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 for III & IV Semesters

2016 SCHEME

BIOTECHNOLOGY

Department Vision

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

Department 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)

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 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

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2016 SCHEME

BIOTECHNOLOGY

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1	VTU	Visvesvaraya Technological University
2	BS	Basic Sciences
3	CIE	Continuous Internal Evaluation
4	BT	Biotechnology
5	CS	Computer Science and Engineering
6	CV	Civil Engineering
7	CHY	Chemistry
8	EC	Electronics and Communication Engineering
9	EE	Electrical and Electronics Engineering
10	ES	Engineering Science
11	HSS	Humanities and Social Sciences
12	ME	Mechanical Engineering
13	PHY	Engineering Physics
14	SEE	Semester End Examination
15	MAT	Engineering Mathematics
16	IS	Information Science

INDEX

III Sem			
Sl. No.	Course Code	Name of the Course	Page No.
1.	16MA31	Applied Mathematics - III	1
2.	16EB32	Biology for Engineers	3
3.	16BT33	Biochemistry	5
4.	16BT34	Cell and Microbiology	8
5.	16BT35	Unit Operations	11
6.	16BT36	Thermodynamics	14
7.	16DMA37	Bridge Course Mathematics	16
IV Sem			
8.	16BT41	Biostatistics	18
9.	16ET42	Environmental Technology	20
10.	16BT43	Biophysics. & Instrumentation techniques	22
11.	16BT44	Basics of Computer applications	25
12.	16BT45	Process Principles and Calculations	29
13.	16BT46	Molecular Biology	31
14.	16HS47	Professional Practice –II (Teamwork & Professional ethics)	33
15.	16DSC48	Bridge Course C programming	35

R V COLLEGE OF ENGINEERNG, BENGALURU-560 059
(Autonomous Institution Affiliated to VTU, Belagavi)

THIRD SEMESTER CREDIT SCHEME								
Sl. No.	Course Code	Course Title	BoS	CREDIT ALLOCATION				
				L	T	P	SS	Total Credits
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	Bridge Course Mathematics	Maths	2*	0	0	0	0
Total number of Credits				17	02	03	03	25
Total Number of Hours / Week				17+2*	04	06	12**	29

FOURTH SEMESTER CREDIT SCHEME								
Sl. No.	Course Code	Course Title	BoS	CREDIT ALLOCATION				
				L	T	P	SS	Total Credits
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 (Communication Skills and Professional Ethics)	HSS	0	0	1	0	1
8.	16DCS48	Bridge Course C programming	CSE	2*	0	0	0	0
Total number of Credits				17	02	03	03	25
Total Number of Hours / Week				17+2*	04	06	12**	27

***Mandatory audit course for lateral entry diploma students**
**** Non-contact hours**

Semester: III		
APPLIED MATHEMATICS – III **(AS, BT, CH, CV, IM, ME)**		
Course Code: 16MA31C		**CIE Marks: 100**
Credits: L:T:P:S: 3:1:0:0		**SEE Marks: 100**
Hours: 36L+12T		**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 functionals with applications to physical situations.
3	Understand the basics of Matrix theory, Eigen values and Eigen vectors, its applications for finding solution of system of linear equations.
4	Analyse the given set of experimental data and fit suitable approximating curves.

Unit-I	
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.	**07 Hrs**
Unit – II	
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 equations.	**07 Hrs**
Unit -III	
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.	**07 Hrs**
Unit –IV	
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.	**08 Hrs**
Unit –V	
Statistics: Curve fitting by method of least squares, fitting of curves-linear, parabolic, exponential, power functions, correlation, regression analysis – problems.	**07 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the fundamental concepts of Laplace and inverse Laplace transforms, variation of functions, elementary transformation of matrices, 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:	Analyse and interpret- solution of IVP and BVP, solution of functionals, solution of linear systems, statistical data occurring in Engineering problems.

Reference Books	
1	Higher Engineering Mathematics, B.S. Grewal, 40th Edition, 2007, Khanna Publishers, ISBN: 81-7409-195-5.
2	Higher Engineering Mathematics, B. V. Ramana, 2008, Tata McGraw-Hill, ISBN: 13-978-07-063419-0.
3	Advanced Engineering Mathematics, Erwin Kreyszig, 9th Edition, 2007, John Wiley & Sons, ISBN: 978-81-265-3135-6.
4	Introduction to Probability and Statistics, Lipshutz and Schiller (Schaum's outline series), ISBN:0-07-038084-8.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	1	2	2	-	-	-	-	-	-	-	-	1
CO4	-	1	1	3	-	-	-	-	-	-	-	1

High-3 : Medium-2 : Low-1

Semester III		
BIOLOGY FOR ENGINEERS **(Theory)** **(Common to BT, CS and IS)**		
Course Code:16EB32		**CIE Marks: 50**
Credits: L:T:P:S: 2:0:0:0		**SEE Marks: 50**
Hours : 23 L		**SEE Duration: 2 Hrs**

Course Learning Objectives: The students will be able to	
1	Familiarize themselves with basic biological concepts
2	Get an interdisciplinary vision of biology and engineering
3	Gain an understanding that the design principles from nature can be translated into novel devices and structures
4	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 Bio inspirations: Bionic leaf and Photovoltaic cells.	
UNIT IV	**05 Hrs**
Bio inspired 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

Reference Books	
1.	Principles of Biochemistry, Donald Voet, Judith G. Voet, Charlotte W. Pratt, 4th Edition, 2012, John Wiley & Sons, ISBN-10: 1118092449, ISBN-13: 978-1118092446
2.	Principles Of Physiology, Pramanik Debasis, 5th Edition, 2015, Jaypee Brothers Medical Publishers, ISBN-10: 9351529290, ISBN-13: 978-9351529293
3.	Biomimetics: Biologically Inspired technologies, Yoseph Bar-Cohen, 1st Edition, 2005, CRC press, ISBN: 9780849331633
4.	Bioinspired Engineering, Jenkins, C.H., 2011, Momentum press, ISBN-10: 1606502239 ISBN-13: 978-1606502235

Continuous Internal Evaluation (CIE); Theory (50 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 05 marks adding up to 15 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 25 marks each and the sum of the marks scored from three tests is reduced to 30. The marks component for Assignment is 05. The total marks of CIE are 50.

