RV 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 of III & IV Semesters

2018 SCHEME

BIOTECHNOLOGY

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

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2018 SCHEME

DEPARTMENT OF
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	Gain knowledge in Basic sciences, Mathematics and Biology to understand the Engineering problems related to Biotechnology and Bioinformatics.
PSO2	Develop the skills in the area of Biotechnology, Chemical Engineering and Informatics to solve complex Biological problems.
PSO3	Acquire technical knowledge to design, analyse, optimize and scale up Bio processes to develop value added products.
PSO4	Develop intellectual, personal and professional abilities through experiential learning and interdisciplinary projects.

Lead Society: American Society of Agricultural and Biological Engineers

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	PE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics

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RV COLLEGE OF ENGINEERING®

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BIOTECHNOLOGY ENGINEERING

THIRD SEMESTER CREDIT SCHEME

Sl. No.	Course Code	Course Title	BoS	Credit Allocation			Total Credits
				L	T	P	
1.	18MA31C*	Engineering Mathematics – III	MT	4	1	0	**5**
2.	18BT32B**	Biology for Engineers	BT	2	0	0	**2**
3.	18BT33	Concepts in Biotechnology	BT	3	0	1	4
4.	18BT34	Basics of Computer Applications	BT	3	0	1	4
5.	18CH35	Process Calculations (common for BT & CH)	CH	3	0	0	3
6.	18BT36	Biochemistry	BT	3	0	1	4
7.	18DMA37***	Bridge Course:Mathematics	MT	2	0	0	**0**
8.	18HS38 #	Kannada Course	HSS	1	0	0	**0**
Total Number of Credits				**21**	**1**	**3**	**22**
Total number of Hours/Week				**18+3***	**2**	**7.5**	

*Engineering Mathematics - III

Sl.No	COURSE TITLE	COURSE CODE	PROGRAMMES
1.	Linear Algebra, Laplace Transform and Combinatorics	18MA31A	CS & IS
2.	Discrete and Integral Transforms	18MA31B	EC, EE, EI & TE
3.	Engineering Mathematics -III	18MA31C	AS, BT, CH, CV, IM & ME

**

Sl. No	COURSE TITLE	COURSE CODE	PROGRAMMES
1.	Environmental Technology	18BT32A	EE, EC, EI, CS, TE & IS
2.	Biology for Engineers	18BT32B	BT & AS
3.	Engineering Materials	18ME32	ME, CH &IM

*** Bridge Course:Audit course for lateral entry diploma students

Sl.No	COURSE TITLE	COURSE CODE	PROGRAMS
1	Bridge Course Mathematics	18DMA37	AS,BT,CH,CV,EC,EE,EI, IM,ME&TE
2	Bridge Course C Programming	18DCS37	CS & IS

Mandatory audit course for all students

RV COLLEGE OF ENGINEERING®

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BIOTECHNOLOGY ENGINEERING

FOURTH SEMESTER CREDIT SCHEME

Sl. No	Course Code	Course Title	BOS	Credit Allocation			Total Credits
				L	T	P	
1.	18MA41	Biostatistics	BT	4	1	0	5
2.	18BT42A **	Environmental Technology	BT	2	0	0	2
3.	18BT43	Unit Operations	BT	3	0	1	4
4.	18BT44	Bioinformatics	BT	3	0	1	4
5.	18CH45	Thermodynamics(common course for Biotechnology and Chemical)	CH	3	1	0	4
6.	18BT46	Molecular Biology	BT	3	0	0	3
7.	18BT47	Design Thinking lab	BT	0	0	2	2
8.	18DCS48 ***	Bridge Course: C Programming	CS	2	0	0	**0**
9.	18HS49	Professional Practice-I Communication Skills	HSS	0	0	1	**1**
Total Number of Credits				**18**	**2**	**5**	**25**
Total number of Hours/Week				**18+2***	**4**	**12.5**	

