-	M	L
CO2	M	M	H	H	M	H	-	H	L	-	L	M
CO3	L	H	L	H	-	H	L	H	M	-	L	-
CO4	M	-	M	H	-	H	-	M	L	-	-	-

High-3 : Medium-2 : Low-1

AGRICULTURAL BIOTECHNOLOGY		
Course Code: 16BT5A2		**CIE Marks:100**
Hrs/Week: L:P:T:S: 3:0:0:4		**SEE Marks:100**
Credits: 04		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. Obtain a strong foundation in principles and fundamentals of plant cultures and its application.
2. Understand the various breeding techniques for crop improvement.
3. Emphasize on potential applications of genetically engineered crops
4. Get an overview of the various applications of agri-biotechnology

UNIT-I	7Hrs

Introduction: History and Scope, Tissue culture as a tool in crop improvement: Introduction to tissue culture, sterilization of field grown tissues, callus induction, initiation of suspension cultures, role of harmones in plant morphogenesis, regeneration of shoots and roots from callus cultures, micropropagation, secondary plant products and their methods of production, Synthetic seeds. Germplasm preservation.

UNIT- II	7Hrs

Application in crop improvement: Production of disease plants: shoot tip culture, grafting, Meristem culture and production of virus-free plants. Somatic embryogenesis, Tissue culture as a source of genetic variability – somoclonal and gametoclonal variant selection. Haploids in plant breeding; Anther and microspore culture. Embryo and ovary culture. Somatic hybridization; Protoplast isolation and fusion, cybrids. Somaclonal variation.

UNIT- III	7Hrs

Genetic Engineering: Principles of recombinant DNA technology, Methods of gene transfer: Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, Agro-bacterium mediatedgene transfer, Preparation and application of molecular probes .Techniques for the insertion of foreign genes into plant cells. Ti plasmid and vectors, production of transgenic plants: Bt, herbicide and virus resistant plants. Radioactive labeling, Non radioactive labeling, use of molecular probes, DNA fingerprinting,

UNIT- IV	7Hrs

Molecular Markers in Plant Breeding : Distinction between various morphological, biochemical and molecular markers with their strength and weaknesses. Types of molecular markers. PCR technology and its implications on molecular biology. Isozymes; RFLP; RAPD; ISSR;STMS; AFLP; SNP; SCAR; CAPS; RAMP; and SSCP markers (techniques, methodology and its application in plant and animal breeding). Functional expression markers. Application of molecular markers in plant breeding especially in varietal identification; markers assisted selection; QTL, mapping and map based cloning, mapping strategies-

UNIT- V	6Hrs

Protected cultivation: Green house technology, Types of Green house, Various component of green house, Design, criteria and calculation. Green house irrigation system, Pytotrons: Hydroponics and aeroponics. Sustainable Agricultural systems: Organic Farming, Concept of Integrated nutrient management and Integrated pest management, molecular farming in animals and plants.

Self Study:

1. Role of markers in Plant Breeding
2. Micropropagation of important commercial crops

Course Outcomes: After completing the course, the students will be able to

1	Remember and explain various fundamentals of Agricultural Biotechnology with reference to breeding techniques and tissue culture
2	Apply the knowledge of modern tools to analyze the improvement of agricultural practices and livestock
3	Evaluate and analyze various parameters of transgenics for crop and livestock improvement
4	Create and work on green house and other sustainable techniques

Text Books

1	. Biotechnological Renovations in Crop Improvement by BiotolSeries, Elsevier
2	S S Purohit, Agricultural Biotechnology, Agribios India, 2^{nd} ed. 2003, digitalized 2011, ISBN: 81-7754-156-0
3	Gene cloning and DNA analysis : an introduction by Brown, T. A. 2001, 4th edition, BlackwellSci. Ltd.,BlackwellPub. Co., USA

Reference Books

1	Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology-The genetic manipulation of plants, Oxford university press, 2^{nd} ed, 2010, ISBN-13:9780199282616.
2	Maarten J. Chrispeels and David E. Sadava , Plants, Genes, And Crop Biotechnology, Jones and Bartlett Publishers, 2^{nd} ed. 2003, ISBN-13: 978-0763715861

Scheme of Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	Course with assignment
Quiz -1	15
Test -1	25
Quiz -2	15
Test -2	25
Quiz -3	15
Test-3	25
Self-Study	20
Total	**100**

Scheme of Semester End Examination (SEE):	
Theory (100 Marks)	
Part- –A	20
Objective type questions	
Part –B	80
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
The UNIT-1, UNIT-4 and UNIT-5 should not have any choice. The UNIT-2 and UNIT-3 should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	100

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12
CO1	M	L	-	L	M	-	-		-	-	-	L
CO2	M	M	H	H	M	-	-	M	-	-	L	M
CO3	L	H	L	H	M	L	-	-	-	-	L	-
CO4	M	-	M	H	L	-	-	-	-	-	-	-

High-3 : Medium-2 : Low-1

PROCESS ENGINEERING (Theory and practice)		
Course Code:16BT5A3		**CIE Marks:100=100**
Hrs/Week: L:T:P:S: 3:0:0:4		**SEE Marks:100=100**
Credits: 4		**SEE Duration (Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. To impart the basic concepts of bioprocess technology.
2. To understand and explain the importance of Unit processes and unit operations in process industries.
3. To compare unit processes and individual operations used to produce value added products.
4. To develop flow sheets for various process operations.

UNIT-I	9 hrs

Introduction and overview of Process Technology. Study of chemical industries with reference to process technology, availability of raw materials, preparation of process flow sheet, production trends and future prospects, pollution and major engineering problems. Pulp and paper industry: Different pulping process; Recovery of chemicals from cooking liquors; Paper making; Role of additives. Oil, fats and waxes industry: Physical and chemical properties of oils and fats; Interesterification, transesterification and randomisation; Winning of oils and fats from vegetables and animal source; Refining; Vanaspati, margarine etc.; Waxes; Soaps

UNIT II	9 Hrs

Food and food by-product industry: Sugar, glucose, fructose, starch; Food processing and reservation; Food by- products. Wood and wood chemicals industry: Composite wood, plywood etc.; Manufacture of oleoresin, turpentine, menthol, rosin, and tall oil; Ethanol production; Essential oils, perfumes, flavors and cosmetics.

UNIT III	9 hrs

Leather industry: Skin and hides; Tanning processes; Leather making; Embossing; Leather chemicals. Petrochemical and synthetic chemical industries: Petrochemicals derived from C1 Compounds (Methane and synthesis gas), C2 Compounds (Ethylene and acetylene),C3 compounds (Propylene) to C4 compounds (Butanes and Butenes).

UNIT IV	9 hrs

Fermentation and life processing industries: Production and isolation of Pencillin, Erythromycin, Streptomycin and Insulin. Production of Beer, wine and distilled liquors from fermentation process. Production of citric acid from dextrose glucose sugar

UNIT V	7hrs

Pharmaceutical industries: Classification of drugs; Drug production based on some selected unit Processes. Agrochemical industries: Manufacturing process of some important pesticides, insecticides, fungicides, fumigants, plant growth regulators, yield stimulators and herbicides

Course Outcomes: After completing the course, the students will be able to

1	Understand and explain the fundamental concepts of bioprocess technology.
2	Analyze and apply various unit processes and unit operations in various process industries.
3	Develop the flow diagram and explain manufacturing process of different value added products.
4	Identify and solve engineering problems during production.

Text Books

1. G.T. Austin,, “Shreve’s Chemical Process Industries”, McGraw-Hill Book Co. New York, 5th edition 1984. ISBN: 0070661677, 9780070661677.

2. C.E Dryden,., “Outlines of Chemical Technology”, Affiliated East-West Press, 2nd edition, 1993. ISBN: 10:8185938792, 13:978-8185938790.

Reference Books

3. “Chemtech” Volume I-IV, Chemical Engineering Education Development Centre, I.I.T., Madras.

4. S.D.Shukla, G.N.Pandey, A text book of Chemical technology, Sangam Books, 3rd edition, 2000. ISBN: 13:9780706904635.

(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units.	
Each question should be for maximum of 16	
Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not	**80**
have any choice.	
The **UNIT-2 and UNIT-3** should have an internal Choice	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	-	-	-	M	M	L	L	-	-	M
CO2	M	L	-	-	-	L	-	-	L	-	-	L
CO3	L	H	M	H	-	M	M	-	L	-	-	M
CO4	H	H	L	-	-	M	-	-	-	-	-	L

High-3 : Medium-2 : Low-1

DATA STRUCTURES IN C AND C++ (THEORY)		
Course Code:16BT5A4		**CIE Marks:100**
Hrs/Week: L:T:P:S: 3:0:0:4		**SEE Marks:100**
Credits:04		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. Explore conceptually programming applications in the domains of Life sciences and in general study the role of computer science in life sciences
2. Acquire knowledge of the Object Oriented Programming and Advanced programming skills in Data Structures in C and C++
3. Study data structures Stack, Queue, Linked Stack and queues, Trees and Tables
4. Understand the importance of various data structures to solve the problems related to High throughput Data analysis
5. Explore practically the applications of various data structures along with object oriented programming.

UNIT-I	9Hrs

Stacks: Introduction to data structures and Standard Template Library. Pointers, Generic types and templates, and structures. Stack specifications, Lists and Arrays. Implementation of Stacks, Application of stack - Reversing a list. **Queues:** Definitions, Queue Operations, Extended Queue Operations, Implementations of Queues - Circular Implementation of Queues. **Linked Stacks and Queues:** Linked stacks, Linked stacks with safeguards - Destructor, Overloading Assignment Operator and Copy Constructor. Modified linked-stack specification. Linked queues - Basic declarations, Extended linked queues.

UNIT II	9Hrs

Recursion: Introduction to Recursion, Stack Frames for Subprograms, Tree of Subprogram Calls, Factorials: A Recursive Definition, Divide and Conquer (Towers of Hanoi). Tail Recursion and Refinement. **Lists and Strings:** List definition, Method specifications, Implementation of lists, Class templates, Contiguous implementation, Simply linked and Doubly Linked implementation of Lists. Strings - Strings in C++, Implementation of strings, String operations. Linked lists in Arrays.

UNIT III	9Hrs

Searching: Searching: Introduction Basic search types - Sequential search, Binary search, Ordered lists. Algorithm Development and Asymptotics – Introduction, Orders of Magnitude, Big-O and Related Notations. **Sorting:** Introduction, Sort types – Bubble sort, Insertion sort, Merge sort, Selection sort, Shell sort, Divide-and-Conquer sorting, Merge sort for linked lists, Ordered insertion. Linked version. Analysis - Algorithm, Contiguous implementation and Comparisons. Analysis of Merge sort. Quick sort for Contiguous lists, Partitioning the list, Analysis of Quicksort, Comparison with Merge sort. Heaps and Heapsort, Analysis of Heapsort.Two-Way trees as lists.

UNIT IV	9 Hrs

Tables and Information Retrieval: Introduction. Tables of various shapes, Triangular tables, Rectangular tables Jagged tables, Inverted tables. Hashing and Sparse tables. Collision resolution with Open Addressing, Collision Resolution by Chaining. **Trees:** Basic terminology. Binary trees - Binary tree representation, algebraic Expressions, Complete binary tree, Extended binary tree, Array and Linked representation of Binary trees. Traversing binary trees, threaded binary trees. Traversing Threaded binary trees, Huffman algorithm.

UNIT V	9 Hrs

Graphs: Terminology & Representations, Graphs &Multi-graphs, Directed Graphs, Sequential representations of graphs - Adjacency matrices, Traversal, Connected component and Spanning Trees, Minimum Cost Spanning Trees and algorithms.

Course Outcomes: After completing the course, the students will be able to	
1	Define and explain concepts of Object Oriented Programming along with the possible data structures
2	Apply Object Oriented programming and data structures to solve the problems in the area of Big Data Analytics
3	Analyze and evaluate both set of sorting and searching algorithms with case studies
4	Design and implement algorithms to perform high throughput data analysis in the field Sequence and structure analysis

Text Books

1. Adam Drozdek. Data Structures and Algorithms in C++. Cengage Learning, 4th ed., 2012. ISBN: 9781285415017.
2. Rajesh K. Shukla. Data Structures Using C & C++. Wiley India Pvt. Limited, 2009. ISBN: 9788126519972.

Reference Books

1. Brijendra Kumar Joshi. Data Structures and Algorithms in C++. Tata McGraw-Hill Education, 2010. ISBN: 9780070669109
2. Stefan Brandle, James Robergé, Jonathan Geisler, David Whittington. C++ Data Structures: A Laboratory Course. Jones & Bartlett Publishers, 2010. ISBN: 9781449660987.

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	**80**
The **UNIT-2 and UNIT-3** should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	L	H	M	-	-	M			
CO2	M	H	H	L	H	L	-	-		M	L	
CO3	L	L	H	M	H	L	-	-	L	L	L	
CO4	H	L	L	L	M	H	-	-				

High-3 : Medium-2 : Low-1

Global B

BIOINFORMATICS (Theory)		
Course Code: 16GE5B1		**CIE Marks:100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks:100**
Credits:04		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. Understand the underlying technologies of Bioinformatics and Programming
2. Explore the various algorithms behind the computational genomics and proteomic structural bioinformatics, modeling and simulation of molecular systems.
3. Apply the tools and techniques that are exclusively designed as data analytics to investigate the significant meaning hidden behind the high throughput biological data.
4. Analyze and evaluate the outcome of tools and techniques employed in the processes of biological data preprocessing and data mining.
5. Use effective tools and powerful techniques to compose innovative ideas to tackle potential challenges in the field of Biotechnology and chemical engineering.

UNIT-I **9hrs**

Biomolecules: Introduction to Biomolecules. Structure, Types and Functions of Carbohydrates, Lipids, Nucleic Acids and Proteins. Genetic code, Codon degeneracy, Genes and Genomes. **Bioinformatics & Biological Databases:** Introduction to Bioinformatics, Goals, Scope, Applications in biological science and medicine. Biological databases – Sequence, structure, Special Databases and applications - Genome, Microarray, Metabolic pathway, motif, and domain databases. Mapping databases – genome wide maps. Chromosome specific human maps.

UNIT II **9hrs**

Sequence Alignment: Introduction, Types of sequence alignments - Pairwise and Multiple sequence alignment, Alignment algorithms (Needleman & Wunch, Smith & Waterman and Progressive global alignment). Database Similarity Searching- Scoring matrices – BLOSSUM and PAM, Basic Local Alignment Search Tool (BLAST), and FASTA. Next Generation Sequencing – Alignment and Assembly. **Molecular Phylogenetics:** Introduction, Terminology, Forms of Tree Representation. Phylogenetic Tree Construction Methods - Distance-Based & Character-Based Methods and Phylogenetic Tree evaluation.

UNIT III **9hrs**

Predictive methods: Predicting secondary structure of RNA, Protein and Genes – algorithms to predict secondary structure of RNA, Protein and Gene. Prediction of Tertiary structure of Protein, Protein identity and Physical properties of protein. **Molecular Modeling and Drug Designing:** Introduction to Molecular Modeling. Methods of Molecular Modeling and Force Fields used in Molecular Modeling. Drug designing process - deriving Pharmacophore, Receptor Mapping, Estimating Receptor-Ligand interactions and Molecular Docking.

UNIT IV **9 hrs**

Perl: Introduction to Perl, writing and executing a Perl program. Operators, Variables and Special variables. Data Types – Scalar, Array and Associative array. Regular Expressions (REGEX), Components of REGEX - Operators, Metacharacters and Modifiers. Subroutines – types of functions, defining and calling functions in Perl, calling function - call by value and call by reference. Object Oriented Programming in Perl – Class and object, Polymorphism, inheritance and encapsulation. Perl Package – writing and calling package. Perl Module – writing and calling module.

UNIT V	9 hrs

BioPerl: Introduction to BioPerl, BioPerl Modules, Applications of BioPerl – Sequence retrieval from Database and submission of sequence to online Database, Indexing and accessing local databases, Transforming formats of database record, Sequence alignments BioPerl and Sequence Analysis - Pair wise and Multiple sequence alignment, Restriction mapping. , Identifying restriction enzyme sites, acid cleavage sites, searching for genes and other structures on genomic DNA, Parsing BLAST and FASTA results. BioPerl and phylogenetic analysis, BioPerl and Phylogenetic tree manipulation, creating graphics for Sequence display and Annotation.

Course Outcomes: After completing the course, the students will be able to

CO1	Understand the Architecture and Schema of online databases including structure of records in these databases.
CO2	Explore the Mind crunching Algorithms, which are used to make predictions in Biology, Chemical Engineering, and Medicine.
CO3	Apply the principles of Bioinformatics and Programming to the problems related to process simulation and process engineering in Biological system.
CO4	Use Bioinformatics tools and Next Generation Technologies to model and simulate biological phenomenon.

Text Books

1. T. Christiansen, B. D. Foy, L. Wall, J. Orwant, Programming Perl: Unmatched power for text processing and scripting, O'Reilly Media, Inc., 4th edition, 2012, ISBN-13: 978-0596004927
2.
3. B. Haubold, T. Weihe, Introduction to Computational Biology: An Evolutionary Approach, newagepublishers, Paperback Edition, 2009, ISBN-13: 978-8184890624
4.