Semester End Evaluation (SEE); Theory (50 Marks)

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 10 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 8 marks adding up to 40 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	-	-	1	-		1	2	-	1
CO2	1	1	2	1	-	1	-	-	1	2	-	1
CO3	1	2	2	1	-	1	-	-	1	2	-	1
CO4	2	3	3	1	2	2	1	-	1	2	-	2

High-3 : Medium-2 : Low-1

Semester III		
BIOCHEMISTRY (Theory and Practice)		
Course Code:16BT33		**CIE Marks:100+50 = 150**
Credits: L:T:P:S: 3:0:1:1		**SEE Marks:100+50 = 150**
Hours: 35 L		**SEE Duration (Theory) : 3 Hrs**
		SEE Duration (Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to	
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	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	Comprehend the different metabolic pathways and their interconnection into tightly regulated networks

UNIT-I	
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.	**07 Hrs**
UNIT II	
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.	**07 Hrs**
UNIT III	
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.	**07 Hrs**
UNIT IV	
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.	**07 Hrs**
UNIT V	
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.	**07 Hrs**

LABORATORY 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 their functions.
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.

Reference Books	
1.	Principles of Biochemistry, Donald Voet, Judith G. Voet, Charlotte W. Pratt, 4th Edition, 2012, John Wiley & Sons, ISBN-10: 1118092449, ISBN-13: 978-1118092446
2.	Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 6th Edition, 2012, W.H. Freeman, ISBN-10: 1429234148, ISBN-13: 978-1429234146
3.	Biochemistry, U Satyanarayana, 2nd Edition, 2008, Books & Allied Ltd, ISBN-10: 8187134453 ISBN-13: 978-8187134459
4.	Biochemistry, Denise Ferrier, Lippincott, 2017, Williams & Wilkins, ISBN: 149636354X, 9781496363541

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total CIE for theory is 100.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory – 100 Marks

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	-	1	1	1	-	-	-	-	-	1
CO2	3	1	-	1	1	-	-	-	-	-	-	1
CO3	3	2	2	2	2	2	2	1	1	2	-	2
CO4	3	3	3	3	3	2	2	3	3	3	-	2

High-3 : Medium-2 : Low-1

Semester III		
CELL AND MICROBIOLOGY (Theory and practice)		
Course Code:16BT34		**CIE Marks:100+50 = 150**
Credits: L:T:P:S: 3:0:1:1		**SEE Marks:100+50 = 150**
Hours: 35L		**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	**07 Hrs**
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	**07 Hrs**
Genetics: Chromosomes, nucleosomes, euchromatin and heterochromatin. 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	**07 Hrs**
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	**07 Hrs**
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	**07 Hrs**
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.	

LABORATORY 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 the experiments in a semester.
Self study topics: 1. Study the effects of compounds on growth and development of microbes/plants. **2.** Isolation of beneficial microorganisms from natural sources.

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.

Reference Books	
1.	Concepts in Biology, Eldon Enger, Frederick C Ross, David Bailey, 14th Edition, 2014, McGraw Hill Education, ISBN-10: 0073403466, ISBN-13: 978-0073403465
2.	Genetics, Elrod SL, Stansfield WD, Bhowmik G, Tata McGraw-Hill, 4th Edition, 2009, ISBN-13: 9780070139190
3.	Cell Biology, Pollard TD, Earnshaw WC, Lippincott-Schwartz J, Johnson GT, 3rd Edition, 2016, Elsevier, ISBN-9780323341264
4.	Prescott's Microbiology, Willey J, Sherwood L and Woolverton CJ, 10th Edition, 2017, McGraw Hill Education, ISBN-13: 978-1259659836, ISBN-10: 1259659836

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total CIE for theory is 100.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory – 100 Marks

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	2
CO2	3	2	-	-	-	-	-	-	-	2	-	2
CO3	2	2	3	2	1	-	-	2	2	2	-	2
CO4	2	2	1	-	-	-	-	-	-	2	-	2

High-3 : Medium-2 : Low-1

Semester III		
UNIT OPERATIONS (Theory and practice)		
Course Code:16BT35		**CIE Marks:100+50 = 150**
Credits: L:T:P:S: 3:0:1:1		**SEE Marks:100+50**
Hours: 36 L		**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 behavior of fluids.
2	Learn the various separation techniques useful to separate the biological compounds.
3	Interpret the behavior of heat transfer in biological systems.
4	Apply principles of Unit operations in biological systems

UNIT-I	**7 Hrs**
Dimensional Analysis: Units, Dimensions, Basic and Derived Units, Dimensional homogeneity, Dimensionlessnumbers, 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'sequation, simple numerical.	
UNIT II	**7 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	**7 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	**8 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	**7 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.	

LABORATORY 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.
Self Study: Chemicals and liquid fuels from biomass Biosynthesis of nanomaterials and its application in biotechnology

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	Design and analyse the performance of heat exchangers and distillation column with reflux
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.