*ENGINEERING MATHEMATICS – IV

Sl.No	COURSE TITLE	COURSE CODE	PROGRAMMES
1.	Graph Theory, Statistics and Probability Theory	18MA41A	CS&IS
2.	Linear Algebra, Statistics and Probability Theory	18MA41B	EC, EE, EI& TE
3.	Engineering Mathematics -IV	18MA41C	AS, CH, CV& ME

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Sl.No	COURSE TITLE	COURSE CODE	PROGRAMMES
1.	Engineering Materials	18EC42	EC,EE,EI&TE
2.	Biology for Engineers	18BT42B	CS & IS
3.	Environmental Technology	18BT42A	CV, ME, IM,CH, BT &AS

*** Bridge Course:Audit course for lateral entry diploma students

Sl.No	COURSE TITLE	COURSE CODE	PROGRAMMES
1	Bridge Course Mathematics	18DMA48	CS&IS
2	Bridge Course C Programming	18DCS48	AS,BT,CH,CV,EC,EE,EI,IM,ME&TE

Note:Internship to be taken up during the vacation period after the 4th semester

Semester: III						
ENGINEERING MATHEMATICS – III (Theory) (Common to AS, BT, CH, CV, IM &ME)						
Course Code	**:**	18MA31C		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	4:1:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	52L+13T		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand variation and extremal of functionals.
2	Analyze the concept of periodic phenomena and develop Fourier series.
3	Solve initial value problems using Laplace transform.
4	Determine the approximate solutions of algebraic/transcendental and partial differential equations using numerical methods.
5	Use mathematical IT tools to analyze and visualize the above concepts.

Unit-I	**10 Hrs**
Calculus of Variations: Introduction to variation of functionals, extremal of a functional, Euler's equation –special cases, problems. Geodesics, Hanging cable and Brachistochrone problems. Exploring geodesics graphically using MATLAB.	
Unit – II	**11 Hrs**
Fourier Series: Introduction, periodic function, even and odd functions. Dirichlet's conditions, Euler's formula for Fourier series, complex Fourier series, problems on time periodic signals (square wave, half wave rectifier, saw-tooth wave and triangular wave), Fourier sine series, Fourier cosine series. Exploring Fourier series using MATLAB.	
Unit –III	**11 Hrs**
Laplace and Inverse Laplace Transform: Existence and uniqueness of Laplace Transform (LT), transform of elementary functions, region of convergence. Properties - Linearity, scaling, s – domain shift, differentiation in the s – domain, division by t, differentiation and integration in the time domain. Transform of periodic functions (square wave, saw-tooth wave, triangular wave, full and half wave rectifier). Inverse Laplace transform – properties, evaluation using different methods. Convolution theorem (without proof), problems. Solution of ordinary differential equations. Exploring Laplace and inverse Laplace transform using MATLAB commands.	
Unit –IV	**10 Hrs**
Numerical Methods – I: Roots of algebraic and transcendental equations. Fixed point iteration method, Newton- Raphson method for multiple roots. Solution to system of linear equations – LU decomposition method, partition method. Sparse linear systems – Thomas algorithm for tridiagonal matrices. Computing numerical solutions using MATLAB.	
Unit –V	**10 Hrs**
Numerical Methods – II: Numerical solutions to partial differential equations – Finite difference approximation to derivatives, solution of Laplace equation in two dimension, heat and wave equations in one dimension (explicit methods). Exploring solution of PDE using MATLAB.	

Course Outcomes: After completing the course, the students will be able to	
CO1 :	Understand the fundamental concepts of variation of functionals, periodic phenomena, Laplace and inverse Laplace transforms and numerical techniques.
CO2 :	Solve the problems on extremal of functional, Fourier series, Laplace and inverse Laplace transforms and basics of numerical methods.

CO3 :	Apply the acquired knowledge to solve variational problems, half range series, differential equations using Laplace transform, system of linear equations and PDEs using finite difference technique.
CO4 :	Analyze and interpret applications of functionals, complex Fourier series, IVP and BVP using LT, sparse linear systems and PDEs occurring in Engineering problems.