Reference Books

3. C. Bessant, I. Shadforth, D. Oakley, Building Bioinformatics Solutions: with Perl, R and MySQL, Oxford University Press, 1st edition, 2009, ISBN

4. D. C. Young. Computational Drug Design: A Guide for Computational and Medicinal Chemists,Wiley-Interscience, 1st edition, 2009, ISBN-13: 978-0470126851.

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units.	
Each question should be for maximum of 16	
Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not	**80**
have any choice.	
The **UNIT-2 and UNIT-3** should have an internal	
choice.	
Both the questions should be of the same	
complexity in terms of COs and Bloom's	
taxonomy level.	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	M	H	M	H	H			L	M	
CO2	H	H	H	M	H	H	M		M			
CO3	H	M	M	M	M	L	L				L	
CO4	L	M	H	H	H	M	L			M		

High-3 : Medium-2 : Low-1

MICROBIAL BIOTECHNOLOGY						
Course Code	**:**	**16BT62**		**CIE Marks**	**:**	**100+50=150**
Hrs/Week	**:**	**L:T:P:S 3:0:2:4**		**SEE Marks**	**:**	**100+50=150**
Credits	**:**	**05**		**SEE Duration**	**:**	**03 hour**

Course Learning Objectives (CLO): Students shall be able to

1. Apply the basic techniques of genetic engineering in the field of microbial biotechnology.
2. Develop methodology for the isolation and screening of recombinants.
3. Develop the fermentation processes for the production of foods, beverages, amino acids, vitamins and antibiotics.
4. Describe the role of microorganisms in mineral recovery and alternative fuel production.

Unit – I **07 Hrs**

Introduction to Microbial Biotechnology: Scope and Applications of Microbial Biotechnology, Microbial Production flow sheet, Microbial biomass, Microbial Enzymes, Microbial Metabolites and recombinant products. Isolation of industrially important microorganisms, preservation techniques of microbes, Strain development by various methods and isolation of fermentation products.

Unit – II **07 Hrs**

Microbial production of proteins and enzymes: Production of therapeutic agents-Pharmaceuticals (engineering human growth hormone), production of antibodies in *E coli.*, Production of attenuated vaccines (for cholera). Microbial insecticides- Cry (Bt) proteins, Enzymes-Alginate lyase and restriction endonucleases.

Unit – III **07 Hrs**

Microbial products in beverage and food industry: Single cell protein production (SCP eg. Yeast) Beverages-Beer and wine. Acids- Citric and lactic acid. Enzymes- Amylase, Lipase. Biopolymers (Xanthan gum). Fermented foods (yoghurt and cheese). Cultivation of Mushroom.

Unit – IV **07 Hrs**

Microbial production of primary and secondary metabolites: Amino acids (glutamic acid and lysine), vitamins (B12, riboflavin and carotenoids), Antibiotics (β lactams, aminoglycosides, macrolides and tetracyclines)- Improving antibiotic production.

Unit – V **08 Hrs**

icrobes in environmental biotechnology: Degradative capabilities of microorganisms, Degradation of xenobiotics, Genetic engineering of biodegradative pathways (Manipulation by transfer of plasmids and by gene alteration), Microorganisms in mineral recovery and removal of metals from aqueous effluent, Production of Biofuels (ethanol, methane and hydrogen).

Lab Experiments

1. Wine production and estimation of alcohol content.
2. Preparation of baker's yeast from molasses.
3. Cultivation of algae (Spirulina).

4. Production and estimation of citric acid.
5. Fungal amylase production and assay of amylase activity.
6. Production of ethanol by immobilized cells.
7. Determination of order and rate constant in batch reactor.
8. Determination of order and rate constant in a continuous stirred tank reactor.
9. Residence time distribution studies in plug flow reactor.
10. Residence time distribution studies in continuous stirred tank reactor.

Self study topics :
1: CFD applications in Microbial Processes.
2: MiniTab Utilization for Optimization.

Course Outcomes: After going through this course the student will be able to:

1. Remember the basic principles to identify and produce compounds from microbial culture using bioreactor.
2. Understand the genetics and biosynthetic pathways of microbes for sustainable solutions.
3. Create and evaluate genetically modified microorganisms for production of primary, secondary and recombinant metabolites.
4. Apply methodology for production and extraction of products from microbial cultures under controlled condition.

Text Books:

1	Glazer,A. N. and H. Nikaido; Microbial Biotechnology; Fundamentals of Applied Microbiology. Cambrige University Press; 2 edition, 2013.ISBN-13: 978-0521842105.
2	Arumugam N , A Mani, Dulsy Fatima, V Kumaresan, A M Selvaraj, L M Narayanan., Microbial Biotechnology., Saras Publication., First Edition. 2007, ISBN-13: 978-8189941260.

Reference Books:

1	Rajesh Arora., Microbial Biotechnology: Energy and Environment., CAB International., 2012. ISBN: 9781845939564.
2	Glick, B.R. J.J.Pasternak and C.L Patten; Molecular Biotechnology – Principles and applications of recombinant DNA; ASM Press; 4th edn; 2016; ISBN: 978155581498.
3	Y K Lee, Microbial Biotechnology-Principles and Applications, World Scientific Publishing Co Pte Ltd 2013 ISBN-13: 9789814513098
4	P.F. Stanbury, A Whitaker. and S. Hall. Principles of Fermentation Technology; Aditya Books Pvt Ltd. New Delhi; 2ndedn; 2003. ISBN: 8185353425.

Continuous Internal Evaluation (CIE)				
(Theory – 100 Marks)		(Laboratory- 50 Marks)		Total (150)
Evaluation method	**Course with assignment**			
Quiz -1	10	Performance of the student inthe laboratory, every week	40	
Test -1	25			
Quiz -2	10	Test at the end of the semester	10	
Quiz -3	10			
Test -2	25			
Self study	20			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory(50 Marks)**		**Total (150)**
Part- –A Objective type questions	**20**	**Experiment Conduction with proper results**	40	
Part –B	**80**	**Viva**	10	
There should be five questions from five units.Each question should be for maximum of 16 marks The UNIT**-1, UNIT-4 and UNIT-5** should nothave any choice. The **UNIT-2 and UNIT-3** should have an internalchoice.Both the questions should be of the samecomplexity in terms of COs and Bloom'staxonomy level.				
Total	**100**	**Total**	**50**	**150**

Mapping of COs with POs												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12
CO1	M	-	-	M	H	-	-	-	-	-	-	-
CO2	H	H	H	H	H	H	-	-	-	-	-	M
CO3	H	H	M	H	H	M	L	H	M	-	-	-
CO4	L	M	H	H	-	H	H	-	-	-	-	-

High-3 : Medium-2 : Low-1

Semester VI		
PROCESS DYNAMICS & CONTROL (Theory and practice)		
Course Code:16BT63		**CIE Marks:100+50=150**
Hrs/Week: L:T:P:S: 3:0:2:4		**SEE Marks:100+50=150**
Credits:05		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to

1. Formulation of dynamic models based on fundamental laws.
2. Understand the different modes of control system, components of control system and analyze the response of controllers for various types of inputs.
3. Solve linear dynamic models of first and second order systems.
4. Determine the stability of a closed-loop feedback control system and know how to tune a single-loop controller for better response.

UNIT-I	**7 Hrs**

First order systems: Laplace transforms: Laplace transformation of standard functions, derivatives and integrals, inversion. Transfer functions, forcing functions, transient response, physical examples o first order systems: mercury in glass thermometer, liquid level system, mixing process in tanks and stirred tank reactors. Linearization of non-linear I order systems.
Response of first order system in series: interacting and non-interacting systems.

UNIT II	**7 Hrs**

Second order systems: Terms of second order under damped process, examples of second order systems: U-tube manometer, Damped vibrator, Underdamped, critically damped and over damping, transient response,. Transportation lag.

UNIT III	**7 Hrs**

Controllers: Controllers, components of a control system, closed loop and open loop control systems, transfer functions for two position, proportional, Proportional +Reset (P+I), Proportional + Rate (P+D), Proportional + Reset +Rate controller (P+I+D).
Final Control element: actuators, valve body, valve characteristics.

UNIT IV	**8 Hrs**

Closed loop systems: Control System, servo and regulator problem, Overall transfer function for single-loop systems and multiloop control system, overall transfer function for set-point change and load change. Lumped and distributed parameter system. Transient response of simple control systems

UNIT V	**7 Hrs**

Stability: Concept of Stability, Stability criterion, Routh Herwitz test for stability, Root Locus method.
Frequency Response: Bode diagrams for first, second order, systems and controllers, Bode stability criterion, Ziegler-Nichols tuning of controller settings.

Self Study: 1.Formulation of dynamic models of realistic processes. 2. Evaluation of dynamic behaviour of linear first-order systems and compare with the experimental results	1credit: 4Hrs/Week

LAB EXPERIMENTS

1.Time constant determination and response to step change of Thermometer: First order
2. Single tank system: First order
3. Non interacting First order elements in series
4. Interacting First order elements in series

5. U tube manometer: II order system
6. Characteristics of thermistors and RTD studies
7. Determination of pH in a process.
8. Flow controller (P, I, D, PID controllers)
9. Pressure controller (P, I, D, PID controllers)
10. Control valve characteristics
11. Temperature controller (P, I, D, PID controllers)
12. Controller tuning

Note: Each student has to perform 12 experiments in semester.10 Experiments are guided experiments, 02 experiments are involving experiential learning.

Course Outcomes: After completing the course, the students will be able to

CO1	Understand and write the transfer functions for First and second order systems
CO2	Analyze the response of first order, second order and controllers for various types of forcing functions
CO3	Develop overall transfer function for closed loop control systems
CO4	Evaluate the stability of the control systems and know the design of modern hardware and instrumentation needed to implement process control.

Text Books

1. Steven E.LeBlanc and Donald R. Coughanour; Process System Analysis and Control; McGraw Hill, New Delhi, 3rd Edition, 2009, ISBN-978- 0073397894.
2. R.P.Vyas; Process Control and Instrumentation; Denett & Company, 4th Edition, 2010, ISBN 978-8189904050.

Reference Books

1. Luyben; Process Modeling, Simulation and Control for Chemical Engineers; McGraw Hill, 2nd Edition, 1990; ISBN-978-0071007931.
2. D.G.Peacock,J.F.Richardson; Coulson and Richardson's Chemical Engineering; vol 3, Pergamon Press, 3rd Edition, 2006, ISBN 978-8131204528.
3. George Stephanopoules; Chemical Process Control, An Introduction to Theory and Practical; Pearson Education, 1st Edition, 2015, ISBN: 978-9332549463.

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)		**(Laboratory- 50 Marks)**		**Total**
Evaluation method	**Course with self study**			
Quiz -1	10	Performance of the student in the laboratory, every week	40	
Test -1	25			
Quiz -2	10			
Quiz -3	10			
Test -2	25	Test at the end of the semester	10	
Self study	20			
Total	**100**	Total	50	**150**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory(50 Marks)**		**Total (150)**
Part- –A	**20**	Experiment Conduction with proper results	40	
Objective type questions				
Part –B	**80**			
There should be five questions from five units.		Viva	10	
Each question should be for maximum of 16				
Marks.				
The **UNIT-1, UNIT-4 and UNIT-5** should not				
have any choice.				
The **UNIT-2 and UNIT-3** should have an internal				
choice.				
Both the questions should be of the same				
complexity in terms of COs and Bloom's				
taxonomy level.				
Total	**100**	**Total**	**50**	**150**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	-	M	-	-	-	-	-		
CO2	H	H	-	-	-	-	-	-	-	-	-	-
CO3	H	H	H		M	-	-	-	--	-	-	--
CO4	H	H	M	M	H	M	-	-	L	-	--	-

High-3 : Medium-2 : Low-1

GENOMICS AND PROTEOMICS		
Course Code: 12BT64		**CIE Marks: 100**
Hrs/Week: L:T:P:S: 3:2:0:0		**SEE Marks: 100**
Credits: 04		**SEE Duration: : 03 Hrs**

Course Learning Objectives: Students will be able to

1. Understand the molecular aspects of the genome.
2. Develop the concepts and principles underlying the human genome project and other genome program.
3. Differentiate between the different structures and functions of the proteome.
4. Identify genetic markers for breeding purposes.

Unit – I	06 Hrs

Introduction: Eukaryotic genes and Polymorphisms: Organization of eukaryotic (microbial, plant and animal genomes) within nucleus, transcription, post transcriptional modification, translation, post translational modification and Inheritance pattern. Mitochondrial and chloroplast genome. Polymorphism. C-Values of eukaryotic genomes.

Unit – II	07 Hrs

Sequencing and genome projects: Early sequencing efforts, Methods of preparing genomic DNA for sequencing, **Sequencing strategies**: shot-gun approach, clone contig approach, **DNA sequencing methods:** Gilbert and Maxim, Sanger Dideoxy method, Fluorescence method, Highthroughput sequencing. **Major genome sequencing projects:** *E.coli, Saccharomyces cerevicea,* rice, *Arabidopsis thaliana, Drosophila melanogaster, Caenorhabditis spp* for human disease and drug targets.

Unit – III	07 Hrs

Genomics: Expressed sequenced tags (ESTs) - Human disease & drug targets. Gene variation & Single Nucleotide Polymorphisms (SNPs) - drug discovery, disease association, diagnostic genes, comparative genomics. **Functional genomics:** Finding genes in the genome, assigning functions to the gene. **Genotyping** – DNA chips and diagnostics assays, RT-PCR, SAGE & DD-PCR. Importance of non coding sequences – miRNA and RNAi.

Unit – IV	08 Hrs

Genome analysis: Molecular markers in genome analysis, principal classes of markers: Repetitive and coding sequences. DNA Fingerprinting - RFLPs & AFLPs. DNA amplification markers RAPDs, SCAR, microsattelites – simple sequences repeats (SSR) and inter simple sequence repeats (ISSR), Allozymes and Isozymes, Telomerase as molecular markers, FISH-DNA amplification markers. Types of mapping and their usefulness to plant and animal breeding.

Unit – V	0 8 Hrs

Proteomics: Methods of protein isolation, purification and quantification, protein separation in 2-DE, staining of 2DE gels, Image analysis of 2DE gels, **Analysis of proteins**: High throughput proteome analysis by stable isotope labelling. Mass-spec based protein analysis, **Protein – protein interactions:** C0- Immuno precipitation, Y2H and its variants, protein chip interaction detection techniques, Applications of proteome analysis to drug development.

Course outcomes: On completion of this course students will be able to

1. Understand and remember the concepts of various genes and their expression.
2. Apply various large scale sequencing methods for sequencing various organisms genome.
3. Acquire and evaluate the methods involved in analysis of genome and proteome.
4. Develop or create a diagnostic tool for plant, animal and human diseases.

Text Books

1. Genome analysis and Genomics- S.B Primrose and R M Tayman, Wiley-Blackwell 3rd Ed.,2002 ISBN: 978-1-4051-0120.
2. D.C Liebler; Introduction to Proteomics; Humana Press; 2002; ISBN:0896039927.

Reference Books

1	B Lewis; Genes X; Jones and Bartlett publications; 9th edn; 2011; ISBN: 9780763766320
2	Savithri Bhat; Genomics; Duckworth Press; 1st edn; 2007; 1st edn;ISBN: 9788190469913

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)

Evaluation method	Course with assignment
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
assignment	10
Total	**100**

Semester End Evaluation (SEE)

Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice	**80**
The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping											
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	-	-	-	-	-	--	-	-	-	-	-
CO2	L	H	H	M	L	-	-	-	-	-	-	-
CO3	H	H	H	L	H	-	-	-	--	--	-	-
CO4	L	H	H	L	H	-	-	-	-	-	-	-

High-3 : Medium-2 : Low-1

CLINICAL TECHNOLOGY
(Theory)

Course Code: 16BT6C1		**CIE Marks:100**
Hrs/Week: L:T:P:S: 3:0:0:4		**SEE Marks:100**
Credits: 4		**SEE Duration (Theory) : 3Hrs**

Course Learning Objectives: The students will be able to

1. Study cell and tissue culture techniques relate to healthcare
2. Provide framework in which clinical technology can be understood in the field of science and technology
3. Learn to use electronic tools for development of clinical records, ehealth and ethics.
4. Know fundamental methods used to facilitate the integration of software and hardware development for variable and mobile health monitoring system.

UNIT-I — 9 Hrs

Stem Cells: Concepts and Types of Stem cells: Embryonic, Adult and Induced. Embryonic stem cells: Pluripotent, Totipotent and Multipotent Cells. Adult stem cells, the tissue specific cells: Hematopoietic, Epidermal and Epithelial stem cell. Induced pluripotent stem cells.
Cell culture methods, Cell isolation, selection, maintenance of primary and early passage cultures. Clinical potential of stem cells: Organ and tissue regeneration, cardiovascular treatment, Cell deficiency therapy, treatment of any brain related defects.