Reference Books	
1.	Unit Operations in Chemical Engineering,W. L. McCabe, J. C. Smith and P. Harriott, 7th Edition, 2005, McGraw-Hill, ISBN-10: 0072848235, ISBN-13: 978-0072848236
2.	Fluid Mechanics and Hydraulics of Machines, R.K.Bansal, 9th Edition., 2017, Laxmi Publications, NewDelhi, ISBN-10: 8131808157,ISBN-13: 978-8131808153
3.	Mass-Transfer Operations, Robert Ewald Treybal, 3rd Edition, 2012, Mc Graw Hill India, ISBN-10: 1259029158, ISBN-13: 978-1259029158
4.	Introduction To Chemical Engineering, Walter L. Badger and Julius T. Banchrero, 1st Edition, McGraw-Hill Education, ISBN-10: 0074630504, ISBN-13: 978-0074630501

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total CIE for theory is 100.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory – 100 Marks

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	2	2	1	1	-	-	2
CO2	3	2	-	-	-	1	-	-	1	-	-	1
CO3	2	2	1	-	-	2	2	-	1	-	-	2
CO4	2	1	1	-	-	2	-	-	-	-	-	1

High-3 : Medium-2 : Low-1

Semester: III		
THERMODYNAMICS (Theory)		
Course Code: 16BT36		**CIE Marks: 100**
Credits: L:T:P:S: 3:1:0:0		**SEE Marks: 100**
Hours: 36L+24T		**SEE Duration: 03Hrs**
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. **SolutionThermodynamics:**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, and 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

Reference Books	
1.	Introduction to Chemical Engineering, Thermodynamics, M. Smith, H. C. Van Ness, M. M. Abbott. 7thEdition, 2009, McGraw Hill Publication, ISBN- 97-800-7310-445.
2.	Chemical Engineering Thermodynamics, K.V. Narayanan, 1st Edition, 2004, Prentice Hall of India, New Delhi, ISBN-81-203-1732-7.
3.	Chemical Engineering Thermodynamics, Y.V.C. Rao, 1st Edition, 2000, New Age International Publication, Nagpur, ISBN-81-737-1087.
4.	Chemical, Biochemical and Engineering Thermodynamics, Stanly I. Sandler, 4th Edition, 2006, John Wiley, Publication, ISBN-04-716-6174-0.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	-	2	2	1	1	-	2	2
CO2	3	3	2	2	-	1	-	-	1	-	2	2
CO3	3	3	3	2	-	2	2	-	1	-	2	2
CO4	3	3	2	2	1	2	-	-	-	-	2	2

High-3: Medium-2: Low-1

Semester: III		
BRIDGE COURSE MATHEMATICS I / II		
Course Code: 16DMA37		**CIE Marks:** 100
Credits: L:T:P:S: 2:0:0:0		**SEE Marks:** 100
Audit Course		**SEE Duration:** 03Hrs

Course Learning Objectives: The students will be able to	
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 formulas, methods of differentiation, methods of integration, reduction formulae, vector algebra.

UNIT-I	
Differential Calculus: Taylor and Maclaurin's series for function of single variable. Partial derivatives – Introduction, simple problems. Total derivative, Composite functions, Jacobian's- simple problems.	**05 Hrs**
UNIT-II	
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.	**05 Hrs**
UNIT-III	
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.	**06 Hrs**
UNIT-IV	
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.	**05 Hrs**
UNIT-V	
Numerical Methods: Algebraic and transcendental equations – Regula-Falsi method, Newton-Raphson method. Ordinary Differential Equations – Taylor's, modified Euler's and 4^{th} order Runge-Kutta methods. Numerical Integration – Simpson's $1/3^{rd}$, $3/8^{th}$ and Weddle's rules.	**05 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	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.
CO2:	Solve problems on total derivatives of implicit functions, double integrals by changing order of integration, homogeneous linear differential equations, velocity and acceleration vectors.
CO3:	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.
CO4:	Evaluate multiple integrals by changing variables, different operations using del operator and numerical solutions of differential equations and numerical integration.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE consists of Two Tests each for 50 marks (20 marks for Quiz + 30 marks for descriptive questions)

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from each unit have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: IV		
BIOSTATISTICS (Theory)		
Course Code: 16BT41		**CIE Marks: 100**
Credits: L:T:P:S: 3:1:0:0		**SEE Marks: 100**
Hours: 35 L + 24 T		**SEE Duration: 03Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the importance of applied mathematics, so that they can use their domain knowledge and apply to Biotechnology.	
2	Understand and explain the importance of applied mathematics in Biotech industries	
3	Use the probability and statistics theory in applied mathematics	
4	Design and analyse mathematical modeling in the field of Biotechnology	

UNIT-I	**07 Hrs**
Introduction and Data presentation: Basic concepts, definitions, formulae, commonterms 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	**07 Hrs**
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	**08 Hrs**
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	**07 Hrs**
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	**07 Hrs**
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.

Reference Books	
1.	Engineering Mathematics-IV, Dr. K S. Chandrashekar, 1st Edition 2017, Sudha publications, ISBN:10: 8193001087, ISBN: 13: 978-8193001080
2.	Introduction to Biostatistics, Pranab Kumar Banerjee, 3rd Edition, 2011, S. Chand & Co. Ltd, ISBN-10: 8121923298, ISBN-13: 978-8121923293
3.	Fundamentals of Biostatistics, Khan and Khanum, 2009, Ukaaz publications, ISBN-10: 8190044109, ISBN-13: 978-8190044103.
4.	Principle of Biostatistics, Marcello Pagano and Kimberlee Gauvreau, 2nd Edition, 2018, Chapman and Hall/CRC, ISBN: 9781138593145

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy

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

Semester: IV		
ENVIRONMENTAL TECHNOLOGY (Theory)		
Course Code: 16ET42		**CIE Marks: 50**
Credits: L:T:P:S: 2:0:0:0		**SEE Marks: 50**
Hours: 25 L		**SEE Duration: 02Hrs**
Course Learning Objectives: The students 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.
Reference Books	
1.	Introduction to environmental engineering and science, Gilbert, M.M. ,Pearson Education. 2nd Edition, 2004, ISBN: 8129072770.
2.	Environmental Engineering, Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, 2000, McGraw Hill Series in water resources and Environmental Engg., ISBN: 0070491348
3.	Environmental Science – 15th Edition, G. Tyler Miller, Scott Spoolman, 2012, Publisher: Brooks Cole, ISBN-13: 978-1305090446 ISBN-10: 130509044
4.	Environment Management, Vijay Kulkarni and T. V. Ramachandra, 2009, TERI Press, ISBN: 8179931846, 9788179931844

Continuous Internal Evaluation (CIE); Theory (50 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 05 marks adding up to 15 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 25 marks each and the sum of the marks scored from three tests is reduced to 30. The marks component for Assignment is 05. The total marks of CIE are 50.