Reference Books	
1	Higher Engineering Mathematics, B.S. Grewal, 44th Edition, 2015, Khanna Publishers, ISBN: 81-7409-195-5.
2	Higher Engineering Mathematics, B.V. Ramana, 11th Edition, 2010, Tata McGraw-Hill, ISBN: 13-978-07-063419-0; ISBN: 10-0-07-063419-X.
3	Advanced Engineering Mathematics, Erwin Kreyszig, 9th Edition, 2007, John Wiley & Sons, ISBN: 978-81-265-3135-6.
4	Numerical methods for scientific and engineering computation, M.K. Jain, S.R.K. Iyenger and R.K. Jain, 6th Edition, 2012, New Age International Publishers, ISBN: 9788122433234, 8122433235.

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

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

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

SEE for 100 marksis executed by means of an examination. The Question paper for the 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/IV						
BIOLOGY FOR ENGINEERS (Theory) (Common to BT,CS and IS)						
Course Code	**:**	18BT32B/18BT42B		**CIE**	**:**	50 Marks
Credits: L:T:P	**:**	2:0:0		**SEE**	**:**	50 Marks
Total Hours	**:**	26L		**SEE Duration**	**:**	2 Hours

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

Unit-I	**05 Hrs**
Introduction: Hierarchy of Biomolecular structure: Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules; Enzymes, vitamins and hormones and its integration to metabolism.	
Unit – II	**06 Hrs**
Genetics and Information transfer: Mendelian inheritance and Gene interaction. Mechanics of cell division: Mitosis and meiosis. Gene disorders in humans. Molecular basis for coding and decoding. Basis for information transfer.	
Unit -III	**05 Hrs**
Bioinspired Engineering based on human physiology: Circulatory system (artificial heart, pacemaker, stents). Nervous system (Artificial neural network) Respiratory system, sensory system (electronic nose, electronic tongue), Visual and auditory prosthesis (Bionic eye and cochlear implant).	
Unit –IV	**05 Hrs**
Relevance of Biology as an interdisciplinary approach. Biological observation that led to major discoveries. Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro).	
Unit –V	**05 Hrs**
Bioinspired Algorithms and Applications. Genetic algorithm, Gene expression modelling. Parallel Genetic Programming: Methodology, History, and Application to Real-Life Problems. Dynamic Updating DNA Computing Algorithms. BeeHive: New Ideas for Developing Routing Algorithms Inspired by Honey Bee Behavior.	

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	Lewin's GENES XII, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2017, Jones and Bartlett Publishers, Inc., ISBN-10: 1284104494, ISBN-13: 978-1284104493
2	Jenkins, C.H. Bioinspired Engineering, NY: Momentum press, 2012 ISBN: 97816066502259
3	Bio mimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2016, CRC Press.13.978-1-4398-3477-0
4	A Practical Guide to Bio-inspired Design, Hashemi Farzaneh, Helena, Lindemann, Udo, Springer 2019, ISBN 978-3-662-57683-0

Continuous Internal Evaluation (CIE): Total marks: 50

CIE is executed by way of quizzes (Q), tests (T) and Assignment (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks which will be reduced to 15marks. 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 CIE for theory is 15(Q) +30(T)+05(A) =50 marks

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 08marks 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	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						
CONCEPTS IN BIOTECHNOLOGY (Theory and Practice)						
Course Code	**:**	**18BT33**		**CIE**	**:**	**100+50Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**39L+35P**		**SEE Duration**	**:**	**3.00+3.00 Hrs**

Course Learning Objectives: The students will be able to	
1	Acquire the basic knowledge of Biotechnology.
2	Understand the various techniques involved in isolation, culture and manipulation of cells.
3	Review the fundamentals of recombinant DNA technology and then use this knowledge to understand the science involved in the many biotechnology techniques and applications.
4	Study and analyze various heterologous products produced in genetically modified organisms.