UNIT II — 9Hrs

Tissue Engineering: History and scope of tissue engineering. The isolation and handling of human and animal tissue. The major methods of preparing a primary culture.Introduction to cell adhesion: cell–cell adhesion, cell–matrix adhesion and signalling, cell proliferation, and differentiation.Tissue engineering for tissue regeneration: using bone marrow mesenchymal stem cells (MSCs) and adipose derived stem cells (ASCs). Therapeutic strategy for repairing the injured spinal cord using stem cells. Wound and Disc repair using stem cells. Engineering of tissues: cartilage, bone and skin.

UNIT III — 9Hrs

E-Health Record & Telemedicine: Technologies and sources of clinical and biomedical information in order to obtain, organise, interpret and convey clinical, scientific and health-related information; Consumer health informatics, transmission and maintenance of e-health records, Clinical decision support system (CDSS), features and characteristics of CDSS, Principles of telemedicine; implementation of the principles of telemedicine based on (the best) evidence.Real-time interactive telemedicine, Telenursing, Tele-pharmacy, Teletransmission of ECG, Teleradiology, Regulatory issues in telemedicine and respective practices in India, Framework of Health Information Technology (HIT).

UNIT IV — 9Hrs

Wearable Health System: Architecture of wearable health monitoring systems (WHMS), WHMS hardware components, WHMS implementation walkthrough, Biosensors and Biosignals, wireless communication standards, wireless data transmission, commercially available WHMS, Research and development in WHMS, IT-based health management solutions, need of WHMS with embedded decision support, User-device interaction and system simulation.

UNIT V — 9Hrs

Information security: client-server architecture, Health Information System (HIS) standards and framework, components of HIS, 360 degree patient centricity solutions, laboratory information system, clinical data repository, Primary and secondary data, importance of clinical data quality and standards, quantitative and qualitative analysis of medical records, clinical coding and data collection, clinical data and statistics, ethical issues in patient safety, understanding risk in patient safety research – social risk, psychological risk, economical risks; Risk assessment.

Course Outcomes: After completing the course, the students will be able to

CO1	Explain type of stem cells, their properties and clinical applications.
CO2	Apply cell culture/ tissue regeneration techniques to heal injured tissues.
CO3	Illustrate the architecture of wearable health monitoring systems and its role in health management.
CO4	Compare current practices of data collection with digital repository or clinical data, and risk involved & ethical issues.

Text Books

1. Pavlovic M and Balint B, Stem Cells and Tissue Engineering, Springer, 2012, ISBN-10-1461455049.
2. Cruz-Cunha MM, Tavares AJ and Simoes R, Handbook of research on developments in E-health and telemedicine: Technological and Social Perspectives (2 volumes), Medical Information Science Reference, 2009 ISBN-10-1615206701

Reference Books:

1. Freshney RI, Culture of Animal Cells: A Manual of basic technique and specialized Applications, Wiley, 2011, ISBN: 9780470528129
2. Bonfiglio, Annalisa, De Rossi, Danilo (Eds.).2011. Wearable Monitoring Systems. ISBN 978-1-4419-7384-9
3. Berner, E. S., & La Lande, T. J. (2007). Overview of Clinical Decision Support Systems. In E.S. Berner (Eds.), Clinical Decision Support Systems. New York: Springer. 10.1007/978-0-387-38319-4_1
4. Bernard Fong, A. C. M. Fong, C. K. Li. (2010). Telemedicine Technologies: Information Technologies in Medicine and Telehealth. ISBN: 9780470972151.
5. Lewis, Deborah; Eysenbach, Gunther; Kukafka, Rita; Stavri, P. Zoe; Jimison, Holly B., eds. (2005). Consumer health informatics: informing consumers and improving health care. Health informatics (illustrated ed.). New York: Science & Business Media. ISBN 978-0-387-23991-0. OCLC 898862674

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)

Evaluation method	Course with assignment
Quiz -1	10
Test -1	25
Quiz -2	10
Quiz -3	10
Test -2	25
Self Study	20
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	
Objective type questions	**20**
Part –B	
There should be five questions from five units. Each question should be for maximum of 16Marks. The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**80**
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	L	L	-	-	M	M	-	L
CO2	M	M	M	M	H	L	-	-	M	M	-	L
CO3	M	M	M	M	M	M	L	-	M	M	-	L
CO4	M	H	M	H	H	L	M	**M**	-	M	-	L

High-3 : Medium-2 : Low-1

FOOD ENGINEERING		
Course Code: 16BT6C2		**CIE Marks: 100**
Hrs/Week: L:T:P:S 3:0:0:4		**SEE Marks: 100**
Credits: 04		**SEE Duration: 03 Hrs**

Course Learning Objectives: The students will be able to

1. Get an insight of food processes namely pasteurization, blanching, sterilization ,extrusion processes
2. Understand the principles of evaporation, drying and freezing techniques
3. Learn about the advances in thermal and nonthermal methods of food processing
4. Able to understand the principle and working of techniques of instruments used in food analysis and sensory evaluation and get an overview of packaging of food materials, design of packaging material and innovative techniques of food packaging

UNIT – I	06 Hrs

Food Processing Systems: Basic principles of pasteurization, blanching, sterilization ,extrusion processes. Ultra high pressure systems and pulsed electric fields. Microbial survivor curves, influence of external agents, thermal death time. General method for process calculation for Pasteurization, sterilization and aseptic processing and packaging. numericals.

UNIT– II	07 Hrs

Food Preservation Methods: Basic principle of evaporator and types (natural circulation, rising film, falling film, agitated thin film evaporators). Basic principles of dryer and types (Tray, tunnel, fluidized bed and spray dryers). Food freezing systems- direct and indirect contact systems, frozen food properties (density, thermal conductivity, enthalpy, specific heat thermal diffusivity), freezing time calculation.

UNIT – III	08 Hrs

Advances in food processing: Techniques both thermal and non thermal.Newer techniques in thermal processing - Retort processing, UHT, Extrusion - hot and cold Ohmic heating, pulsed electric field, high-intensity light pulses, radio-frequency heating, microwave, thermo-sonication, modified atmosphere, enzymic processing and hurdle technology. Advanced Membrane Technology for water and liquid foods and effluent treatment. Application of Microwave for food cooking, dehydration. High hydrostatic processing of foods.

UNIT – IV	08 Hrs

Modern Techniques in Food Analysis and Sensory Evaluation Application of modern techniques including spectroscopy, chromatography including GC, GC –MS, HPLC, HPTLC, gel permeation, ion-exchange, etc. Enzymes in food analysis; Supercritical fluid extraction in food analysis; Rapid methods for detection of food pathogens, biosensors, automation and use of computers in food analysis. Sensory evaluation – different scales, training, skills and importance for consumer acceptance, Quantification of sensory attributes - Artificial Tongue, Artificial Nose.

UNIT – V	06 Hrs

Food packaging: Packaging as a method for conservation of foods; Packaging materials and their physico-chemical characteristics. RTE frozen foods with reference to packaging. Evaluation of quality of packaging materials; Package design; Test procedures for packages; Cushioning

materials; Selection of packaging materials and package design for food products; Prepackaging. Packaging materials for newer techniques like radiation processing, microwave and radiowave processing, high pressure processing, modified atmosphere and thermal processing as retortable pouches; Biodegradable packaging.	
Self study topics 1. Food preservation methods to increase shelf life 2. Tools and techniques for food analysis, sensory evaluation and packaging	1 credit: 4Hrs/Week

Expected Course Outcomes: After going through this course the student will be able to:

1.	Understand and remember the principles of food processing and preservation methods
2.	Apply the knowledge of freezing to calculate food freezing time and understand advanced food processing applications.
3.	Analyze the problems and do the calculations involved in pasteurization, sterilization and aseptic processing and packaging
4.	Evaluate the instrumentation techniques of food analysis, sensory analysis and food packaging materials characteristics

Text books

1.	R. Paul Singh and Dennis R. Heldman, **Introduction to Food Engineering,** Academic Press, Elsevier, 5th ed., 2013. ISBN 9780123985309
2.	Fellows, P.J, Food processing Technology: Principles and Practice, Woodhead Publishing limited, Cambridge, 2nd edition, 2009. ISBN 978-1-84569-216-2

Reference Books

1.	Sablani S., Rahman M, Handbook of Food and Bioprocess Modeling, CRC press, 1st ed., 2006. ISBN 9780824726713
2.	Romeo T. Toledo, Fundamentals of Food Process Engineering, Springer, 3rd ed., 2007. ISBN-13: 978-0-387-29019-5
3.	Murlidhar Meghwal, Megh R. Goyal, Food Process Engineering: Emerging Trends in Research and Their Applications, CRC press, 1st ed., 2016. ISBN 9781771884020
4.	Amit K. Jaiswal, Food Processing Technologies: Impact on Product Attributes, CRC Press, 1st ed., 2016. ISBN 9781482257540

Continuous Internal Evaluation (CIE)	
Theory (100 Marks)	
Evaluation method	**Course with Self study**
Quiz -1	10
Test -1	25
Quiz -2	10
Quiz -3	10
Test -2	25
Self study	20
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	**80**
The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L	L	L	L	--	--	--	--	--	M
CO2	L	H	M	L	L	L	--	--	--	--	--	M
CO3	M	M	M	L	L	L	--	--	--	--	--	M
CO4	M	L	H	L	L	L	--	--	--	--	--	M

High-3 : Medium-2 : Low-1

FERMENTATION TECHNOLOGY						
Course Code	**:**	**16BT6C3**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 3:0:0:4**		**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**03 hour**

Course Learning Objectives (CLO): Graduates shall be able to

1. Develop the conceptualization for production of industrial biotechnological products by using industrial microbes and raw materials.
2. To design the fermentor for the growth of culture.
3. To develop the production flow sheet for primary, secondary and recombinant products.
4. To comprehend different process controllers involved in the fermentation process.

Unit – I	07 Hrs

INTRODUCTION: Background of fermentation- historical review. Fermentation as a Biochemical process, Microbial biomass, Enzymes, Metabolites recombinant products, general flow sheet for microbial fermentation. **Microbes:** Isolation of industrially important microorganisms, preservation techniques of microbes, Strain development for primary, secondary and recombinants, Mode of operation: batch, fed batch and Continuous.

Unit – II	07 Hrs

Raw Materials and Sterilization: Selection of typical raw materials, Different media for fermentation, Optimization of media, Different sterilization methods – batch sterilization, continuous sterilization, filter sterilization.

Preparation of Inoculum: Introduction to media preparation, nutrient requirements of the cell, Inoculum preparation from laboratory scale to pilot scale and large scale fermentation, maintenance of aseptic conditions.

Unit – III	07 Hrs

Design of Fermenters: Basic structure of fermenter, body construction and space requirements. Description of different parts of fermenter and types of fermenters.

Process Control: Instruments involved in the fermentation: flow rate, temperature, pH, Dissolved oxygen and pressure. Foam sensing and control. Online analysis for substrate and biomass estimation. Computer based data acquisition-SCADA.

Unit – IV	07 Hrs

Aeration and Agitation: Oxygen requirement and Supply of oxygen, fluid rheology, Estimation of Kla by sulphite oxidation technique, Static method of gassing out, Dynamic Methods of Gassing out and Oxygen balance technique (only final equations and graphical analysis), factors affecting Kla and aeration & agitation. Scale up-major factors involved in scaling up and its aeration/agitation regimes in stirred tank reactor and scale down aspects in design of laboratory experiment.

Unit – V	08 Hrs

Industrial Operations: Effluent treatment: Characteristics of effluent from fermentation industries- brewery, antibiotics and organic acids. Methods of Treatment and Disposal: treatment process- aerobic and anaerobic treatment, byproducts. **Economic Aspects:** Economy of fermentation, market potential. Legalization of products like antibiotics and recombinants.

Self study topics :

1. Scale-Down and Scale-Up strategies for Recombinant products.
2. Reactor Design-Agitated, Hallow, Air Bubble, Packed bed and Immobilized Reactor.

Expected Course Outcomes: After going through this course the student will be able to:

1. Remember and understand the processes for isolating the industrial important microorganism for production various biotechnological products.
2. Implement the techniques for fermentation Process and its parameters Optimization.
3. Analyze the scale up techniques, process economics and effluents management.
4. Design fermenter and its accessories involved in the process.

Text Books

1	P. Stanbury, A Whitaker. and S. Hall. Principles of Fermentation Technology; Aditya Books Pvt Ltd. New Delhi; 2ndedn; 2003. ISBN: 8185353425.
2	E. M. T. El-Mansi, C. F. A. Bryce., Fermentation Microbiology and Biotechnology, CRC Press., Third Edition, 12 Jan 2012 ISBN-13: 978-1439855799.

Reference Books

1	Ian McNeil, Linda Harvey., “Practical Fermentation Technology”, John Wiley & Sons., 2008, ISBN: 0470725281.
2	Pauline M. Doran., “Bioprocess Engineering Principles”, 2nd Edition, Academic press, 2012, ISBN: 978-0-12-220851-5.
3	Hui Y.H., Lisbeth Meunier-goddik, JytteJosephen, Wai-kit Nip, Peggy S. Stanfield. “Handbook of Food and Beverage Fermentation Technology”, CRC Publishers 2014, ISBN: 0824751221
4	Henry C Vogel and Celeste L. Todaro., Fermentation and biochemical Engineering Hand Book, Standard publishers distributors, New Delhi; 2nd Edition. 2012. ISBN: 0080946437.

Scheme of Continuous Internal Evaluation (CIE):

(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	15
Test -1	25
Quiz -2	15
Test -2	25
Quiz -3	15
Test-3	25
Self-Study	20
Total	**100**

Scheme of Semester End Examination (SEE):

Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	**80**
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
The UNIT-1, UNIT-4 and UNIT-5 should not have any choice. The UNIT-2 and UNIT-3 should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12
CO1	M	M	-	H	M	-	-	-	L	-	-	-
CO2	M	M	H	L	H	-	-	-	-	-	-	-
CO3	L	H	H	H	M	-	H	L	L	-	-	L
CO4	M	M	H	H	H	-	-	-	M	-	-	-

High-3 : Medium-2 : Low-1

JAVA and J2EE (Theory)		
Course Code:16BT6C4		**CIE Marks:100**
Hrs/Week: L:T:P:S: 3:0:0:4		**SEE Marks:100**
Credits:04		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. Explore conceptually programming applications in the domains of Life sciences and in general study the role of computer science in life sciences
2. Acquire knowledge of the Object Oriented Programming and Advanced programming skills in Java
3. Study Threading, Event management, Database connectivity as well as Web programming in Java
4. Understand the importance of Threading, Event management, Database connectivity as well as Web programming to High throughput Data analysis
5. Explore practically the applications of BioJava to sequence, structure and micro-array data analysis

UNIT-I	8 Hrs

Introduction to Java:
Java and Java applications. Java Development Kit (JDK). Java Basics – Data Bytes, Operators, Statements and Object-oriented programming. Classes, Inheritance. Classes in Java - Declaring a class, Constructors and Creating instances of class. Super classes and Inner classes. Inheritance - Simple, multiple, and multilevel inheritance; Overriding, overloading. Exception Handling and Exception Classes in Java.

UNIT II	8 Hrs

Multi Threaded Programming, Event Handling:
Multi Programming: Extending threads; Implementing rentable. Synchronization, Changing state of the thread. Bounded buffer problems, Read-write problem, Producer-Consumer problems. Event Handling: Two event handling mechanisms, Delegation event model, Event classes; Sources of events; Event listener interfaces. Delegation event model; Adapter classes; Inner classes. Eevnt handling for Buttons, Text boxes, List boxes, radio buttons, Check boxes, slide bars and menu options.

UNIT III	7 Hrs

Applets:
The Applet Class: Two types of Applets, Applet basics, Applet Architecture, An Applet skeleton; The HTML APPLET tag; Passing parameters to Applets, Simple Applet display methods; Requesting repainting; Using the Status Window. getDocumentbase() and getCodebase(); ApletContext and showDocument(); The AudioClip Interface; The AppletStub Interface;
Drawing Lines; Drawing Other Stuff; Color; Mouse Input; Keyboard Input and Output to the Console. Threads and Animation, Backbuffers, Graphics and Painting.

UNIT IV	7 Hrs

Java 2 Enterprise Edition:
The Concept of JDBC; JDBC Driver Types; JDBC Packages; A Brief Overview of the JDBC process; Database Connection; Associating the JDBC/ODBC Bridge with the Database; Statement Objects; ResultSet; Transaction Processing; Metadata, Data types; Exceptions.
Servlets: Background; The Life Cycle of a Servlet; Simple Servlet; The Servlet API. The Javax.servlet Package. Reading Servlet Parameter, Handling HTTP Requests and Responses. Cookies and Session Tracking.

UNIT V	8 Hrs
BioJava: Working with Nucleic Acid and Protein Sequences – create, read, compare sequences. Working with Protein Structures – fetching, parsing PDB structures, Calculating structure alignment, interacting with Jmol. Sequence alignment – performing global, local and multiple sequence alignment. BioJava and Next Generation sequencing Analysis.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Define and explain concepts of Object Oriented Programming along with Threading, Event management, Database connectivity as well as Web programming
CO2	Apply Threading, Event management, Database connectivity as well as Web programming to solve the problems in the area of Big Data Analytics
CO3	Analyze and evaluate efficiency threading and multithreading with case studies
CO4	Design and implement basic algorithms to perform high throughput data analysis in the field Sequence and structure analysis

Text Books

1. Herbert Schildt , Java - The Complete Reference, 9th Edition, 2014, ISBN: 0071808558
2. John Hunt, Chris Loftus, Guide to J2EE: Enterprise Java, Springer Science & Business Media, 2012, ISBN – 9781447100171.