Semester End Evaluation (SEE); Theory (50 Marks)

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 10 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 8 marks adding up to 40 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	3	-	2	-		-
CO2	2	3	3	2	1	-	3	3	2	-	2	1
CO3	-	3	1	3	-	2	3	3	2	-	1	2
CO4	1	-	2	1	3	-	2	-	2	-	-	2

High-3: Medium-2: Low-1

Semester IV		
BIOPHYSICS AND INSTRUMENTATION TECHNIQUES (Theory and Practice)		
Course Code:16BT43		**CIE Marks:100+50 = 150**
Credits: L:T:P:S: 3:0:1:1		**SEE Marks:100+50 = 150**
Hours: 36 L		**SEE Duration (Theory) : 3 Hrs**
		SEE Duration (Laboratory) : 3 Hrs

Course Learning Objectives: The students will be able to	
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	Get familiarized 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 sidechains 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 IV	**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	

LABORATORY EXPERIMENTS
1. Estimation of DNA concentration in a given sample using ultravioletspectrophotometer. 2. Estimation of protein concentration in a given sample using visiblespectrophotometer. 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 flamephotometer. 6. Analysis of biologically important metals using atomic absorptionspectrometer. 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

Reference Books	
1.	Principles of Biochemistry, Donald Voet, Judith G. Voet, Charlotte W. Pratt, 4th Edition, 2012, John Wiley & Sons, ISBN-10: 1118092449, ISBN-13: 978-1118092446
2.	Principles and Techniques of Biochemistry and Molecular Biology, Keith M. Wilson, John M. Walker., 8th Edition, 2010, Cambridge University Press. ISBN-13: 978-1316614761 ISBN-10: 131661476X
3.	Chromatography: Concepts and Contrasts, James M. Miller, 2nd Edition, 2004, John Wiley& Sons, ISBN-10: 0471472077, ISBN-13: 978-0471472070
4.	Essentials of Biophysics, Narayanan P, 2nd Edition, 2009, New Age International Pvt Ltd Publishers, ISBN-10: 1848290349, ISBN-13: 978-1848290341

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total CIE for theory is 100.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory – 100 Marks

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	-	1	1	1	-	-	-	-	-	1
CO2	3	1	-	1	1	-	-	-	-	-	-	1
CO3	3	2	2	3	2	2	2	1	1	2	-	2
CO4	3	3	3	3	3	2	2	3	3	3	-	2

High-3: Medium-2: Low-1

Semester IV		
BASICS OF COMPUTER APPLICATIONS (Theory and Practice)		
Course Code:16BT44		**CIE Marks:100+50 = 150**
Credits: L:T:P:S: 3:0:1:1		**SEE Marks:100+50 = 150**
Hours: 36 L		**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	**07 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	**08 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	**07 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	**07 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	**07 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, RungeKutta 2nd and 4th order method, and Euler's backward method.	

LABORATORY EXPERIMENTS

1. Write and execute the following Linux commands
   a. sed command that deletes the first character in each line in a file.
   b. sed command that swaps the first and second words in each line in a file.
   c. sed command that trim HTML codes in a given HTML file.
   d. sed command that trim empty lines in a given HTML file.
   e. grep command to display lines containing 'phrase' in a file.
2. Write and execute the following shell scripts
   a. Write a shell script that takes a command–line argument and reports on whether it is directory, a file, or something else.
   b. Write a shell script that accepts two integers as its arguments and computers the value of first number raised to the power of the second number.
   c. Write an interactive file-handling shell program. Let it offer the user the choice of copying, removing, renaming, or linking files. Once the user has made a choice, have the program ask the user for the necessary information, such as the file name, new name and so on.
3. Write and execute the following shell scripts
   a. Write a Shell program that parse information on author, taxonomy and coding sequence of 100 GenBank sequence files.
   b. Write shell program to parse fasta ids and the sequences from the BLAST Reports.
4. Write and execute a shell program to read a gene ids from one file and parse corresponding sequence from present in another sequence file in the current working directory.
5. Write and execute a shell program to parse atomic and hetero-atomic sections of PDB file and estimate the atomic frequencies.
6. 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, and BCA as its members. Use friend class that access the details of student and calculates total, average marks and prints the result.
7. a. Write a C program to maintain a record of "n" student details using an array of structures with four or five lds (Roll number, Name, Marks, and Grade). Assume appropriate data type for each field. Print the marks of the student, given the student name as input.
   b. Write a C program using pointers to compute the sum, mean and standard deviation of all elements stored in an array of "n" real numbers.
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 sequences from the sequence database based on set of fasta Ids'.
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
eperiments are GUIDED experiments
03 Experiments involving experiential learning.

Self study:

1. Sequence analysis
2. Molecular modeling and Simulation

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.