Unit-I	**07 Hrs**
Introduction: Structure of prokaryotic and eukaryotic cell. Nucleic acids. DNA as the Genetic Material: Griffith/Hershey-Chase experiments. Cell cycle. Cell signalling: Reception, Transduction and Response. Basics of Central dogma of molecular biology: Replication, Transcription and Translation. Programmed cell death.	
Unit – II	**08 Hrs**
Basic Techniques: Isolation of DNA and RNA**.** Agarose gel Electrophoresis.Polymerase Chain Reaction. Restriction endonucleases. Ligases. Vectors (Plasmid, yEP). Genomic and cDNA libraries. Genetic Transformation of Microbes, Plants and Animals. Screening and Selection of Transformants.	
Unit -III	**08 Hrs**
Microbial Biotechnology: Structure of bacteria, fungi, protozoa and viruses. Horizontal genetic transfer in bacteria: conjugation, transformation and transduction. Cultivation of microorganisms. Replica platting technique. Growth and measurement of Bacteria. Biochemical activities of microorganisms (IMViC and starch hydrolysis test). Simple and Differential (Gram) staining techniques. Beneficial microflora for humans, agriculture, environment and industry. Human diseases of bacterial, fungal, protozoan and viral origin with examples. Applications: Production of antibiotics, Enzymes (Alginate lyase), Biopolymer (Xanthum gum), and Human interferon.	
Unit –IV	**08 Hrs**
Plant Biotechnology: Photosynthesis, Respiration, Photorespiration. Plant Growth regulators: Physiological functions and molecular mechanism of Auxin, Cytokinin, ABA, GA and Ethylene. Plant Tissue Culture Media (MS): Components and preparation. Applications: Micropropagation, Production of insect resistant plants. Production of vitamins (Vitamin A in rice).	
Unit –V	**08 Hrs**
Animal Biotechnology: Immune system, Immune response, Immunity in health and disease, Antigen Antibody interactions; Immunofluorescence, flow cytometry, Radio immuno-assay, ELISA. Animal Cell culture technique: Media, Primary culture and Cell lines. Embryonic stem cell engineering, Applications: Production of Monoclonal antibodies and Vaccines. Transgenic animals: Sheep, Mice and Fish.	
LAB EXPERIMENTS	
1. Isolation of microorganisms by serial dilution, pour plate, spread plate and streak plate methods. Colony, bacterial growth curve **2.** Staining of microorganisms– simple (fungi) and differential (bacteria). **3.** Isolation of antibiotic producing organisms. **4.** Identification of bacteria by biochemical tests (IMViC and Starch Hydrolysis). **5.** Antibiotic sensitivity testing of bacteria. **6.** Study of divisional stages of Mitosis in plants (preparation of slides from root tips of onion). **7.** Study of divisional stages of Meiosis in plants (preparation of slides from flowers buds of onion).	

8. Agglutination Technique: Blood group identification. **9.** Bacterial Agglutination technique - Widal test (Tube / Slide agglutination). **10.** Ouchterlony Double Diffusion (ODD). **11.** Rocket immunoelectrophoresis (RIEP). **12.** Enzyme Linked Immunosorbent Assay (ELISA). **Note: Each student has to perform all the experiments in a semester.**	

Course Outcomes: After completing the course, the students will be able to	
CO1 :	Understand the basic concepts of biotechnology.
CO2 :	Explain various processes involved in isolation, culture and manipulation of cells,
CO3 :	Apply various techniques required for the isolation, culture and manipulation of cells.
CO4 :	Analyze the products produced by microbial, plant and animal cells and also from genetically modified cells.