Reference Books

1. Joyce Farrell, Java Programming, Cengage Learning, 8th Edition, 2015, ISBN - 9781305480537
2. Buyya, Java The Complete Reference, 8th Edition, McGraw Hill Professional, 8th Edition, 2011, ISBN - 9780071606318

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units.	
Each question should be for maximum of 16 Marks	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	**80**
The **UNIT-2 and UNIT-3** should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L	M	M	H	H			L	L	
CO2	H	H	H	H	H	H	L		M			
CO3	H	M	M	M	L	M	H				M	
CO4	M	H	H	H	H	L	M					

High-3 : Medium-2 : Low-1

Professional Elective D

MEDICAL INSTRUMENTATION		
Course Code:16BT6D1		**CIE Marks:100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks:100**
Credits:04		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. To study the source of bioelectric signals, propagation of action potential, their transduction and biomedical application
2. To give an insight into the working principle of instruments of cardiovascular measurement, oxymetry and audiometry
3. To understand the applications of imaging such as X-ray, MRI I and ultrasonics n medical diagnostics
4. To get an idea of therapeutic applications of pacemakers, defibrillators, stimulators and diathermy.

UNIT-I	**9 Hrs**

Introduction To Medical Instrumentation: Sources of biomedical signals, basics of medical instrumentation system, different bioelectrical signals. Transducers: Definition, classification and biomedical application. Bio-potential Electrodes, Resting and Action potential, Propagation of Action potential, bioelectric potentials.

UNIT II	**9 Hrs**

Cardiovascular Measurements:

Anatomy of heart, cardiac cycle, Measurement of blood pressure, characteristics of Electrocardiogram (ECG) and its Block diagram description, lead configuration and recorders. Blood flow meters, electromagnetic, ultrasonic , NMR and laser Doppler blood flow meters.
Biotelemetry: wireless telemetry, single channel / multi channel telemetry. implantable telemetry for ecg & temperature, blood pressure / flow.

UNIT III	**8 Hrs**

Blood gas analyzers:

pCO2, pO2, Complete blood gas analyzer, Commercial blood gas analyzer, Pulse oxymetry. In vitro, in-vivo, transmission, ear, fingertip oxymetry, skin reflectance oxymetry.
Blood cells counters: methods of. – microscopic, coultercounter. Audiometers: Mechanism of hearing, requirements of audiometer, calibration of audiometer. Biological effects of radiofrequency and microwave fields

UNIT IV	**9 Hrs**

Diagnostic And Medical Imaging System:

X-Ray: general principles of Imaging, Instrumentation: collimators, X-Ray intensifying Screen, X-ray films. Special imaging techniques for X-rays. Magnetic Resonance imaging (MRI): general principles of MRI, Instrumentation, Magnet design, Magnet field gradient coils, radiofrequency coils, MR Imaging, Clinical application of MRI.

UNIT V	**9 Hrs**

Therapeutic Equipments:
Cardiac pacemakers: External and Implantable pacemakers, Cardiac defibrillators: AC/DC and Implantable defibrillators. Nerve and muscle stimulator, Diathermy: shortwave, microwave and ultrasonic wave.

Ultrasonic Imaging System:
General principle of Ultrasonic Imaging and Instrumentation, Single- Crystal

transducers, Diagnostics scanning modes, Biological effect of ultrasound.

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand the sources of biomedical signals and instruments to measure them.
CO2	Have knowledge of parameters to measure the heart function and conditions in which therapeutic equipments are to be used and precautions taken.
CO3	Appreciate the limitations and potentials of non-invasive imaging systems in medical diagnostics
CO4	Apply audiometry and oxymetry to measure hearing and blood gas concentration.

Text Books

1. Ananda natarajan .R. Biomedical Instrumentation and Measurements. PHI Pub. 2011. ISBN:978-81-203-4227-9.
2. Khandpur R.S. Biomedical Instrumentation Technology and Applications McGraw –Hill Pub. First edition, 2004.ISBN-9780071777469

Reference Books

1. Shakti. Chatterjee, Aubert Miller. Biomedical Instrumentation Systems. Delmar cengage learning Pub.2010.ISBN:139781418018665
2. Mandeep Singh. Introduction to Biomedical Instrumentation.PHI Pub., 2010. ISBN: 9788120341630.

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	15
Test -1	30
Quiz -2	15
Test-2	30
Quiz-3	15
Test-3	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part – A: Objective type questions	20
Part – B: There should be five questions from five units. Each question should be for maximum of 16 marks. **The UNIT – 1, UNIT – 4 and UNIT – 5** should not have any choice. The **UNIT – 2 and UNIT – 3** should have an internal choice. Both the questions should be of the same complexity in terms of Cos and Bloom's taxonomy level.	80
Total	100

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	M	-	-	-	L	M	-	-
CO2	H	H	M	M	M	-	-	-	L	M	-	-
CO3	H	H	M	M	M	-	-	-	L	M	-	-
CO4	H	H	M	M	M	-	--	-	L	M	-	--

High-3 : Medium-2 : Low-1

FOOD AND DAIRY TECHNOLOGY		
Course Code:16BT6D2		**CIE Marks:100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks:100**
Credits:04		**SEE Duration : 3 Hrs**

Course Learning Objectives: The students will be able to

1 Understand concept of food and dairy along its intricacies for better utility
2 Utilize various components and assets of food for good health
3 Comprehend various techniques and tools for increasing shelf life of food
4 Apply the knowledge of various supplements and adjuvants along with packaging for healthier society.
5 Figure out various standards and regulations for quality foods

UNIT-I	**8 Hrs**
History and development of food biotechnology, Application of genetics to food production. Methods of molecular cloning, immobilization of microbial and cultured plant cells. Scope and importance of food processing: national and international perspectives, Principles of Preservation methods, fermentation methods for preservation, and chemical preservations of foods. Food preservation by low-temp: Refrigeration, freezing and freeze-drying. Food preservation by heating: drying, osmotic dehydration, blanching, canning, pasteurization, sterilization, extrusion cooking. Non-thermal preservation: Hydrostatic pressure, dielectric heating, microwave processing, hurdle technology, membrane technology, irradiation. retort processing, concentration and drying	
UNIT II	**7 Hrs**
Contaminants of foods-stuffs, vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing. Biochemical changes caused by micro-organisms, deterioration and spoilage of various types of food products, microbial food fermentation Food poisoning and microbial toxins, standards for different foods. Food borne intoxicants and mycotoxins. Food contaminants, food toxicants. Naturally occurring toxic substances, protease inhibitors, bioactive components: phytates, polyphenols, saponins, phytoestrogens..	
UNIT III	**5 Hhrs**
Water in food, water activity and shelf life of food. Natural food flavours and characterization. Pigments in food and their industrial applications. Energy value of foods. Pathways of metabolism of carbohydrates, proteins, lipids. Enzyme biosynthesis and regulation. Metabolic regulation, Release of energy and its trapping. Metabolic rate and caloric needs, RDAs. Nutrition of dietary fibres. Additives in food processing and preservation. Various additives such as preservatives, antioxidants, emulsifiers, sequesterants, humectants, stabilizers. Colours, flavours, sweeteners, acidulants.	
UNIT IV	**8 Hrs**
Composition of milk, processing of market milk, toning of milk, homogenization, pasteurization, sterilization, storage, transportation and distribution of milk. Milk product processing-cream, butter, condensed milk, evaporated milk, whole and skimmed milk powder. Instantization of milk and milk products, Fermented milk products. Dairy equipments and sanitization. Pasteurisation, sterilization, HTST and UHT processes, Substitutes for milk and milk products. Casein, lactose and other by-products, Weaning foods, therapeutic foods; Fortification and enrichment; Traditional dairy products. Milk confections. Toning of milk, Judging and grading of milk and its products. In-plant cleaning system.	
UNIT V	**8 Hrs**
Introduction to packaging. Basic packaging materials and their properties, types of packaging, packaging design, packaging for different types of foods, Deteriorative changes in foodstuff and packaging methods for prevention, shelf life of packaged foodstuff, methods to extend shelf-life. Retort pouch packing, Biodegradable packaging. Active packaging. Importance and functions of quality control. Methods of quality, assessment of food materials, Sanitation and hygiene, GMP, GLP, Statistical quality control. Food laws and standard, Food Safety and Standards Act India 2006, Prevention of Food Adulteration Act, India, 1954, PFA, AGMARK. Concept of Codex Almentarious/ /USFDA/ISO 9000 series. Food adulteration and food safety. HACCP, Sensory evaluation, Refractometry, Rheology measurements. consumer protection, food audit.	

Course Outcomes: After completing the course, the students will be able to

CO1: Understand the food and dairy components in detail for the healthier society under monitoring and control

CO2:Analyse the various components of food and food safety
CO3: Apply the knowledge of tools techniques for preservation of dairy, dry and other food assets
CO4: Evaluate the significance of food components and its packaging with standards and regulations for the societal benefits

Text Books

1. Selia, dos Reis Coimbra and Jose A. Teixeir 2016 "Engineering Aspects of Milk and Dairy Products" , CRC Press, , ISBN: 1420090399, 9781420090390
2. Parker R. 2003. Introduction to food science. Albany NY: Delmar. 636 p. TP 370 P33 2003
3. Vaclavik VA and Christian EW. 2014 Essentials of food science, 4^{th} ed. New York NY: Springer. ISBN 978-1-4614-9137-8.

Reference Books

1. Batty, J.C. and Folkman, S.L. 1983. Food Engineering Fundamentals. John Wiley and Sons, New York. 9780471056942
2. Heldman D.R. (1992). Food Freezing (eds. D.R. Heldman, and D.B. Lund), 277 pp. Handbook of Food Engineering. New York: Marcel Dekker..
3. Rao M.A. (1997). Engineering properties of foods: current status (eds. P. Fito, E. Ortega-Rodríguez, and G.V. Barbosa-Cánovas), 39-54. Food Engineering 2000.New York: Chapman & Hall: International Thomson Publication.

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)

Evaluation method	Course with assignment
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE) Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
UNIT-1, UNIT-4 and UNIT-5 should not have any choice.	**80**
The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	M	L	-	M	M	L	-	M
CO2	M	H	H	H	H	M	H	M	H	L	-	H
CO3	L	H	H	M	M	H	H	H	M	M	L	M
CO4	M	M	H	L	L	H	H	H	M	H	M	H

High-3 : Medium-2 : Low-1

PLANT DESIGN & ECONOMICS (Theory)				
Course Code	**16BT6D3**		**CIE Marks**	**100**
Hrs/Week	**L:T:P:S: 4:0:0:0**		**SEE Marks**	**100**
Credits	**04**		**SEE duration**	**03 Hrs**

Course Learning Objectives:

1. Explore the technical feasibility, survey safety factors involved during design of biochemical plant.
2. To have knowledge of breakeven analysis, fixed and working capital investment, working production cost and fixed charges.
3. To apply economic concepts to solve biochemical engineering problems.
4. Study of the cost estimation and profitability analysis of a biochemical plant.

UNIT – I	08 Hrs

Process design development: Technical feasibility survey, process design of projects, types of design, process development, process flow diagrams– qualitative, quantitative and combined detail, safety factors and considerations.

UNIT – II	09 Hrs

General design considerations: Plant location- Marketability of the product, availability of technology, raw materials equipment, human resources, land and utilities, site characteristics, waste disposal, government regulations & other legal restrictions, community factors and other factors affecting investment and

production costs. Plant layout- type and quantities of product to be produced, health & safety considerations, new site development, transportation, future expansion etc. Plant operations and control– Instrumentation, maintenance, utilities, structural design, storage, materials handling.

UNIT – III	09 Hrs

Cost estimation: Cash flow for industrial operation, factors affecting investment and production costs. Break even analysis and sensitivity analysis, problems. Capital Investments: Fixed capital investments, working capital investments, estimation of capital investment. Estimation of total product cost, Manufacturing costs: Direct production costs, fixed charges and plant overhead costs. Estimation of total product cost.

UNIT – IV	09 Hrs

Depreciation and interest: Depreciation and methods of determining depreciation, problems. Interests and investment costs, time value of money, income taxes.

UNIT – V	09 Hrs
Profitability analysis and Balance Sheets: Methods of evaluating profitability return on original investment, interest rate of return accounting for uncertainty and variations and future developments. Replacement and alternative investments. Financial statements, cash flow diagrams and Types of design report.	

Course Outcome: At the end of the course the student's will be able to

1. Understand the concept of plant design and development the cost estimation for a chemical or biochemical industry that is essential for the feasibility study.
2. Develop the flow sheet for qualitative and quantitative material flow.
3. Calculate profitability and compare with the standard diagrams.
4. Prepare the cost estimation and company balance sheet.

Text Books

1	T.R. Banga and S.C. Sharma; Industrial organization and Engineering Economics; Khanna Publishers; 24^{th} edition; 2006; ISBN: 9788174090782
2	Peters M. and P. Timmerhaus; Plant Design and Economics for Chemical Engineers; Mc Graw Hill;. 5^{th} edition; 2002. ISBN-10: 0072392665

Reference Books

1	D.F. Rudd and C.C. Watson; Strategy of Process Engineering; John Wiley; 1^{st} edition; 1968; ISBN: 9780471744559
2	F.P.Helmus; Process plant design: Project management from inquiry to acceptance; Wiley-VCH; 1^{st} edition; 2008; ISBN: 9783527313136

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)

Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10

Test -2	30
Assignments	10
Total	**100**
Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	20
Objective type questions	
Part –B	80
There should be five questions from five units.	
Each question should be for maximum of 16	
Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not	
have any choice.	
The **UNIT-2 and UNIT-3** should have an internal	
choice.	
Both the questions should be of the same	
complexity in terms of COs and Bloom’s	
taxonomy level.	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	-	-	-	M	M			-	-	M
CO2	M	H	-	L	-	L	-	-	L	-	-	L
CO3	H	M	L	-	-	L	L	-	L	-	-	L
CO4	M	H	L	-	-		-	-	-	-	-	L

High-3: Medium-2: Low-1

SYSTEMS BIOLOGY (Theory)		
Course Code:16BT6D4		**CIE Marks:100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks:100**
Credits:04		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. To define the field of systems biology and its sub-fields.
2. Identify large-scale methods used in systems biology research and their basic results.
3. Compare different systems biology approaches in their advantages and disadvantages.
4. Apply the knowledge of systems biology to give solution to practical issues.

UNIT-I	**9 Hrs**

Introduction to Systems Biology: Scope, Applications. Concepts, implementation and application. A review of network concepts: properties and modeling of feedback/feed-forward systems. Databases for Systems Biology, Mass Spectrometry and systems Biology. Cell-to-Cell variability, stochastic gene induction, stochastic simulation. Fick's law, Local excitation and Global inhibition theory.

UNIT II	**9 Hrs**

Network Models and Applications: Natural Language Processing and Ontology enhanced Biomedical data mining, text mining. Integrated Imaging Informatics - Integrin, centroid, cell culture. Standard platforms and applications - metabolic control analysis, glycolysis, metabolic network, Michaelis-Menten kinetics, and flux balance analysis. Signal Transduction - phosphorylation, Jak-Stat pathway, MAP kinase. Biological Processes - mitochondria, cyclin, Cdc2. Modeling of Gene Expression - lactose, lac operon, tRNA. Analysis of Gene Expression Data - support vector machines, cDNA microarray. Evolution and Self organization - hypercycle, quasispecies model, self-replication. Reconstruction of metabolic network from Genome Information.Modelling and Analysis of networks-mathematical and statistical methods used to evaluate and analyse large-scale data sets.Network Motifs.

UNIT III	**9 Hrs**

Integrated Regulatory and Metabolic Models - Phosphorylation, Gene expression, and Metabolites. Estimation Modeling and Simulation - Circadian rhythms, Petri net, mRNA. Deterministic - Circadian rhythms, mRNA, Circadian oscillations. Multi scale representations of Cells and Emerging Phenotypes - Gene Regulatory Networks, attractor, and Boolean functions. Mathematical models and Optimization methods for De Novo Protein design. Global Gene expression assays. Mapping Genotype - Phenotype relationship in cellular networks. Network motifs in biology.

UNIT IV	**6 Hrs**

Multiscale representations of cells and Emerging phenotypes: Multistability and Multicellurarity, Spatio-Temporal systems biology, Interactomics, Cytomics – from cell state to predictive medicine.Metagenomics-concept and application of systems biology in metagenomics study. Pathway modelling. Conformational transition in biomolecules revisited (on an evolutionary scale). Metabolism and Metabolic Control Analysis.