Reference Books	
1.	Linux Command Line and Shell Scripting Bible, Richard Blum, Christine Bresnahan , 3rd Edition, 2015, John Wiley & Sons, ISBN-13: 978-1118983843, ISBN-10: 111898384X
2.	C ++for Engineers and Scientists, GaryJ.Bronson, Cengage Learning, 4th Edition, 2012, Course Technology, ISBN-10: 1133187846, ISBN-13: 978-1133187844
3.	Linux: The Complete Reference, Richard Petersen, 6th Edition, 2007, McGraw-Hill Education, ISBN-13: 978-0071492478, ISBN-10: 007149247X
4.	Object Oriented Programming with C++, Balagurusamy, 6th Edition, 2013, Tata McGraw-Hill Education, ISBN-10: 125902993X, ISBN-13: 978-1259029936

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total CIE for theory is 100.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory – 100 Marks

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	3	2	3	3	-	-	2	1	-
CO2	3	3	2	2	3	1	2	-	2	-	-	-
CO3	3	2	3	2	2	3	3	-	-	-	2	-
CO4	1	3	3	3	3	2	1	-	-	-	-	-

High-3: Medium-2: Low-1

Semester: IV		
PROCESS PRINCIPLES AND CALCULATIONS (Theory)		
Course Code: 16BT45		**CIE Marks:** 100
Credits: L:T:P:S: 3:0:0:1		**SEE Marks:** 100
Hours: 36 L		**SEE Duration:** 03Hrs

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 absoebed and released in chemical 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	

Course Outcomes: After completing the course, the students 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

Reference Books	
1.	Stoichiometry, Bhatt B. I. and Thakore S.B., 5th Edition, 2010, McGraw Hill, ISBN-10: 0070681147, ISBN-13: 978-0070681149
2.	Basic Principles and Calculations in Chemical Engineering, Himmelblau D.M. and J.B.Riggs, , 8th Edition, 2012, Prentice Hall, ISBN-13: 978-0132346603, ISBN-10: 0132346605
3.	Chemical Process Principles Part–I, Material and Energy Balances,vHougen O. A., Waston K. M. and Ragatz R. A., 2nd ed, CBS Publishers and Distributors, ISBN- 13: 9798123909539.
4.	Elementary Principles of Chemical Processes, Felder R.M. and Rousseau R.W., L.G.Bullard, 4th Edition, 2015, Wiley, ISBN-13: 978-1118431221, ISBN-10: 1118431227

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	1	1	-	-	-	-	-	-	2
CO2	2	2	2	2	1	-	-	-	1	-	-	2
CO3	2	3	1	2	1	-	-	-	1	-	-	2
CO4	2	3	1	2	1	-	-	-	1	-	-	2

High-3: Medium-2: Low-1

Semester: IV		
MOLECULAR BIOLOGY (Theory)		
Course Code: 16BT46		**CIE Marks:** 100
Credits: L:T:P:S: 3:1:0:0		**SEE Marks:** 100
Hours: 36 L + 24 T		**SEE Duration:** 03Hrs
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	**06 Hrs**
Macromolecularorganization 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	**08 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, Tumor suppressor genes and their mechanism of action. DNA recombination; homologous and site-specific recombination,Transposons.	
UNIT III	**08 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	**07 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	**07 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 post translational 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 publications.

Reference Books	
1.	Molecular Biology, David P. Clark, Nanette J. Pazdernik., 2nd Edition, 2013, Academic Press, ISBN-13: 978-0123785947, ISBN-10: 0123785944
2.	Molecular Biology, Lodish H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H, 7th Edition, 2013, Freeman, ISBN-10: 1464109818, ISBN-13: 978-1464109812.
3.	Cell and Molecular Biology, Gerald Karp, 7th Edition , 2013, Wiley, ISBN-13: 978-1118301791 ISBN-10: 111830179X
4.	Principles of Biochemistry, Donald Voet, Judith G. Voet, Charlotte W. Pratt, 4th Edition, 2012, John Wiley & Sons, ISBN-10: 1118092449, ISBN-13: 978-1118092446

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	2	-	2
CO2	2	2	2	2	-	-	-	-	-	2	-	2
CO3	2	2	2	2	-	-	-	-	-	2	-	2
CO4	3	3	3	3	-	-	-	-	3	3	-	3

High-3: Medium-2: Low-1

III / IV Semester			
Professional Practice – II **COMMUNICATION SKILLS AND PROFESSIONAL ETHICS**			
Course Code: 16HS47			**CIE Marks:** 50
Credits: L:T:P:S: 0:0:1:0			**SEE Marks:** NA
Hours: 18 Hrs			**CIE Duration:** 02 Hrs
Course Learning Objectives: The students will be able to			
1	Develop communication style, the essentials of good communication and confidence to communicate effectively.		
2	Manage stress by applying stress management skills.		
3	Ability to give contribution to the planning and coordinate Team work.		
4	Ability to make problem solving decisions related to ethics.		

III Semester	
UNIT-I	
Communication Skills: Basics, Method, Means, Process and Purpose, Basics of Business Communication, Written & Oral Communication, Listening. **Communication with Confidence & Clarity**- Interaction with people, the need the uses and the methods, Getting phonetically correct, using politically correct language, Debate & Extempore.	**06 Hrs**
UNIT-II	
Assertive Communication- Concept of Assertive communication, Importance and applicability of Assertive communication, Assertive Words, being assertive. **Presentation Skills**- Discussing the basic concepts of presentation skills, Articulation Skills, IQ & GK, How to make effective presentations, body language & Dress code in presentation, media of presentation.	**06 Hrs**
UNIT-III.A	
Team Work- Team Work and its important elements Clarifying the advantages and challenges of team work Understanding bargains in team building Defining behaviour to sync with team work Stages of Team Building Features of successful teams.	**06 Hrs**
IV Semester	
UNIT-III.B	
Body Language & Proxemics - Rapport Building - Gestures, postures, facial expression and body movements in different situations, Importance of Proxemics, Right personal space to maintain with different people.	**06 Hrs**
UNIT-IV	
Motivation and Stress Management: Self-motivation, group motivation, leadership abilities, Stress clauses and stress busters to handle stress and de-stress; Understanding stress - Concept of sound body and mind, Dealing with anxiety, tension, and relaxation techniques. Individual Counselling & Guidance, Career Orientation. Balancing Personal & Professional Life-	**06 Hrs**
UNIT-V	
Professional Practice - Professional Dress Code, Time Sense, Respecting People & their Space, Relevant Behaviour at different Hierarchical Levels. Positive Attitude, Self Analysis and Self-Management. **Professional Ethics** - values to be practiced, standards and codes to be adopted as professional engineers in the society for various projects**.** Balancing Personal & Professional Life	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Inculcate skills for life, such as problem solving, decision making, stress management.
CO2:	Develop leadership and interpersonal working skills and professional ethics.
CO3:	Apply verbal communication skills with appropriate body language.
CO4:	Develop their potential and become self-confident to acquire a high degree of self.
Reference Books	
1.	The 7 Habits of Highly Effective People, Stephen R Covey,Free Press, 2004 Edition, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie,General Press, 1st Edition, 2016, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan, 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Aptimithra: Ethnus, Best Aptitude Book ,2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE)
Evaluation of CIE will be carried out in TWO Phases