Text Books	
1	Karp's Cell Biology. Janet Iwasa and Wallace marshall, John Wiley & Sons, Global edition, 2018, ISBN-10: 1119454174
2	Prescott's Microbiology, Willey J, Sherwood L and Woolverton CJ, McGraw Hill Education, 10th edition, 2017, ISBN-9781259657573.
3	Kuby Immunology. J.Punt, S. Stanford, P.Jones, J.Owen, W.H. Freeman Publication, 8th edition, 2018. ISBN 13: 978-1464189784
4	Glick BR and Patten CL, Molecular Biotechnology – Principles and applications of recombinant DNA, ASM Press, 5th Edition. 2017. ISBN-13: 978-1555819361

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.
Scheme of Continuous Internal Evaluation (CIE); Practical Test for 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 marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marksis executed by means of an examination. The Question paper for the 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.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

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						
BASICS OF COMPUTER APPLICATIONS (Theory and Practice)						
Course Code	**:**	18BT34		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	40L+35 P		**SEE Duration**	**:**	**3.00+3.00 Hours**

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	**08 Hrs**
Linux and Shell Programming: Introduction to Linux, basic commands. 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 RDBMS. 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	**08 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	**08 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	**08 Hrs**
Problem solving techniques in sequence analysis: Overview of Programming in Life sciences. Applications. Basic problem solving techniques for sequence analysis – Introduction to sequence alignment, 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.	

LAB EXPERIMENTS	**25 Hrs**

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. Design, Write and Execute a C++ program to find total and average marks of each student using the concept of friend class. Create a student base class with USN, Name, Biochem, Bioinfo, Microbio, MolBio, BCA as its private members. Use friend class that access private members of student class through friend class and calculate total, average marks and print 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.
   c. 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. Write a function template to sort an array using bubble sort. Illustrate how you sort array of integer, string as well as double data type using function template.
9. Design, write and execute C++ program that 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.
10. 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.
11. Design, Write and Execute a C++ program to connect to database ProteinDB stored at local database server using ODBC, and perform various queries on the backend database.
12. Design, Write and Execute a C++ program to implement Needleman and Wunch Algorithm to align any two given sequences.
13. Design,Write and Execute a C++ program to parse fasta ids from large DNA sequence database and print them.
14. Write a C++ program to perform sequential clustering data given in the Distance matrix.

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

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

Text Books	
1	Richard Blum, Christine Bresnahan, Linux Command Line and Shell Scripting Bible, John Wiley & Sons,3rd Edition, 2015, ISBN - 9781118984192
2	GaryJ.Bronson, C++for Engineers and Scientists, Cengage Learning, 4th Edition, 2012, ISBN- 978-1133187844.
3	Balagurusamy, Object Oriented Programming with C++, Tata McGraw-Hill Education, 6th Edition, 2013, ISBN – 9781259029936
4	KarlineSoetaert,JeffCash,FrancescaMazzia, Solving Differential Equations in R, Springer, 1stEdition; 2012, ISBN - 978-3642280696.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 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 marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marksis executed by means of an examination. The Question paper for the 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.
Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.
Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

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						
PROCESS CALCULATIONS (Theory)						
Course Code	**:**	18CH35		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Convert units from one system to the other.
2	Make material balances for unit operations and processes.
3	Make material balances for systems with bypass, recycle and recycle with purge
4	Calculate the adiabatic reaction temperatures/ theoretical flame temperatures

Unit-I	**07 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. Expressions for composition of mixtures of solids, liquids and gases, percentage by weight, mole and volume. Composition of mixtures and solutions- Normality, Molarity, Molality and ppm. Concentration scales based on specific gravity-Baume, Twaddle, Brix and API gravity scales.	
Unit – II	**08 Hrs**
Vapor Pressure: Definition of vapour pressure, partial pressure, relative saturation % saturation, humidity, molal humidity, relative humidity, % humidity, Psychometry. Simple problems solving using psychrometric charts. Evaporation and condensation processes **Material balance without reaction:** Introduction to material balances, general material balance techniques for material balance without reaction, problems on mixing, distillation.	
Unit -III	**08 Hrs**
Material balance without reaction: Extraction, crystallization, evaporation, absorption, leaching. **Material balance Involving Chemical reactions:** Principles of Stoichiometry, definitions of limiting and excess reactants, fractional and percentage conversion, yield and selectivity. **Fuels and combustion:** Ultimate and proximate analyses of fuels. Problems based on various unit processes.	
Unit –IV	**08 Hrs**
Material balances with and without reactions involving bypass, recycle and purging.	
Unit –V	**08 Hrs**
Energy Balance: General energy balance equation for steady state. Thermo physics and Thermo chemistry, heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Standard heat of formation, standard heat of reaction, standard Heat of combustion, and calorific value of fuels. Calculation of ΔHR at elevated temperatures. Adiabatic reaction temperature and adiabatic flame temperature and their calculations.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the unit conversions, basic principles of Unit operations and processes
CO2:	Recall the fundamentals of unit operation, processes and their calculations
CO3:	Apply the conservation principles to solve problems.
CO4:	Analyze the unit operations and processes to carry out material and energy balance.