UNIT V	**9 Hrs**

Modeling Tools and applications: SBML, Math MLCellML, Petri Nets and Boinformatics with case studies. Systems biology approaches to solve biological problems-case studies.Models for Eukaryotic Gradient Sensing. Rapid Pole-to-pole Oscillations in E. coli. Synthetic biology-concept and applications. The Systems Biology of Cancer, on cogenes, and p53 tumor suppressor. Gene Circuit Design (optimal expression of a protein in a constant, periodic and stochastic environment).

Course Outcomes: After completing the course, the students will be able to

1	Understand the concepts, implementation and applications of systems biology.
2	Apply genetic networks and models currently used in systems biology.
3	Analyze modeling and simulation of various biological processes using bioinformatics tools.
4	Demonstrate successful biological models designed using systems biology and also learn about the extend applications of the subject.

Text Books

1. Andres Kriete, Roland Eils. Computational Systems Biology. Academic Press, 2006. ISBN: 9780124059382.
2. Andrzej K. Konopka. Systems Biology. CRC, 2006. ISBN: 978-1-4200-1512-6.

Reference Books

1. Corrado Priami. Transactions on Computational Systems Biology I. Springer, Edition 2009. ISBN: 978-3-540-32126-2.
2. Fred C. Boogerd, H.V. Westerhoff. Systems Biology. Elsevier, Edition 2007. ISBN: 9780080475271.
3. Sangdun Choi. Introduction to Systems Biology, Springer, Edition 2007. ISBN: 978-1-59745-531-2.
4. Michael G. Katze. Systems Biology. Springer, Edition2013. ISBN: 978-3-642-33099-5.

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	25
Quiz -2	10
Quiz -3	10
Test -2	25
Assignments	20
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	**80**
There should be five questions from five units.	
Each question should be for maximum of 16 Marks.	

The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	
The **UNIT-2 and UNIT-3** should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	-	-	L	H	M	-	LSS	L	L	-
CO2	H	H	M	H	M	-	L	M	-	L	M	-
CO3	M	M	M	H	H	H	M	M	-	L	M	M
CO4	M	M	H	H	M	-	L	M	L	-	-	-

High-3: Medium-2: Low-1

BIOINSPIRED ENGINEERING
(Theory)

Course Code:16GE6E1		**CIE Marks:100**
Hrs/Week: L:T:P:S:3:0:0:0		**SEE Marks:100**
Credits:03		**SEE Duration : 3 Hrs**

Course Learning Objectives: The students will be able to

1. To familiarize engineering students with basic biological concepts
2. Utilize the similarities noted in nature for a particular problem to bring inspiration to the designer.
3. Explain applications of smart structures, self-healing materials and biosimilars
4. To gain an understanding, that the design principles from nature can be translated into novel devices and structures.

UNIT-I	**07Hrs**
Introduction to Biology: Biomolecules-Proteins, carbohydrates, lipids and Nucleic acids. Cell types- Microbial, plant, animal. Stem cells. Antibodies. Organ system- Circulatory, digestive, respiratory, excretory and nervous system.	
UNIT II	**07Hrs**
Nature as a source of Inspiring innovation: Super hydrophobic and self-cleaning surfaces - lotus leaf effect, Ultrasonography - echolocation of bats and whales, high performance fibers and flexible medical tapes - silk processing and assembly by insects and spiders, Velcro - plant burrs. Strong light weight structure: Honey comb structures.	
UNIT III	**07Hrs**
Biomimetics – Orthopedic; Artificial hips, discs and artificial knees. Dental; Dentures, tooth cap, single tooth and multiple tooth replacement. Cardiovascular; Heart pacemakers, coronary stents, implantable cardioverter-defibrillator. Sense organs: Optical; Artificial lenses, retinal implant. Auditory; cochlear implant, ear tubes,	
UNIT IV	**06 Hrs**
Biosimilar Drugs: Basics of Biosimilars, FDA approval, Current status of Biosimilars, Ten most used drugs: Pharmaceutical and Biotech drugs, eg; Clinical development of insulin biosimilar.	
UNIT V	**06 Hrs**
Biological inspired process and products: Biosensors -natural recognition receptors. Artificial senses- Electronic nose and tongue. Bionic eyes.Artificial muscles. Plant as Bio-inspirations: Plant process- Photosynthesis. Bionic leaf and Photovoltaic cells	

Course Outcomes: After completing the course, the students will be able to

1	Remember and explain the fundamental aspects of Biology
2	Differentiate biological phenomena to support inspiration for visual and conceptual design problems.
3	Analyze and comprehend the applications of biological, self-healing materials and biosimilars.
4	Address the problems associated with the interaction between living and non-living materials and systems.

Text Books

1	Donald Voet, Charlotte W. Pratt. Principles of Biochemistry: International Student Version. Wiley John and Sons, 2012. ISBN: 1118092449.
2	Jen- Louios Prugnaud, Jean-Hugues Trouvin. Biosimilars. A New Generation of Biologics. Springer-Verlag Paris. 2011. 9782817803357
3	Yoseph Bar-Cohen, Biomimetics-Nature Based Innovation, 2011, CRC press, ISBN: 9781439834763

Reference Books	
1	Jenkins, C.H. Bioinspired Engineering, NY: Momentum press, 2012 ISBN: 97816066502259
2	C.C.Chatterjee, Human Physiology Volume 1 (11th Edition), 2016, ISBN 10: 8123928726 / ISBN 13: 9788123928722

(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments/ seminars	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	**80**
Part –B	
There should be five questions from five units.	
Each question should be for maximum of 16 Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	
The **UNIT-2 and UNIT-3** should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	-	-	L	-		L	M	-	L
CO2	L	L	M	L	-	L	-	-	L	M	-	L
CO3	L	M	M	L	-	L	-	-	L	M	-	L
CO4	M	H	H	L	M	M	L	-	L	M	-	M

High-3 : Medium-2 : Low-1

PLANT BIOTECHNOLOGY (Theory and practice)		
Course Code:16BT71		**CIE Marks:100+50=150**
Hrs/Week: L:T:P:S: 4:0:2:0		**SEE Marks:100+50=150**
Credits:05		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to

1. Understand tissue culture techniques and its application for enhanced production of various bioactive compounds.
2. Analyze and comprehend the various molecular and genetic transformation mechanisms in generating transgenic plants
3. Interpret the modern mechanisms and strategies for the production of various resistant/tolerant plants for the crop improvement
4. Apply the omics and edge cutting transgenic strategies for crop improvement adhering to environmental and ethical standards for societal betterment.

UNIT-I	09Hrs

Introduction: Plant tissue culture; Plasticity and Totipotency**,** culture media, growth regulators.Culture types; callus, cell suspension culture.Micropropgation; Regeneration Methods of plants in Culture Organogenesis-direct and Indirect Organogenesis. Organ culture: root cultures, Shoot, meristem culture, embryoculture and endosperm culture. Molecular basis of Organogenesis protoplast culture and somatic hybridization and cybridization. Haploid plants; Microspore culture, somatic embryogenesis.Gene regulation during somatic embryogenesis. Artificial seeds. somaclonalvariation for crop improvement, Cryopreservation. Advantages of tissue culture as source of secondary metabolites**,** Growth and production kinetics of cell cultures,scale-up procedures in bioreactors, types of bio--reactors for plant cell cultures. Biotic and abiotic elicitation, biotransformation.

UNIT II	09Hrs

Techniques for plant transformation. Modes of gene delivery in plants; physical, chemical and biological methods. Ti and Ri plasmids, Plant expression vectors; co-integrative and binary vectors. Promoters and terminators, selectable markers, reporter genes,. Methods of transformation; tissue culture based, *in planta* and floral dip. Transplastomic transformation. Transformation systems: transposon tagging, enhancer/promoter/gene trap, transactivation, over expression and under expression, gene silencing, virus induced gene silencing, gene replacement, gene targeting. Screening and selection of transformants; Histochemical, PCR and hybridization methods. Generation and maintenance of transgenic plants, Transgene silencing. Clean gene technology. Molecular breeding.

UNIT III	09Hrs

Stress tolerant/resistant plants: Plant defence system Genetic basis of plant pathogen interaction, R genes and R gene mediated resistance, Biochemistry and Molecular biology of defence reactions, Systemic acquired resistance, ABA in stress tolerance, Role of Salicylic, Jasmonic acid and ethylene in plant defence. Plant Stress Response. Biotic stress resistance plants- Disease resistance plants; Insect resistant plants (Case study: BT Cotton).Viral resistant plants, Bacterial resistance plants and Fungal resistant plants. Nematode resistance Herbicide resistance plants.Abiotic stress tolerant plants; Drought and Salt tolerance plants (Case study- rice). *Arabidopsis* as a model for molecular genetic studies in plant biology, an introduction to systems approaches.

UNIT IV	09Hrs

Application of transgenic plants: Molecular farming/pharming.Improvement of Products and Food Quality; Nutritional Improvements- Golden rice. Modified Plant lipids, carbohydrates and proteins. Pharmaceutical Products; genetic manipulations involved in the production of commercially important enzymes, therapeutic proteins, edible vaccines, bioplastics, and other novel compounds. Biofuels, Bioplastics. Genetic manipulation of fruit ripening; Delay of fruit ripening;polygalacturanase, ACC synthase, ACC oxidase (Case study –tomato), flower color (Case study- Anthurium, rose and Gerbera). Genetic manipulation of crop yield by enhancement of photosynthesis

UNIT V	08Hrs

The Omics in Plant world: Interrelationships of omic disciplines.Identifying genes of interest through genomic studies. Plant Cyc databases. RNAi for Crop Improvement. Advanced genetic tools for plant biotechnology; plant genome editing- (CRISPR)/CRISPR-associated protein 9 (Cas9) system, Zinc finger nucleases (ZFNs), meganucleases and transcription activator-like effector nucleases (TALENs). Recent advances of Epigenetics in Crop Biotechnology**.**

Plant transgenics- Science and society: The public acceptance of GM crops; issues and concerns, biosafety, societal and ethical aspects of genetically modified foods and crops.

LAB EXPERIMENTS

1. Callus induction from various explants
2. Cell suspension culture and elicitation studies
3. Extraction and estimation of total phenolics from callus cultures
4. Extraction and estimation of lycopene from tomato.
5. Protoplast isolation and culture. Anther and microspore culture technique for the production of haploids.
6. Isolation of genomic DNA from plant tissue.
7. Competent cell preparation of Agrobacterium tumefaciens and transformation of plant expression vector
8. Genetic transformation in plants (in planta and tissue culture based).
9. Screening and selection of transformants (GUS Assay and PCR using GUS specific primers).
10. PAL enzyme assay in Cell cultures
11. Antioxidant assay in cultures
12. Functional annotation using plant cyc databases
13. Pathway using Gen map
14. Mapping QTLs using Join map.

Note: Each student has to perform all the 12 experiments in a semester.

Course Outcomes: After completing the course, the students will be able to

1	Conceptualize the fundamentals of plant biotechnology from tissue culture intricacies to modern transgenics using omic strategies for crop improvement.
2	Apply and execute the mechanism of plant transformation to generate functionally designer transgenic plants for better outreach.
3	Analyze and evaluate the wide array application considering the ethical issues ofplant biotechnology for crop improvement.
4	Design and formulate genetically modified plant for a desired trait complying tobiosafety, societal and ethical aspects.

Text Books

1	C. Neal Stewart, Jr.Plant Biotechnology and Genetics: Principles, Techniques, and Applications.Wiley publishers. 2nd Edition. 2016.ISBN: 9781118820124.
2	Arie Altman, Paul Hasegawa.Plant Biotechnology and Agriculture. Academic Press 2012. 1st Edition. ISBN: 9780123814661.

Reference Books

1	Mark R. Fowler,AdrianSlater,Nigel W. Scott.Plant Biotechnology: The genetic manipulation of plants : Oxford University Press. 2nd Edition. ISBN: 9780199560875.
2	DebmalyaBarh,Muhammad Sarwar Khan, Eric Davies .PlantOmics: The Omics of Plant Science. Springer India. 1st Edition, 2015. ISBN: 9788132221715.

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)		(Laboratory- 50 Marks)		Total
Evaluation method	**Course with assignment**			
Quiz -1	10	Performance of the student in the laboratory, every week	40	
Test -1	30			
Quiz -2	10			
Quiz -3	10	Test at the end of the semester	10	
Test -2	30			
Assignments	10			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)

Theory (100 Marks)		Laboratory(50 Marks)		Total (150)
Part- –A	**20**	**Experiment Conduction with proper results**	40	
Objective type questions				
Part –B	**80**	**Viva**	10	
There should be five questions from five units.				
Each question should be for maximum of 16				
Marks.				
The **UNIT-1, UNIT-4 and UNIT-5** should nothave any choice.				
The **UNIT-2 and UNIT-3** should have an internalchoice.				
Both the questions should be of the same				
complexity in terms of COs and Bloom’s				
taxonomy level.				
Total	**100**	**Total**	**50**	**150**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	M	L	-	M	M	L	-	M
CO2	M	H	H	H	H	M	H	M	H	L	-	H
CO3	L	H	H	M	M	H	H	H	M	M	L	M
CO4	M	M	H	L	L	H	H	H	M	H	M	H

High-3 : Medium-2 : Low-1

DOWNSTREAM PROCESSING (Theory and practice)		
Course Code:16BT72		**CIE Marks:100+50=150**
Hrs/Week: L:T:P:S: 4:0:2:0		**SEE Marks:100+50=150**
Credits:05		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to

1. Understand the importance of purification technology of biological products at industrial scale.
2. Comprehends various primary purification techniques for bio products.
3. Learn Purification techniques for isolation of products from complex biological mixtures
4. Impart membrane technology application to lab scale and process scale techniques for handling crude broth and purification techniques.
5. Apply the knowledge towards secondary and advanced separation techniques for lab and process scale purification of biological products

UNIT-I	9Hrs

Introduction: Overview of a bioprocess including upstream and downstream processing, Basic concepts of bioseparation technology, Economic importance of downstream processing in biotechnology, nature and basis of bioseparation, properties of biological materials. Characteristics of biological molecules, New Separation process in modern biotechnology; Separation characteristics of recombinant proteins, enzymes and monoclonal antibodies. Numerical on properties of biological materials and purification efficiency

UNIT II	9Hrs

Biomass removal and disruption: Cell disruption by Mechanical and non- mechanical methods, Chemical lysis, Enzymatic lysis, physical methods, Sonication, High pressure Homogenizer, Flocculation methods and its applications. Centrifugation and ultracentrifugation. Simple Numerical on cell disruption and centrifugation

UNIT III	9Hrs

Product Isolation: Separation of particulate by filtration: dead end filtration, depth filtration, concept of filter medium resistance, Rotary Vacuum Filtration, scale up of filtration systems, different modes of operation.

Extraction: principles of solid-liquid extraction and Liquid - liquid extractions, material balance for single, concurrent multistage and countercurrent multistage extraction. Simple problems, Selection of solvent, extraction equipment: working of Bollman, Mixer-settler and York-Scheibel extractors. Precipitation (salt, pH, organic solvent, high molecular weight polymer).Numerical problems on filtration and extraction

UNIT IV	9 Hrs

Diffusion: Types of diffusion, measurement and calculation of diffusivities, theoretical estimation of diffusitivities, mass transfer co-efficients and their correlations. Theory of mass transfer.

Membrane Based Separation: Structure and characteristics of membranes, types of membranes, membrane equipment, Phenomenon of concentration polarization, membrane fouling and its consequences. Membrane based purification: Microfiltration, Ultrafiltration, Nanofiltration and Diafiltration. Biotechnological applications of membrane based separations. Numerical on membrane based bioseperation.