Phase	Activity	Weightage
I	Test 1 is conducted in III Sem for 50 marks (15 Marks Quiz and 35 Marks Descriptive answers) after completion of Unit-1, Unit-2 and Unit -3.A for 18 hours of training sessions.	50%
II	Test 2 is conducted in IV Sem for 50 marks ((15 Marks Quiz and 35 Marks Descriptive answers) after completion of Unit -3B, Unit - 4 and Unit-5 for 18 hours of training sessions.	50%
	At the end of the IV sem Marks of Test 1 and Test 2 is consolidated for 50 marks (Average of Test1 and Test 2 (T1+T2/2). The grading is provided by the Coe. The final CIE marks is scrutinized by the committee comprising of HSS- Chairman, Training Co-ordinator, respective department Staff Placement co-ordinator before submitting to CoE.	

SEE: NA

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	---	___	---	----	1	----	1	1	1	2	1
CO2	1	2	2	---	---	---	----	1	2	1	2	1
CO3	---	---	3	---	---	1	---	2	1	2	1	---
CO4	---	---	___	---	----	1	3	1	1	1	1	---

Low-1 Medium-2 High-3

IV Semester		
C PROGRAMMING (BRIDGE COURSE) **(Theory)**		
Course Code: 16DCS48		**CIE Marks: 100**
Credits: L:T:P:S : 2:0:0:0 (Audit Course)		**SEE Marks: 100**
Hours: 24L		**SEE : 03 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 functions, Functions with arrays, Storage classes.	**03 Hrs**
Structures and Unions Introduction, Structure definition, Declaring structure variables, Accessing structure members, Structure initialization, Copying and comparing structure variables, Arrays of	**03 Hrs**

structure, Arrays within structures, Structures and functions, Unions.	
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	
CO1.	Understand and explore the fundamental computer concepts and basic programming principles like data types, input/output functions, operators, programming constructs and user defined functions.
CO2.	Analyze and Develop algorithmic solutions to problems.
CO3.	Implement and Demonstrate capabilities of writing 'C' programs in optimized, robust and reusable code.
CO4.	Apply appropriate concepts of data structures like arrays, structures, and files to implement programs for various applications.

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

Scheme of Continuous Internal Evaluation:

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The two tests are conducted and each test is evaluated for 30 marks adding up to 60 marks The marks component for assignment is 10. The total marks of CIE are 100.

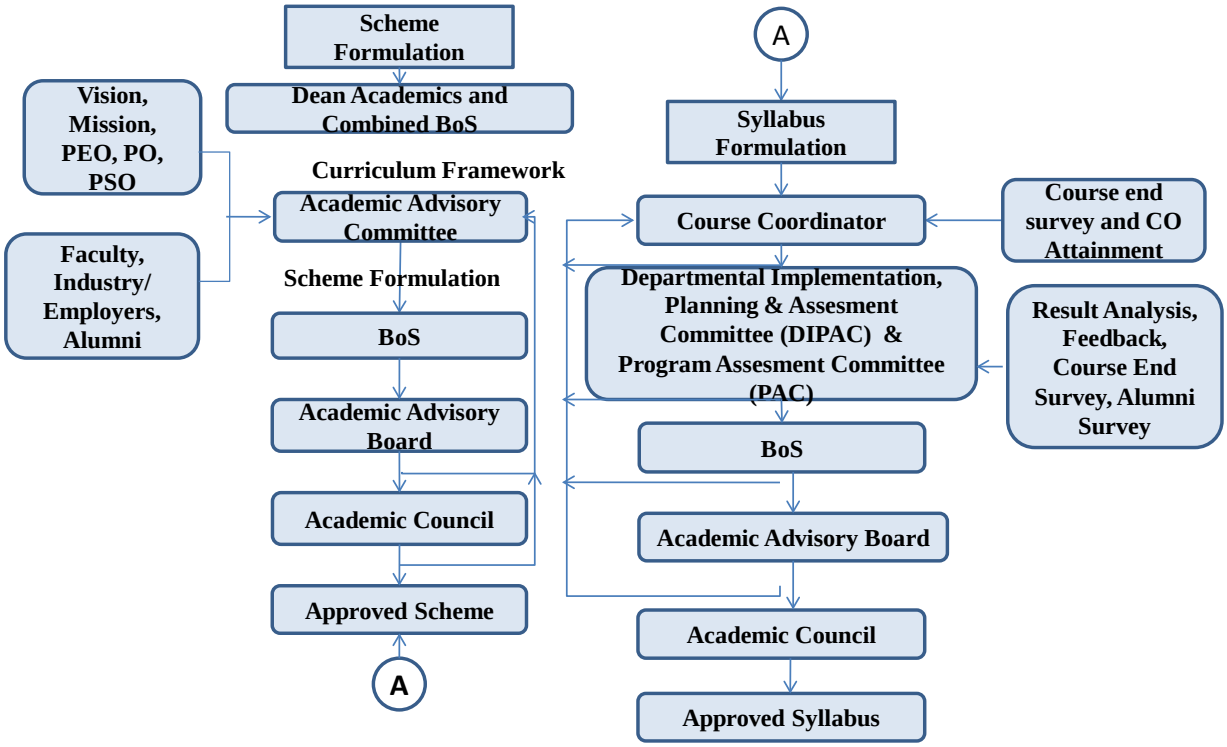
Scheme of Semester End Examination:

SEE for 100 marksis executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

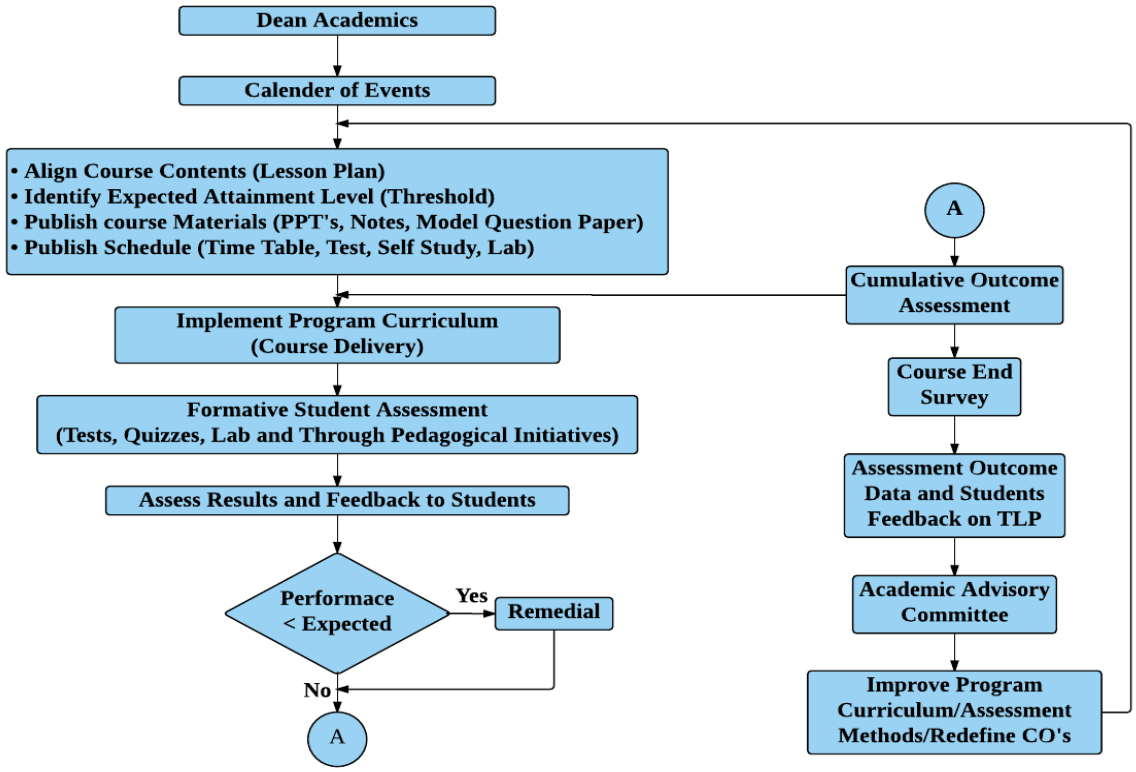
CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**1**
CO2	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**1**	**-**	**1**
CO3	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**-**	**2**	**2**	**1**	**2**
CO4	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**-**	**2**	**2**	**1**	**2**