Reference Books	
1	Stoichiometry, Bhatt B. I., Vora S. M., Fourth Edition,2004, Tata McGraw Hill Publishing Ltd., New Delhi , ISBN 0-07-462039-8
2	Chemical Process Principles Part I , Material and Energy Balances, Hougen O. A., Waston K.M. and Ragatz R.A. Second Edition, 2004, CBS Publishers and distributors, New Delhi, ISBN-81-239-0953-5
3	Basic Principles and Calculations in Chemical Engineering, Himmelblau D.M., Sixth Edition, 2002, Prentice Hall of India, New Delhi, ISBN-81-203-1145-0
4	Bioprocess Engineering Basic Concepts, Shuler M.L., and Kargi F., Second Edition, 2002, Prentice Hall of India, New Delhi, ISBN-0130819085

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marksis executed by means of an examination. The Question paper for the 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						
BIOCHEMISTRY (Theory and Practice)						
Course Code	**:**	18BT36		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100+50Marks**
Total Hours	**:**	39L+35 P		**SEE Duration**	**:**	**3.00+3.00 Hours**

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	**07 Hrs**
Chemical foundations of Biology: Water in biological system: Physical and chemical properties of water, weak interactions in macromolecular structure and function, Water as solvent for biochemical reaction- physical and chemical properties of water. Concentration of solutions, pH, buffers. Buffering against pH changes in biological systems.	
Unit – II	**08 Hrs**
Carbohydrates and Lipids: Carbohydrates: Structure and function of monosaccharide, disaccharide and polysaccharide. Carbohydrate metabolism: Aerobic and anaerobic glycolysis, tricarboxylic acid cycle, gluconeogenesis and pentose phosphate pathway. Lipids: Classification and function. Lipid metabolism: Biosynthesis and biodegradation of fatty acids. Biochemical functions of fatty acids, triacylglycerol's, phospholipids, glycolipids, lipoproteins and steroids.	
Unit -III	**08 Hrs**
Proteins and Nucleic acids: Amino Acids: Classification, structure and properties of amino acids. Proteins: primary, secondary, tertiary and quaternary structures of proteins. Nucleic acids: Structure, properties and functions of nucleotides. Types, structure and function of DNA and RNA. Biodegradation of amino acids- deamination, transamination and urea cycle.	
Unit –IV	**08 Hrs**
Enzymes and Enzyme Kinetics: Enzymes as biological catalysts, classification, examples of enzymes catalysed reactions, Allosteric enzymes, Enzyme kinetics and mechanism of enzyme action, co-factors and co-enzyme. Factors affecting enzyme activity. Extraction and Purification of enzymes, Determination of molecular mass of enzymes, Enzyme assays. Enzyme Inhibition: Competitive, uncompetitive and non-competitive.	
Unit –V	**08 Hrs**
Mammalian Fuel metabolism: Integration and regulation: Organ specialization (Brain, Muscle, Adipose tissue, Liver, Kidney), Hormonal Regulation of Fuel Metabolism. Metabolic Disorders: Diabetes Mellitus, Atherosclerosis. Vitamins: Classification, source, functions and deficiency disorders.	