UNIT V	9Hrs
Advanced Separation Techniques: Chromatography:- general theory; separation based on Size, Charge, Hydrophobicity and Affinity: Gel filtration, Ion exchange chromatography, Affinity chromatography, and hydrophobic interaction chromatography (HIC). Polishing of Bioproducts by Crystallization, Drying- definition of Bound, Unbound, Critical Moisture Content, Wet and dry moisture content, Drying Curve, Drying equipment- Tray Drier, Rotary Drier and Freeze Drier. Case study: Large scale separation and purification of Recombinant products Insulin, Interferon, Streptokinase and Monoclonal Antibodies	

LAB EXPERIMENTS	
1. Cell disruption techniques- physical method. 2. Solid-liquid separation methods: sedimentation by flocculating agents. 3. Solid-liquid separation methods: Membrane filtration. 4. Solid-liquid separation methods: Centrifugation. 5. Product enrichment operation: ammonium sulfate precipitation of proteins. 6. Product enrichment operation: aqueous two phase extraction (single stage). 7. Separation of amino acids/carbohydrates/pigments by Thin Layer Chromatography. 8. Estimation of citric acid from Fermentation Broth. 9. Product drying technique-vacuum tray drier. 10. Crystallization Technique for bioactive compound.	
Note: Each student has to perform 10 experiments in a semester. **10 Experiments are guided experiments**	
Course Outcomes: After completing the course, the students will be able to	

CO1	Highlight the importance of downstream processing of biological products.
CO2	Interpret the techniques for various intracellular and extracellular products from complex biological mixtures.
CO3	Apply techniques to concentrate and purify biological products
CO4	Develop different processes for separation and purification of biological products

Text Books

1. R.Ghosh, Principles of Bioseparation Engineering. World Scientific Publishing, 1st edition, 2006. ISBN: 9812568921.
2. J.C Janson and L. Rayden., "Protein Purification: Principles, High Resolution Methods, and Applications". John Wiley and sons. 2012. ISBN: 1118002199.
3. N.Krishnaprasad.,"Downstream Process Technology: A New Horizon In Biotechnology", PHI Learning India ltd, Eastern Economy Edition, 2010. ISBN: 9788120340404.
4 Mukesh Doble, Principles Of Downstream Techniques In Biological And Chemical Processes, Apple Academic Press And CRC Press, 2015, ISBN: 9781771881401

Reference Books

5. G Uwe, Process scale purification of antibodies, Wiley Publication, 2009, ISBN:978-0-470-20962-2

6. P.A. Belter and E L Cussler., Bioseparations Downstream Processing For Biotechnology, Wiley-India Pvt Ltd., 2nd edition 2011 , ISBN:8126531975

Continuous Internal Evaluation (CIE)				
(Theory – 100 Marks)		(Laboratory- 50 Marks)		Total
Evaluation method	Course with assignment			
Quiz -1	10	Performance of the student in the laboratory, every week	40	
Test -1	30			
Quiz -2	10			
Quiz -3	10	Test at the end of the semester	10	
Test -2	30			
Assignments	10			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory(50 Marks)**		**Total (150)**
Part- –A	**20**	**Experiment**		
Objective type questions		**Conduction with proper results**	40	
Part –B		**Viva**	10	
There should be five questions from five units. Each question should be for maximum of 16 Marks.				
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	**80**			
The **UNIT-2 and UNIT-3** should have an internal choice.				
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.				
Total	**100**	**Total**	**50**	**150**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	-	-	-	-	-	M	L	-	-	L
CO2	M	H	-	H	-	-	-	M	-	-	L	-
CO3	H	M	L	M	-	-	-	L	-	-	-	-
CO4	H	M	M	L	-	-	-	L	-	-	-	M

High-3 : Medium-2 : Low-1

ANIMAL BIOTECHNOLOGY (Theory)		
Course Code:16BT73		**CIE Marks:100**
Hrs./Week: L:T:P:S: 3:0:0:0		**SEE Marks:100**
Credits: 03		**SEE Duration : 3 Hrs.**

Course Learning Objectives: The students will be able to

1. Understand principles of animal cell culture techniques, properties and applications of specialized cells.
2. Demonstrate the properties of specialized cells, monolayer culture and bioreactor design of scaling up of cells.
3. Explore the knowledge of health care products vaccine, toxoids and Hybridoma technology.
4. Evaluate on ethical dimensions, laboratory safety and validation of tissue products.

UNIT- I	7 hrs

Animal Cell Culture Technology: Principles of animal and cell culture, origin of concept, types of cells, Culturing of cells, primary and secondary cell lines, kinetics of cell growth, Cell lines and their applications. Sources of cells, Techniques of cell culture, Equipment's, substrate for cell growth, Media handling equipment's, Types of culture media, Primary culture, somatic cell fusion. Specialized techniques animal cell cultures.

UNIT- II	6 hrs

Specialized cells and Scaling up of animal cells: stem cells, epithelial cells, Hemopoitic cells and cryopreservation, Amniocentesis, Oncofetal antigens, 3D culture, cell immobilization, application of molecular genetics, storage of DNA and handling of enzymes, Cytotoxicity. Mono layer culture, types of bio-reactors used for animal cell cultures.

UNIT III	7 hrs

Hybridoma Technology and Healthcare: Production of Hybridomas- Antibodies, Immunotoxins, Vaccines, Toxoids, Inerferons and Antiviral substances, and organ culture, Tumour immunology, Immune diagnosis and therapy monoclonal antibodies. DNA finger printing in forensic medicine. Gene Therapy- Prospects and problems; Knockout mice and mice model for human genetic disorder.

UNIT IV	6 hrs

Transgenic Animal Technology and applications: Strategies for gene transfer in animal cells; mechanisms of transfection, vectors used in transfection. Methods of production of transgenic animals, recent advances in gene targeting technology. Characterization and screening of transgenic animals. Applications of genetically modified animals and molecular bio pharming. Stem cell research - Hematopoietic and embryonic stems cells.

UNIT V	7 hrs

Animal Breeding, Ethical Issues and Safety: Artificial insemination and storage; In vitro fertilization and embryo transfer micro manipulation of embryos, advantages of cell manipulation techniques, Ethical issues in animal biotechnological products and techniques. Ethical issues related to transgenic animals, Human tissue cell and products. Laboratory safety, Risk assessment, Standard operating systems, Biohazards, Bioethics and Validation.

Course Outcomes: After completing the course, the students will be able to

CO1	Comprehend the principles of animal cell biotechnology and techniques
CO2	Analyze the environmental, societal, ethical, health and safety issues of anthropogenic activities.

CO3	Appraise the elements of environmental designs and models and examine their significance in sustainable development.
CO4	Animal improvement and vaccine technology and other industrial applications.

Text Books

1	Textbook of animal biotechnology - B Singh, S K Gautam and M S Chauhan, The Energy and Resource Institute First Edition, ISBN No: 9788180301032, 2015.
2	Textbook of Animal Biotechnology - P. R. Yadav, Discovery Publishing House, First Edition, ISBN No: 9788183564953, 2016.

Reference Books

1	Animal cell biotechnology – R.E. Spier and J.B. Griffiths, Academic Press, 5th edition, 2012.
2	Animal Biotechnology – M.M Ranga, Agrobios India,Student edition, 5th edition, 2016
3	Molecular biotechnology – Glick Pasternak, Asm Press, 4th, Edition, 2009.
4	Culture of Animal cells A manual of basic techniques – R. Ian Freshney, John Wally and Sons Publishers, 7th edition, 2015.

Continuous Internal Evaluation (CIE)

Evaluation method	**(Marks)**
Quiz -1	15
Test -1	30
Quiz -2	15
Test -2	30
Quiz -3	15
Test -3	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Evaluation method	**(Marks)**
Part- –A	
Objective type questions	**20**
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	**80**
The UNIT-**1, UNIT-4 and UNIT-5** should not have any choice.	
The **UNIT-2 and UNIT-3** should have an internalchoice.Both the questions should be of the samecomplexity in terms of COs and Bloom'staxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	-	-	-	M	M	L	L	-	-	M
CO2	M	M	-	-	-	L	-	-	L	-	-	L
CO3	M	M	L	-	-	M	M	-	L	-	-	M
CO4	M	M	L	-	-	M	-	-	-	-	-	L

High-3 : Medium-2 : Low-1

Professional Elective F

NANOBIOTECHNOLOGY		
Course Code : 12BT7F1		**CIE Marks: 100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks: 100**
Credits : 4		**SEE Duration: 3 Hrs**

Course Learning Objectives:

1. Describe methods by which nanoscale manufacturing can be enabled.
2. To design a concept for a nanoscale product and their applications in mechanical, electrical, electronic, Magnetic, Chemical field and in Medical field.
3. To design a concept for a nanoscale product and their applications in medical field.
4. To learn about Nano sensors and nano biosensors and products available in the market.
5. To study about the nanosensors used in diagnostic and therapeutics.

	UNIT – I	08 Hrs

Introduction to nanomaterials: Types of nanomaterials, Top-Down and Bottom-up methods of nanofabrication and Nanosynthesis. Nanolithography: soft- and hard-lithography. Characterization of nanomaterials: Atomic Force Microscopy, Scanning & Tunneling Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy.

	UNIT– II	08 Hrs

Micro & Nano Electromechanical systems and Microfluidics: MEMS/NEMS: Nanotransducers: Nano- mechanical, electrical, electronic, Magnetic and Chemical Transducers. Nano sensors and Nano Actuators. Microfludics: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps. Approaches toward combining living cells, Microfluidics and 'the body' on a chip, Chemotaxis, cell mobility.

	UNIT – III	08 Hrs

Medical Nano biotechnology: Diagnostics: Resonance Light Scattering (RLS) Technology, Nano chips, gene and protein chips. Therapeutic: Drug delivery: Bioavailability, Sustained and targeted release. Benefits of nanodrug delivery system. Use of Microneedles and nanoparticles for targeted and highly controlled drug delivery. Drug delivery applications, Nano robots in drug delivery system. Tissue Engineering: Nanostructuring, nano implants, nanocoating.

	UNIT – IV	10 Hrs

Nanosensors: Overview of nanosensors, prospects and market. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, Mechanics of CNTs, Biosensors in modern medicine.

	UNIT – V	10 Hrs

Nanobiosensors: Types of nanobiosensors: Cantilever, nanotube, nanowire and nanoparticle based sensor., Nanofabricated devices to separate and interrogate DNA, Interrogation of immune and neuronal cell activities through micro- and nanotechnology based tools and devices. Benefits of Nano-imaging agents, Nanosensors in Drug Discovery, Drug Delivery. Nanotoxicity studies

Course Outcomes: After completing the course the students will be able to:

CO1: Remember, understand and apply knowledge about nanomaterials and their uses
CO2: Interpret and apply the techniques of manufacturing and characterization processes.
CO3: Apply knowledge of nanosensors,in applications like electronics, mechanical, chemical, and biological systems
CO4: Create and evaluate nano design, devices and systems applicable to various disciplines.

Reference Books:

1. L. H, Gabor. J, Dutta., H. F.,Tibbals., A. Rao., Introduction to Nanosciences, , CRC press, 1st edition, 2008, ISBN- 1420048058.
2. B.S., Murty, P.Shankar, B.Raj, B.B. Rath and J. Murday, Textbook of Nanosciences and Nanotechnology, , Springer, Co-publication with University Press (India) Pvt. Ltd. VCH, XII. 2013,ISBN- 978-3-642-28030-6.
3. Niemeyer and C.A. Mirkin, Nanobiotechnology: Concepts, Applications and perspectives, Wiley –VCH, 2nd edition, 2013.ISBN -978-3-527-30658-9.
4. V.K. Khanna, Nanosensors:, Physical, Chemical and Biological, CRC press, 1st edition,2013,ISBN 9781439827123.
5. J. Sandra, D. Rosenthal, W. Wright, NanoBiotechnology Protocols, Springer (1st edition, 2005, ISBN-10 1588292762), 2nd edition, Humana Press, 2013. ISBN- 13 978-158829276.

Continuous Internal Evaluation (CIE)

Evaluation method	(Marks)
Quiz -1	15
Test -1	30
Quiz -2	15
Test -2	30
Quiz -3	15
Test -3	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Evaluation method	**(Marks)**
Part- –A	
Objective type questions	**20**
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	**80**
The UNIT-**1, UNIT-4 and UNIT-5** should not have any choice.	
The **UNIT-2 and UNIT-3** should have an internalchoice.Both the questions should be of the samecomplexity in terms of COs and Bloom'staxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	H			M	M	L	L	-	-	M
CO2	M	M	H			L	-	-	L	-	-	L
CO3	M	M	M			M	M	-	L	-	-	M
CO4	M	M	M			M	-	-	-	-	-	L

High-3 : Medium-2 : Low-1

PLANT-BASED VACCINES (Theory)		
Course Code:16BT7F2		**CIE Marks:100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks:100**
Credits:04		**SEE Duration (Theory) : 3Hrs**

Course Learning Objectives: The students will be able to

1. Know the principle and applications of Plant-based vaccines.
2. Outline the various techniques involved in Plant-basedvaccine production.
3. Acquire knowledge on mechanism of action of various kinds of Plant-based vaccines.
4. Present the scientific importance, advantages and disadvantages of Plant-based vaccine technology.

UNIT-I	**8hrs**
Principles of plant-based vaccines, Production of Plant-Based Vaccines: DirectGeneDeliveryMethod, Indirect Gene Delivery Methods (*Agrobacterium*-MediatedGeneTransfer), Mechanism of action, Plant-based vaccines as a global vaccination approach current perspectives.	
UNIT II	**9hrs**
Viral vector-based expression strategy (Tobacco mosaic virus, Cowpea mosaic virus, Geminiviruses). Plastid-based expression strategy (Technology, engineering of plastid transgenes for high level protein expression). Seed-based expression strategy (Rice seed for delivery of vaccines to gut mucosal immune tissues, Production of Biologically Active CecropinA Peptide in Rice Seed Oil Bodies).	
UNIT III	**9hrs**
Plant cell culture types: Plant Cell Suspension Culture, Culture of hairy roots, Factors affecting biomass production, Bioreactor: design and types, choice of different bioreactor systems for plant cell culture,Scale-up, Bioprocess optimization and control. Commercial production of recombinant proteins from plant cell culture. Monoclonal antibodies production against cancer.	
UNIT IV	**10hrs**
Plant-based vaccines against influenza: Transient plant expression systems, production of virus-like particles (VLPs), characterization, assessment of immune response. HIV: strategies targeting structural (Env, Gag) and early non-structural HIV-1 proteins (Rev, Tat, and Nef),expression in plants. Hepatitis-B: Production of HBV Antigens in Plant Systems, characterization of the major surface antigen in plant tissues, efficacy of plant-based hepatitis B vaccines. Vaccines against HPV and Ebola viruses.	
UNIT V	**9hrs**
Mucosal Immunology and oral vaccination: Mucosal immune system, oral vaccination, immunogenicity, immunoprotection. Plant-based vaccines against Toxoplasmosis: Expression of GRA4 and SAG1 in plants. Plant-based vaccines against pollen-allergy: Development of Seed-based pollen allergy vaccines. Plant-based vaccines against some neglected tropical diseases: developing low-cost vaccination, vaccines against rabies, cysticercosis, dengue, and helminthiasis.	

Course Outcomes: After completing the course, the students will be able to

CO1	Explain the principle, applications and mechanism of action of Plant-based vaccines.

CO2	Apply the techniques for production and characterization of Plant-based vaccines.
CO3	Differentiate between production processes and various kinds of Plant-based vaccines.
CO4	Assess the quality of synthesized Plant-derived vaccines, and effect of Plant-based vaccines in the target cell.

Text Books

6. Rosales-Mendoza S, Genetically Engineered Plants as a Source of Vaccines against Wide Spread Diseases-An Integrated View. Springer, 2014, ISBN: 9781493908493
7. GlickBR, DelovitchTL, and Patten CL, Medical Biotechnology, ASM Press, 2013, ISBN : 9781555817053

Reference Books:

8. Buonaguro FM (Edi), Plant-derived Vaccines: Technologies & Applications, Future Medicine Ltd, 2012, ISBN-10: 1780841469
9. Hefferon KL, Biopharmaceuticals in Plants: Toward the Next Century of Medicine, CRC Press, 2009, ISBN-10:1780841469

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignment	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	
Objective type questions	**20**
Part –B	
• There should be five questions from five units. Each question should be for maximum of 16Marks. • The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice. • The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**80**
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L	L	L	-	L	-	-	M	M	-
CO2	M	H	M	H	H	-	M	-	-	M	M	-
CO3	M	H	M	H	H	-	M	M	-	M	M	-
CO4	M	H	M	H	H	L	M	M	-	M	M	-

High-3: Medium-2: Low-1

EQUIPMENT DESIGN AND DRAWING (Theory and practice)		
Course Code:16BT7F3		**CIE Marks:100=100**
Hrs/Week: L:T:P:S: 2:0:2:0		**SEE Marks:100=100**
Credits: 4		**SEE Duration(Theory) : 3 Hrs**
		SEE Duration(Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to

1. Learn the basics of design using Code book and Perry Hand book
2. Explore the abilities of sectional front view and top view of the biochemical equipment accessories.
3. Study mechanical design of equipments involved in biological reactions as per IS2825 unfired pressured vessels code book.
4. Study the process design of equipment involved in biological reactions as per Perry Hand book.

UNIT-I	36 hrs

Detailed Process Design and mechanical design of the following equipments using standard code books. The detailed dimensional drawings shall include sectional front view, Full Top/Side view depending on equipment and Major component drawing with dimensioning and Part Template.
1. Shell and tube heat exchanger
2. Packed bed Distillation Column
3. Batch continuous bio reactors
4. Jacketed vessel
5. Adsorption column

Course Outcomes: After completing the course, the students will be able to

CO1	Remember and understand the concepts of design and use of the IS 2825 code book and J H Perry hand book
CO2	Integrate the standard design parameters to design of bio equipments.
CO3	Evaluate the various parameters of distillation column, heat exchangers
CO4	Generate drawings of distillation column, heat exchanger and bioreactors.

Text Books

1. R.H. Perry & D.W. Green : "Chemical Engineers Handbook", 7th edition, McGraw Hill 2008;**ISBN:** 9780071422949
2. IS 2825 Code: Unfired pressure vessels, BIS New Delhi.