Low-1 Medium-2 High-3

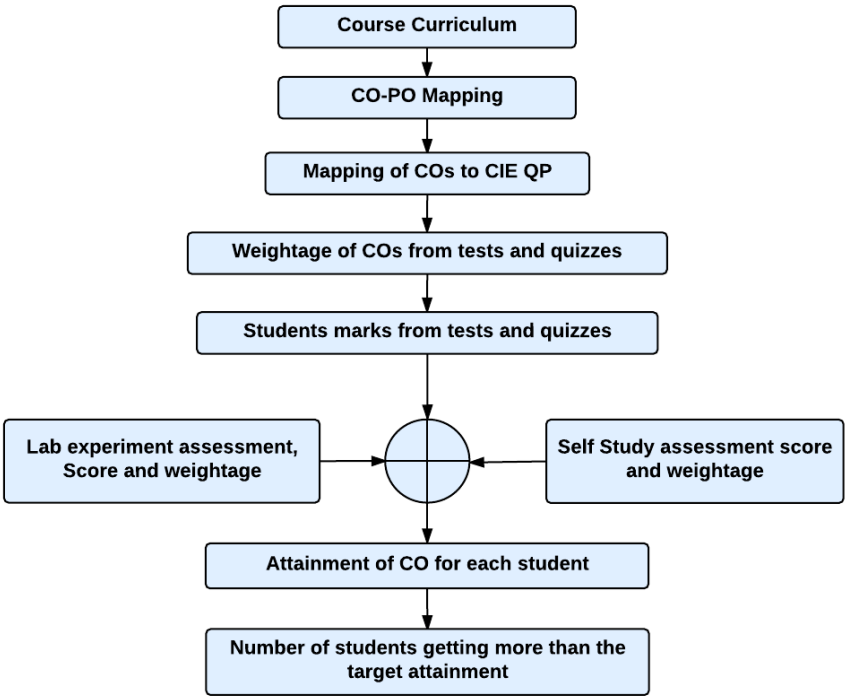
Curriculum Design Process



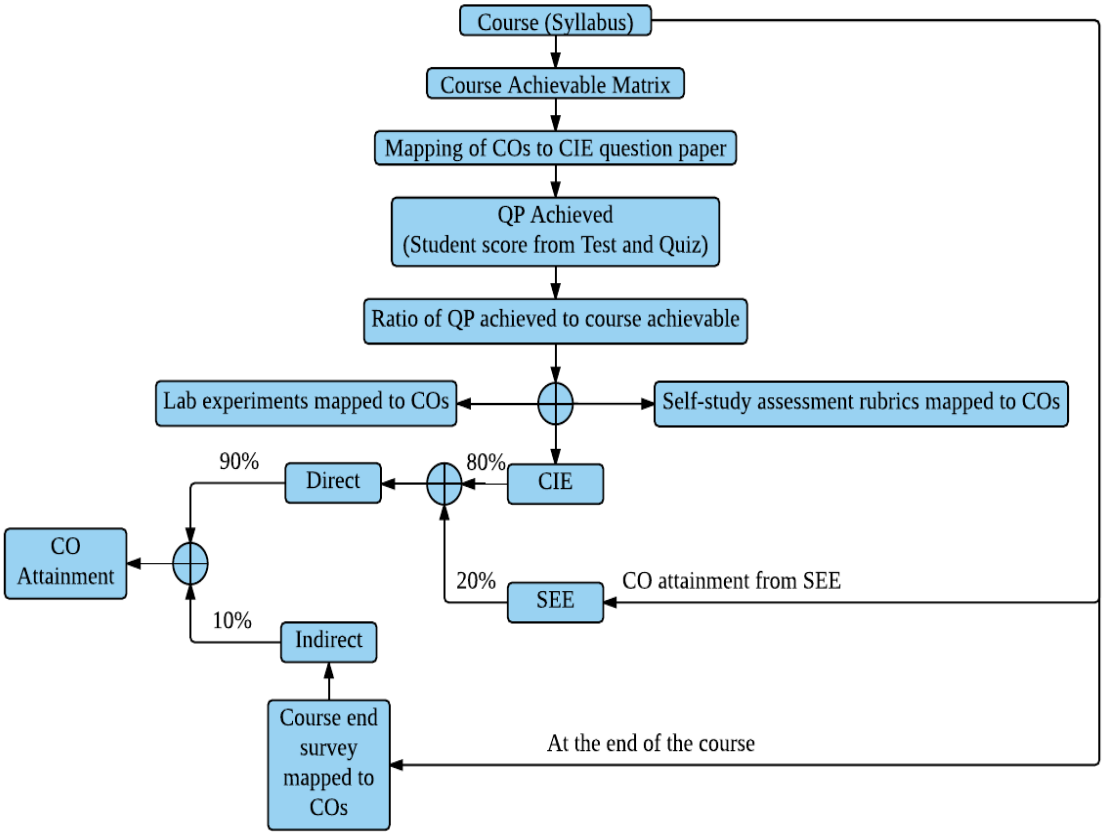
Academic Planning and Implementation



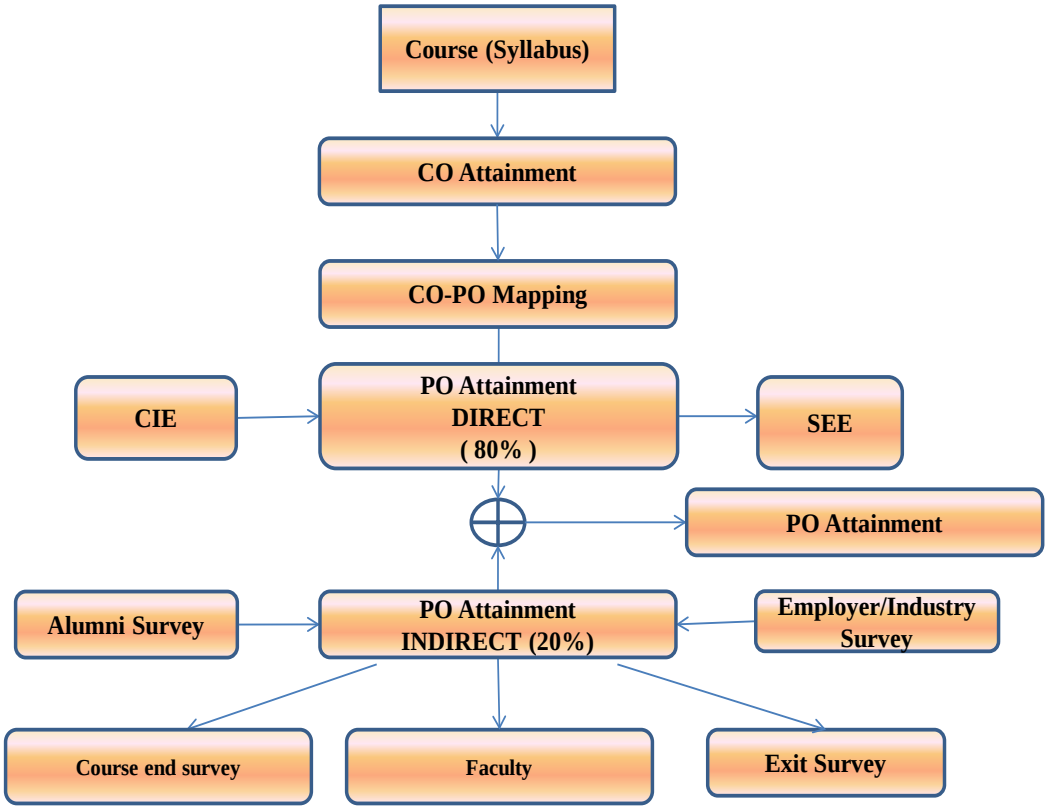
PROCESS FOR COURSE OUTCOME ATTAINMENT



Final CO Attainment Process



Program Outcome Attainment Process



Guidelines for Fixing Targets

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

PROGRAM OUTCOMES (POs)

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 solutions:** 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. **Life-long learning:** Have thorough knowledge in Biotechnology Engineering and will also be ready to engage themselves in lifelong learning.