Reference Books

1. M.V. Joshi and V.V. Mahajan, "Design of Process Equipment Design", 4th edition, McMillan India 2009; ISBA: 978-0230638105
2. J.M. Coulson & J.F. Richardson, "Chemical Engineering" Vol. 6, Pregman Press, 1993; ISBN 07506 65386

(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
There should be TWO questions from five EQUIPMENTS.	100
Each question should be for maximum of 100	
Marks.	
Both the questions should be of the same	
complexity in terms of COs and Bloom's	
taxonomy level.	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	-	-	M	M	L	L	-	-	M
CO2	M	M	-	H	H	L	-	-	L	-	-	L
CO3	H	M	L	-	-	M	M	-	L	-	-	M
CO4	M	H	M	M	M	M	-	-	-	-	-	L

High-3 : Medium-2 : Low-1

MATLAB (Theory)		
Course Code: 16BT7F4		**CIE Marks:100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks:100**
Credits:04		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

5. Explore conceptually MATLAB applications in the domains of Life sciences and in general study the role of computer science in life sciences
6. Acquire knowledge of the Programming and Advanced programming skills in MATLAB
7. Study MATLAB ToolBoxes that are used for Graphics analysis, Next Generation Sequence Analysis, Spectral Analysis, Sequence and Structure analysis.
8. Understand the importance of MATLAB ToolBoxes to solve the problems related to High throughput Data analysis, Biophysical Data, Microarray data analysis, Modeling and Simulation.
9. Explore practically the applications of various MATLAB ToolBoxes along with programming capability of MATLAB.

UNIT-I	9hrs

Introduction to Java:
Introduction to MATLAB, Basic computer programming - Variables and constants, operators and simple calculations - Formulas and functions, Functions and Commands, Arrays - Vectors and matrices. Operators', expressions and Statements.

UNIT II	9hrs

Matrix Graphics – Basic 2D Graphs, Subplot, logarithmaic and polar plots. 3D plots – mesh and contour plots. Handle graphics, Editing plots, applying effects to plots. Algorithms and structures, MATLAB scripts and functions (m-files). Applications of MATLAB; Simulation - Rolling dice, Bacteria division, Normal Random Numbers. Numerical methods – Integration, Numerical differentiation, solving first order differential equations (Bacterial growth), Linear Ordinary Differential Equations, Runge-Kutta methods and Partial Differential equations(Heat conduction)

UNIT III	9hrs

MATLAB Toolbox
Overview of Matlab Toolbox, Introduction to Bioinformatics Toolbox. Applications of Bioinformatics Toolbox - Scanning of Genome wide differences, Identification of Differentially Expressed genes, Prediction of Protein-DNA binding sites, Mapping of sequence reads, Sequential clustering of sequences, Bootstrapping of Phylogenies, and metagenomic analysis.

UNIT IV	9 hrs

MATLAB and Microarray Data analysis – preprocessing Affymetrix® oligonucleotide microarray probe-level data, estimation of Gene expression pro, file, detect DNA copy number alterations, Visualizing Microarray data, Finding patterns in gene expression profiles, identification of differentially expressed genes. Performing pairwise and Multiple sequence alignment, Accessing local and remote databases, Working with Illumina®/Solexa Next-Generation Sequencing Data.

UNIT V	9 hrs

Spectral Analysis and Machine Learning: mass spectrometry data, manipulate, preprocess and visualize data from Liquid Chromatography, preprocess a large set of mass spectrometry signals, classification mass spectrometry data, Differential Analysis of Complex Protein and Metabolite

Mixtures. Machine Learning in Bioinformatics - Identifying Biomolecular Subgroups, Prediction of proein secondary structure, enrich microarray gene expression data. Visualisation of molecules – creation and visualization of molecular graph, Finding the shortest path, Traversing a graph, Working with the Clustergram Function, Navigation of 3D structure of macromolecules.

Course Outcomes: After completing the course, the students will be able to

CO1	Understand the MATLAB ToolBoxes that are used for Graphics analysis, Spectral Analysis, Sequence and Structure analysis.
CO2	Explore the Mind crunching Algorithms in MATLAB, which are used to make predictions in Biology, Chemical Engineering, and Medicine.
CO3	Apply the Programming and Analytical skills to solve the problems related to process simulation and process engineering in Biological system, analysis of High throughput Data, Biophysical Data, Microarray data aswell as Modeling and Simulation..
CO4	Use MATLAB ToolBoxes along with programming capability of MATLAB to model and simulate biological phenomenon.

Text Books

3. Joseph V. Tranquillo. MATLAB for Engineering and the Life Sciences. Morgan & Claypool Publishers, 2011. ISBN: 9781608457106
4. Stormy Attaway. Matlab: A Practical Introduction to Programming and Problem Solving. Butterworth-Heinemann, 2016. isbn: 9780128045411

Reference Books

6. Steven Chapra. Applied Numerical Methods with MATLAB for Engineers and Scientists. McGraw-Hill Education, 2017, 4th Illustrated Ed. ISBN: 9780073397962
7. Stephen J. Chapman. eMATLAB Programming for Engineers. Cengage Learning, 2015. 5th ed. ISBN: 9781305445369

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units.	
Each question should be for maximum of 16	
Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not	**80**
have any choice.	
The **UNIT-2 and UNIT-3** should have an internal	
choice.	
Both the questions should be of the same	
complexity in terms of COs and Bloom’s	
taxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	M	H	M	H	H			L	M	
CO2	H	H	H	M	H	H	M		M			
CO3	H	M	M	M	M	L	L				L	
CO4	L	M	H	H	H	M	L			M		

High-3 : Medium-2 : Low-1

VACCINE TECHNOLOGY						
Course Code	**:**	**16BT7G1**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S 4:0:0:0**		**SEE Marks**	**:**	100
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives (CLO): Graduates shall be able to

1. Explain role of immune cells and their mechanism in preventing the body from foreign attack and infectious disease, cancer and other disease development
2. Apply the knowledge of immune associated mechanisms in medical biotechnology research.
3. Design experiment to see effect of drug molecule on immune response
4. Carry out immunological techniques in industry.
5. Able to apply the concept of vaccine technology in new vaccines development.

Unit – I	09Hrs

Immunopathology: Tolerance and Autoimmunity, Hypersensitive reactions, Primary and Secondary Immunodeficiency, Active and passive immunization, General immunization practices, , AIDS, Immune response to Infectious disease, Basic principles of vaccine development. Vaccination of immune-compromised hosts, Vaccination of human immunodeficiency virus- infected persons. Vaccines and its historical perspective.

Unit – II	09 Hrs

Traditional and modern methods of vaccine production, Egg and cell based vaccine development, Current and future scenario of Vaccines, Edible Vaccines, Reverse vaccinology, Immunoinformatics approach to identify T and B cell epitopes, Bacterial and Viral vaccine. Passive immunization; antibody, transfusion of immune competent cells, cell based vaccines. Immunomodulators (cytokines) Innovative methods of delivery of immunogens through liposomes, microspheres, ISCOMS.

Unit – III	09 Hrs

Vaccine Technology: Criteria for effective vaccine, Vaccines, Live, killed, attenuated, sub unit vaccines; Role and properties of adjuvants, recombinant DNA and protein based vaccines, Multivalent subunit vaccines, mini cell vaccines, conjugate vaccines plant-based vaccines, recombinant antigens as vaccines. Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals—mechanism of action and drug resistance. Comparative Genomics as a tool for vaccine design

Unit – IV	09 Hrs

Vaccines: Licensed vaccines, Viral Vaccine (Poliovirus vaccine-inactivated & Live, Rabies vaccines Hepatitis A & B vaccines), Bacterial Vaccine (Anthrax vaccines, Cholera vaccines, Diphtheria toxoid), Parasitic vaccine (Malaria Vaccine). Vaccines against Hepatitis A, Malaria, Typhoid (in clinical trials). Conventional vaccines, antiidiotype vaccine, naked DNA vaccine. Recombinant Vaccines - Definition, recombinant vector vaccines, DNA vaccines. Vaccine potency testing.

Unit – V	08 Hrs

The vaccine industry, Vaccine manufacturing, Vaccine additives and manufacturing residuals, Regulation and testing of vaccines, Vaccine safety and Legal issues. Regulatory issues- Environmental concerns with the use of recombinant vaccines- Disease security and biosecurity principles and OIE guidelines Method of manufacture- in process control, batch control, test on final products. large scale manufacturing—QA/QC issues

Expected Course Outcomes: After going through this course the student will be able to:
1: Apprehend the concepts of immunization and vaccination
2: Analyse the various types of vaccines
3: Apply the knowledge of vaccine technology to cure various health ailments and intricacies.
4: Evaluate the biosafety, ethical and quality issues of various vaccine technologies.

Reference Books:

1.	Stanley A. Plotkin& Walter Orenstein & Paul A. Offit, Vaccines, 6th Edition 2013 BMA Medical Book Awards Highly Commended in Public Health. Elsevier Publication. **ISBN:** 9781455700905
2.	Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002. *ISBN: 3527304401.*
3.	Roitt, I. Essential Immunology by Blackwell Scientific Publications, Oxford. 2001, ISBN 0-63205902-8
4.	Ronald W. Ellis, “New Vaccine Technologies”, Landes Bioscience, 2001. ISBN: 1587060507

Scheme of Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE) Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units.Each question should be for maximum of 16 Marks.	
UNIT-1, UNIT-4 and UNIT-5 should not have any choice.	**80**
The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom’s taxonomy level.	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	M	L	-	M	M	L	-	M
CO2	M	H	H	H	H	M	H	M	H	L	-	H
CO3	L	H	H	M	M	H	H	H	M	M	L	M
CO4	M	M	H	L	L	H	H	H	M	H	M	H

High-3 : Medium-2 : Low-1

NUTRACEUTICALS		
Course Code:16BT7G2		**CIE Marks:100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks:100**
Credits:04		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. Obtain a solid foundation the nutraceutical constituents and health benefits of functional foods
2. Understand various food components and their broader array of interactions in lines of nutraceuticals
3. Emphasize on potential applications and health risk assessment through nutrigenomics
4. Get an overview of various modes and mechanism for nutigenomics and nutrigenetics

UNIT-I	**8hrs**

Food Pyramid, Nutritional assessment of Carbohydrates, proteins and lipids. Dietary Fibre – Components, physiological Effects, potential health benefits, recommended Dietary Intake. Glycemic index. RDA, Protein Efficiency Ratio (PER). Basics of Energy Balance - Basal Metabolic Rate (BMR) and Factors Affecting BMR. Food Styles.

UNIT II	**9hrs**

Nutrigenetics and Nutrigenomics: Organizational elements of nutraceuticals, classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutracuticals **Gene-Diet Interactions**: Functional Foods and Personalized Nutrition, Microbiome, Nutritional Epigenomics, Nutritional Signaling and Aging **Technologies in Nutrigenetics/Nutrigenomics:** Data Mining and Network Analysis, Metabolomics, Epigenetics and Personalized Nutrition. Foodomics: Human Dietary Interventions Metabolomics**, Nutrigenomics to Industry, Health Professionals, and the Public:** Indian and global scenario.

UNIT III	**9 hrs**

Carbohydrates, Protein, Fat - Excess and deficiency, Metabolic disorders– types Nutritional Factors, prevention and treatment. Role of nutraceuticals in the prevention and treatment with special reference to diabetes mellitus, hypertension, hypercholesterolemia. Concept of antioxidants, minerals and enrichment - dietary supplements in prevention and treatment of cancer, obesity and stress. Role of nutraceuticals and functional foods in pediatrics, geriatrics, sports, pregnancy and lactation.

UNIT IV	**9 hrs**

Role of medicinal and aromatic plants in nutraceutical industry, Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Applications with reference to skin, hair, eye, bone, muscle, heart, brain, liver, kidney, general health and stimulants. Concept of cosmoceuticals and aquaceuticals. Animal metabolites- chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides of animal origin, uses and applications in preventive medicine.

UNIT V	**8hrs**

Concept of prebiotics and probiotics - principle, mechanism and applications of probiotics, prebiotics Synbiotics for maintaining good health. Source of omega - 3 fatty acids, formulations, toxicology, bioavailability, bioequivalence; use of animal models and pre-clinical and clinical trials involved. Hopes and Concerns about Nutrigenomics and Public Health, Commercialization and Potential of Nutrigenetics and Nutrigenomics, ethics and morals in nutrigenomics and its future.

Course Outcomes: After completing the course, the students will be able to

1	Remember and explain various fundamentals of nutraceuticals, nutrigenomics and nutrigenetics.
2	Apply the knowledge of modern tools of nutraceuticals to analyze human health and diagnostics.
3	Comprehend better usage of food as nutraceuticals for societal, ethical and environmental sustainability.
4	Evaluate and analyze latest research area on nutraceutical and functional food components.

Text Books

1. Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition, Lynnette R.

Ferguson, 2013 CRC Press ISBN 9781439876800
2. Functional foods, Nutraceuticals and Natural Products- concepts and application, Dhiraj A Vattem and Vatsala Maitin, Destech Publication 2016, ISBN - 101-59506-1-879.
3. Nutrigenetics: Applying the Science of Personal Nutrition 1st edn. Martin Kohlmeier, Academia Press 2012 **ISBN:** 9780123859013
Reference Books
1. Handbook of Nutraceuticals and functional foods, 2nd edn, E C Willdman, CRC Press 2006, ISBN: 978-0-8493-6409-9
2. Nutraceutical and Functional Food Processing Technology. Joyce I. Boye, Wiley-Blackwell 2014, ISBN: 978-1-118-50494-9
3. Functional foods and Nutraceuticals, Aluko R E, Springer 2012, ISBN: 978-1-4614-3479-5

(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE) Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
UNIT-1, UNIT-4 and UNIT-5 should not have any choice.	**80**
The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	M	L	-	M	M	L	-	M
CO2	M	H	H	H	H	M	H	M	H	L	-	H
CO3	L	H	H	M	M	H	H	H	M	M	L	M
CO4	M	M	H	L	L	H	H	H	M	H	M	H
High-3 : Medium-2 : Low-1												

Professional Elective		
GMP, GLP, BIOSAFETY AND BIOBUSINESS (Theory)		
Course Code:16BT7G3		**CIE Marks:100**
Hrs/Week: L:T:P:S: 3:0:0:0		**SEE Marks:100**
Credits:03		**SEE Duration(Theory) : 3 Hrs**

Course Learning Objectives: The students will be able to

1. Promotes entrepreneurship in the field of engineering and acquire the awareness about the biosafety principles and their significance in engineering education.
2. Demonstrate the risks involved in various manufacturing activities, products and services
3. Conceptualizes safety measures in laboratory for handling and releasing of engineered products.
4. Evaluates the bio business dimensions of professional engineering and scientific practice and to develop an effective conceptual framework for addressing biobusiness related opportunities and challenges.

UNIT-I	6hrs

GLP (Good Laboratory Practice): Principles; Commodities; Apparatus. General Precautions-Storage, Test Systems, Standard protocols, and Quality assurance. Laboratory signage- safety level and containment. Treatment and disposal. Stock & lab ware- toxin and waste.

UNIT II	7hrs

GMP (Good Manufacture Practice): Basic components of GMP Facilities, Design, Materials, Flow, Environment Control, Prevention of Cross Contamination. Quality, concept of GMP, Quality Assurance & Quality control. Legal requirements pertaining to GMP.

UNIT III	7hrs

Biosafety: Guidelines for biosafety in teaching laboratories. ASM guidelines, Biological Materials, containment levels and zones. Biosafety program management, Biosecurity, Large scale work, Biological safety cabinets, Decontamination, Waste management, Emergency response plan, Incident reporting and Investigation.

UNIT IV	9 hrs

Business models; meaning and functions of a business model, basic types of models: vertical, product, platform and hybrid models. Transition in business models, models for biotech business in India, Intellectual property – plant patents: characteristics, composition, subject matter on microbial processes and products, patents involving micro-organisms, protection of Plant Varieties, Geographical Indications, protection of Traditional Knowledge. Governance of biotechnology and multilevel regulatory framework for GMOs.

UNIT V	7hrs

Biobusiness: Business plan – model vs plan, general considerations, proposal content, proposal preparation, risk analysis, case study. Funding: financial alternatives for start ups and established firms, venture capital, exit strategy, valuation, funding for biotech in India, case study. Licensing: meaning, scope, types, terms and trends, accessing technology, technology transfer, collaborations, partnerships, alliances, mergers and acquisitions, licensing of biotechnological inventions, case study.

Course Outcomes: After completing the course, the students will be able to

CO1	Describe in outline good laboratory practice and good manufacture practices respect to slander operating day to day in engineering practices.
CO2	Instilling an appreciation of the impact of technology on society and develop a higher level of an understanding of safety of engineering technologies.
CO3	Describe in outline of framework engineering concepts and biobusiness models.
CO4	Select suitable product and/ process for commercialization and Develop business plans.

Text Books

1. GMP for Equipment, Utilities and Facilities; Dr Jürgen Hofmann; ECA, Academy Publishers; Berlin Germany; First Edition; 2017
2. Canadian Biosafety Handbook, 24^{th} Edition; Public Health Agency of Canada; 2016. ISBN : 978 -1-100-25773-0

Reference Books

1. Dr. R. Ridley, Handbook on Good Laboratory Practice, World Health Organization, 2nd Edition. 2010 WHO Library Catalogues for non-clinical research and development ISBN 978 9241547550
2. Phillip A. Carson, N. Den, Good Clinical, Laboratory and Manufacturing Practices: Techniques for the QA Professionals 1st Edition Royal Society of Chemistry 2007. ISBN 9780854048342
3. Laird Wilson, Doug McCutcheon, Marilyn Buchanan Industrial Safety and Risk Management 1st Edition University of Albarta Press 2003. ISBN 0888643942.
4. Gurinder Shahi, Biobusiness: A Strategic Perspective Global BioBusiness Books, 2005. ISBN: 978080126456.

Scheme of Continuous Internal Evaluation (CIE):

(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	15
Test -1	30
Quiz -2	15
Test -2	30
Quiz -3	15
Test-3	30
Assignment	10
Total	**100**

Scheme of Semester End Examination (SEE):

Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	**80**
There should be five questions from five units. Each question should be for maximum of 16 Marks.	
The UNIT-1, UNIT-4 and UNIT-5 should not have any choice. The UNIT-2 and UNIT-3 should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom’s taxonomy level.	
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	-	-	-	M	M	L	L	-	-	M
CO2		M	-	M	-	L	-	-	L	-	-	L
CO3	M	M	L	-	-	M	M	-	L	-		M
CO4	H	M	L	-	M		-	-	-	-	-	L

High-3 : Medium-2 : Low-1

HPC AND BIG DATA ANALYSIS (Theory)		
Course Code:16BT7G4		**CIE Marks:100**
Hrs/Week: L:T:P:S: 4:0:0:0		**SEE Marks:100**
Credits:04		**SEE Duration(Theory) : 3 hrs**

Course Learning Objectives (CLO): Graduates shall be able to

1. Impart the basic concepts of High performance computing(HPC) in applied bioinformatics.
2. Understand and explain the role of HPC in large data driven operations.
3. Compare the difference in normal computing and HPC processing speed.
4. Develop basic scripts to run the commands in HPC

Unit – I	9 Hrs

Introduction to HPC: Introduction to Linux operating system, Basic commands used in HPC cluster, Major components and its functions in HPC Cluster- head node, login node, interactive node, compute node, I/O node, Hardware architecture of HPC-processor design, cache architectures, design and evaluation techniques, operating systems and compilers, communications libraries, programming strategies for vector and parallel computers, optimization strategies, grid computing.

Unit – II	9 Hrs

Introduction to shell scripting: Basics of shell scripting,invocation, variables, if-then-else. Loops, Workflows and nested workflows, How to submit and monitor workflow execution. HPC Data Storage, Serial and parallel batch jobs and scripting to run processes in parallel.

Unit – III	9 Hrs

Big Data analytics: Introduction of Cloud computing, Hadoop architecture. MIKE2.0, Multiple layer architecture, Distributed Parallel architecture, NGS data analysis using Hadoop.

Unit – IV	9 Hrs

Installation of Software Packages: Install R packages, Perl modules, Python modules and general software packages. Molecular dynamics and use of VMD Software's and tools used to access HPC cluster with examples. Applications of High performance Computing in the field of Bioinformatics.

Unit – V	9 Hrs

High throughput data analysis with HPC : Conversion of SRA files, FASTQC analysis using HPC – Command and tools required, interpretation of results. Adapter trimming, Alignment, Variant calling, Performing BLAST search, interpretation of results. Comparison of the results from various tools using HPC.

Expected Course Outcomes: After going through this course the student will be able to:

CO1	Understand the basic knowledge of High Performance Computing
CO2	Describe architectural hardware for high performance computing systems and

		installation of software packages
	CO3	Analyze and apply the appropriate tools and techniques to perform high throughput data analysis
	CO4	Develop parallel software tools using High Performance Computing

Reference Books:

1.	Naiara Rodríguez-Ezpeleta, Michael Hackenberg, Ana M. Aransay. Bioinformatics for High Throughput Sequencing. Springer, 2012. ISBN-13: 9781461407812.
2.	Stuart M. Brown. Review of Next-generation DNA sequencing informatics. Cold Spring Harbor Laboratory Press, Cold Spring Harbor: New York, 2013. ISBN-13: 978-1936113873.

Continuous Internal Evaluation (CIE) (Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	**20**
Objective type questions	
Part –B	**80**
There should be five questions from five units.	
Each question should be for maximum of 16 Marks.	
The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice.	
The **UNIT-2 and UNIT-3** should have an internal choice.	
Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	
Total	**100**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	M	M	L	-	L	L	M	
CO2	M	H	H	M	H	M	M	L	M	L	M	
CO3	M	H	H	H	M	H	H	M	H	M	H	
CO4	L	L	H	M	M	H	M	M	H	M	M	

High-3 : Medium-2 : Low-1

NANOTECHNOLOGY

Course Code : 12BTGH7XX		**CIE Marks: 100**
Hrs/Week: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Credits : 3		**SEE Duration: 3 Hrs**

Prerequisite: Physics, Chemistry, Biology, Mechanical engineering and electronics.

Course Learning Objectives:

1. To have the basic knowledge of nanomaterials and the process.
2. Describe methods of nanoscale manufacturing and characterization can be enabled.
3. To learn about Nano sensors and their applications in mechanical, electrical, electronic,
4. Magnetic, Chemical field.
5. To understand the concept for a nanoscale product based on sensing, transducing, and actuating mechanism.
6. To have awareness about the nanoscale products used in multidisciplinary fields.

	UNIT – I	**06 Hrs**

Introduction to Nanomaterials: History of Nanotechnology, structures and properties of carbon based, metal based, bionanomaterails and hybrids: Bucky Ball, Nanotubes, Diamond like carbon(DLC),Quantum Dots, Magnetic, Nano Shells, Dendrimers, Nanocarriers, Nanocrystals, hybrid biological/inorganic, protein & DNA based nanostructures. Nanosafety Issues: Toxicologyhealth effects caused by nanoparticles.

	UNIT– II	**06 Hrs**

Characterization of Nanostructures: Spectroscopy: UV-Visible spectroscopy, Fourier Transform infrared spectroscopy (FTIR), Raman Spectroscopy, X-ray spectroscopy. **Electron microscopy**: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM).**Scanning probe microscopy**: Atomic Force microscopy (AFM), Scanning tunnel microscopy (STM).

Nano Synthesis and Fabrication: Introduction & overview of Nanofabrication: Bottom up and Top down approaches using processes like Ball milling, Sol-gel Process, Chemical Vapour deposition (CVD), electrodeposition and various lithography techniques (Hard & Soft lithography).

	UNIT – III	**06 Hrs**

Nanosensors: Overview of nanosensors, prospects and market. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, Mechanics of CNTs, Biosensors: Biosensors in modern medicine.

	UNIT – IV	**06 Hrs**

Micro & Nano-Electromechanical systems **and Microfluidics**: MEMS/NEMS: Magnetic, Chemical and Mechanical Transducers –Sensing and Actuators. Microfludics: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps.

	UNIT – V	**06 Hrs**

Applications of Nanotechnology: Molecular electronics, molecular switches, mechanical cutting tools, machine components, magnets, DLC coated grinding wheels. Electrical, electronic, solar cells, Batteries, fuel cells, Nanofilters. Medical nanotechnology: in Diagnostics, Therapeutics, Drug delivery and Nanosurgery.

Course Outcomes: After completing the course the students will be able to:
CO1: Remember, understand, and apply knowledge about of nanomaterials and their uses.
CO2: Interpret and apply the techniques of manufacturing and characterization processes
CO3: Apply the knowledge of Nanosensors, related to nanosensors in electronics, mechanical, chemical, and biological systems.
CO4: Create and evaluate nano Design, Devices and Systems in various disciplines.

Text Books:

1. B.S. Murty., P. Shankar., B.Raj, B..B. Rath, and J. Murday, Textbook of Nanosciences and Nanotechnology, Springer, Co-publication with University Press (India) Pvt. Ltd. VCH, XII.1st Edition, 2013, ISBN- 978-3-642-28030-6.
2. V. K. Khanna, Nanosensors:, Physical, Chemical and Biological, CRC press, 1st edition, 2013, ISBN 9781439827123 (Unit III).

Reference Books

1. C. C. Kock., Nanostructured materials, Nanostructured materials, William Andrew Publishing, 2nd edition, 2007, ISBN 0-8155-1534-0.
2. M .Wilson., K. Kannangara., G.Smith., M.Simmons., B. Raguse., Nanotechnology, , overseas Press (India) Private Ltd.,1st edition, 2005,ISBN 81-88689-20-3.

Continuous Internal Evaluation (CIE)	
(Theory – 100 Marks)	
Evaluation method	**Course with assignment**
Quiz -1	10
Test -1	30
Quiz -2	10
Quiz -3	10
Test -2	30
Assignments	10
Total	**100**

Semester End Evaluation (SEE)	
Theory (100 Marks)	
Part- –A	
Objective type questions	**20**
Part –B	
There should be five questions from five units.	
Each question should be for maximum of 16	
Marks.	**80**
The **UNIT-1, UNIT-4 and UNIT-5** should not	
have any choice.	

The **UNIT-2 and UNIT-3** should have an internal	
choice.	
Both the questions should be of the same	
complexity in terms of COs and Bloom's	
taxonomy level.	
Total	**100**

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	M	H	M	H	H			L	M	
CO2	H	H	H	M	H	H	M		M			
CO3	H	M	M	M	M	L	L				L	
CO4	L	M	H	H	H	M	L			M		

High-3 : Medium-2 : Low-1

MAJOR PROJECT

COURSE CODE: 16BTP81 | **CIE Marks : 100**
HOURS/WEEK : L:T:P:S: 0:0:32:0 | **SEE Marks : 100**
CREDITS : 16 | **SEE Duration: 03 Hrs**

Objectives:

1. ***Knowledge Application:*** Students will acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
2. ***Communication:*** Students will acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both the written and oral forms.
3. ***Collaboration:*** Students will acquire collaborative skills through working in a team to achieve common goals.
4. ***Independent Learning:*** Students will be able to learn on their own, reflect on their learning and take appropriate action to improve it.
5. ***Management and Finance:*** Students will prepare schedules and budgets, they along with the guide keep track of the progress and expenditure.

Guidelines

1. Students are required to form a project team/batch before the end of 7th semester.
2. The departments must complete the Internal Guide allotment process before the end of 7th semester .
3. The project topic, title and synopsis has to be finalized and submitted to their respective internal guide(s) before the beginning of the 8th semester.
4. The detailed Synopsis (approved by the department ***Project Review Committee***) has to be submitted during the 1st week after the commencement of 8th semester.

Batch Formation:

- Students are free to choose their project partners from within the program or any other program (as interdisciplinary projects are encouraged).
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house / Industry / R & D Institution.
- ***The project work is to be carried out by a team of two to four students , in exceptional cases where a student is placed in a company and offered an internship through the competitive process or student is selected for internship at national or international level through competitive process***, the student can work independently.
- ***The students are allowed to do either a project for full 5 days in the industry or full 5 days in the college.***
- ***In case the project work is carried out outside Bengaluru, such students must be available during Project Evaluation process scheduled by the respective departments and they must also interact with their guide regularly through Email / Webinar / Skype etc.***

Project Topic Selection:

The topics of the project work must be in the ***field of respective program areas or in line with CoE's(Centre of Excellence) identified by the college*** or **List of project areas as given by industry/Faculty. The projects as far as possible should have societal relevance with focus on sustainability.**

Place of Project Work:

- The project work should be carried out in the college.
- The project work can also be carried out in the Industry, in case the project is given by the industry ***as internship, provided the department Project Review Committee approves the project*** and the facilities for carrying out such project work are not available in the college.
- In case additional facilities are required for testing etc., students are permitted to visit research labs, where such facilities are available. The HoD should be informed in such cases and No objection obtained.

Attendance Requirement:

- Students are required to satisfy minimum attendance criteria as prescribed by the Institution, i.e. (85%)
- Students who are doing project work in the industries are required to go to the industry for full 5 days.
- Students who are doing project work in the college, are required to come to the college for full 5 days (Monday- Friday) and attendance is mandatory.
- Students are requested to adhere to the schedule of various phases of project work.
- The guides shall be responsible to send attendance details every month through HoD, to the Dean(Student affairs)

Project Evaluation:

- Continuous monitoring of project work will be carried out and cumulative evaluation will be done.
- The students are required to meet their internal guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Internal Guide regularly.
- In case of ***Industry project***, during the course of project work, the internal guides will be in constant touch with external guides and will visit the industry at least thrice during the project period.
- For CIE assessment the project groups must give a final seminar with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to defend the work done.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department and a Soft copy on a CD, to the Central library.

- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.
- The Project team is required to demonstrate the functioning of the modules and the integrated application along with a presentation on the details of the project carried out during the Semester End Examination (SEE) in the department.
- Before the final evaluations the project group is required to produce a No dues certificate from Industry, Central Library and Department.

Course outcomes:

After the successful completion of the course, the students should be able to

CO1. Perform literature review, identify state of the art in that field and be able define the problem.

CO2. Establish a methodology using advanced tools / techniques for solving the problem including project management and finances.

CO3. Design, Develop Analytical models, Perform Numerical Analysis and Interpret the rresults.

CO4. Prepare quality document of project work for publications, patenting and final thesis.

CIE Assessment:

The following are the weightings given for the various stages of the project.

1. Selection of the topic and formulation of objectives 10%
2. Design and Development of Project methodology 25%
3. Execution of Project 25%
4. Presentation, Demonstration and Results Discussion 30%
5. Report Writing 10%

SEE Assessment:

The following are the weightages given during Viva Examination.

1. Written presentation of synopsis 10%
2. Presentation/Demonstration of the project 30%
3. Methodology and Experimental Results & Discussion 30%
4. Report 10%
5. Viva Voce 20%

Calendar of Events for the project Work:

Week	Event
Beginning of 7th Semester	Formation of Project Committee in the Department. Formation of group and approval by the department committee.
7th Semester	Problem selection and literature survey
Last two weeks of 7th Semester	Finalization of project and guide allotment

II Week of 8th Semester	Synopsis submission and preliminary seminar
III Week	First visit of the internal guides to industry (In case of project being carried out in industry)
III to VI Week	Design and development of project methodology
VII to IX Week	Implementation of the project
X Week	Second visit by guide to industry (In case of project being carried out in industry) & submission of draft copy of the project report
XI and XII Week	Third visit by guide to industry for demonstration. Final seminar by Department project Committee and guide for internal assessment. Finalization of CIE.

Evaluation Scheme for CIE and SEE

Scheme of Evaluation for CIE		Scheme of Evaluation for SEE	
Particulars	**%Marks**	**Particulars**	**%Marks**
Project Evaluation I	10%	Project Synopsis (Initial Write up)	10%
Project Evaluation II	25%	Project Demo / Presentation	30%
Project Evaluation III	25%	Methodology and Results Discussion	30%
Project Evaluation Phase-IV **(**Submission of Draft Project Report for Verification**)**	30%	Project Work Report	10%
Project Evaluation Phase-V **(**Project Final Internal Evaluation**)**	10%	Viva-voce	20%
Total	100	Total	100

TECHNICAL SEMINAR

COURSE CODE: 16BTS82 | **CIE Marks : 50**
HOURS/WEEK: L:T:P:S: 0:0:4:0 | **SEE Marks : 00**
CREDITS: 02 | **SEE Duration : NA**

Course Learning Objectives:

1. To create awareness to recognize recent developments in Electronics & Communication and in multidisciplinary fields.
2. To summarize the recent technologies and inculcate the skills for literature survey.
3. To demonstrate good presentation skills.
4. To plan and improve the Technical Report writing skills.
5. To support Group discussion and Team work.

General Guidelines for the Seminar

1. The seminar has to be presented by individual student.
2. The topic of the seminar should be from current thrust area. This is to be decided in consent with internal guide.
3. The topic can be based on standard papers (like IEEE/ACM/CSI etc.) in the thrust area for the selected topic.
4. Each student has to prepare a technical paper out of seminar topic.
5. Presenting/publishing this paper in conference/ Journal will be given weightage in CIE.
6. The student needs to submit both hard & soft copy of the seminar report.

Course Outcome:
At the end of this course the student will be able to:

CO1. Understand and interpret latest advancements through different technical papers, reports, Journals, Data sheets, books etc..
CO2. Communicate his/her ideas with his peers as audience, which will enhance both oral and written communication skills.
CO3. Learn to manage resources effectively.
CO4. Create interest to pursue lifelong learning.

Evaluation of CIE Marks:

1. Relevance of the topic :10%
2. Literature Survey :10%
3. Presentation : 40%
4. Report : 20%
5. Paper Publication : 20%

INNOVATION & SOCIAL SKILLS

COURSE CODE: 16 HSS83
HOURS/WEEK: L:T:P:S : 0:0:4:0
CREDITS: 02

Objectives:

- To provide a platform for the students to exhibit their organizational capabilities, team building, ethical values and extra mural abilities.
- To encourage to carryout innovative ideas and projects.
- Take part in societal and community building activities.
- Make self learning, ethics and lifelong learning a motto.

Guidelines

The HSS will be evaluated individually based on the broad parameters which include the progress made by student during 3^{rd}& 4^{th} year in innovative projects, Seminar, Paper Presentation, Field activity & other Co-curricular activities. Students shall submit a report and documents as a proof his/her achievements.