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 catalysed reaction

10. Effect of Temperature on enzyme activity Students should perform all the experiments in a semester

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: 1 9781464126116, ISBN-13: 978-1464126116
2	Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 67h Edition, 2017, W.H. Freeman, ISBN-10: 9781464126116, ISBN-13: 978-1464126116
3	Biochemistry, U Satyanarayana, 5th Edition, 2017, Books & Allied Ltd, ASIN: B073Y7XGH4
4	Biochemistry, Denise Ferrier, Lippincott, 2017, Williams & Wilkins, ISBN: 149636354X, 9781496363541

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

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 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 marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

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

SEE for 100 marksis executed by means of an examination. The Question paper for the 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.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

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/IV						
MATHEMATICS **Bridge Course** **(Common to all branches)**						
Course Code	**:**	18DMA37/48		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	2:0:0		**SEE**	**:**	**50 Marks**
Audit Course				**SEE Duration**	**:**	**2.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the concept of functions of several variables, types of derivatives involved with these functions and its applications, approximate a function of single variable in terms of infinite series.
2	Acquire concepts of vector functions, scalar fields and differential calculus of vector functions in Cartesian coordinates.
3	Explore the possibility of finding approximate solutions using numerical methods in the absence of analytical solutions of various systems of equations.
4	Recognize linear differential equations, apply analytical techniques to compute solutions.
5	Gain knowledge of multiple integrals and their applications.
6	Use mathematical IT tools to analyse and visualize the above concepts.

Unit-I	**05 Hrs**
Differential Calculus: Taylor and Maclaurin series for function of single variable. Partial derivatives – Introduction, simple problems. Total derivative, composite functions. Jacobians – simple problems.	
Unit – II	**05 Hrs**
Vector Differentiation: Introduction, simple problems in terms of velocity and acceleration. Concepts of gradient, divergence – solenoidal vector function, curl – irrotational vector function and Laplacian, simple problems.	
Unit –III	**06 Hrs**
Differential Equations: Higher order linear differential equations with constant coefficients, solution of homogeneous equations - Complementary functions. Non homogeneous equations –Inverse differential operator method of finding particular integral based on input function (force function).	
Unit –IV	**05 Hrs**
Numerical Methods: Solution of algebraic and transcendental equations – Intermediate value property, Newton-Raphson method. Solution of first order ordinary differential equations – Taylor series and 4^{th} order Runge-Kutta methods. Numerical integration – Simpson's $1/3^{rd}$, $3/8^{th}$ and Weddle's rules. (All methods without proof)**.**	
Unit –V	**05 Hrs**
Multiple Integrals: Evaluation of double integrals, change of order of integration. Evaluation of triple integrals. Applications – Area, volume and mass – simple problems.	

Course Outcomes: After completing the course, the students will be able to	
CO1 :	Understand the concept of partial differentiation, double integrals, vector differentiation, and solutions of higher order linear differential equations and requirement of numerical methods.
CO2 :	Solve problems on total derivatives of implicit functions, Jacobians, homogeneous linear differential equations, velocity and acceleration vectors.
CO3 :	Apply acquired knowledge to find infinite series expansion of functions, solution of non-homogeneous linear differential equations and numerical solution of equations.
CO4 :	Evaluate triple integrals, area, volume and mass, different operations using del operator on scalar and vector point functions, numerical solution of differential equations and numerical integration.

Reference Books	
1	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2015, ISBN: 978-81-933284-9-1.
2	Higher Engineering Mathematics, B.V. Ramana, 11th Edition, 2010, Tata McGraw-Hill, ISBN: 978-0-07-063419-0.
3	N.P. Bali & Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications, 7th Edition, 2010, ISBN: 978-81-31808320.
4	Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th Edition, 2016, ISBN: 978-0470458365.

Continuous Internal Evaluation (CIE); Theory (50 Marks)
CIE is executed by way of quizzes (Q) and tests (T**)**. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. The two tests are conducted for 30 marks each and the sum of the marks scored from two tests is reduced to 30.
Total CIE is 20(Q) +30(T)=50 Marks.

Semester End Evaluation (SEE); Theory (50 Marks)
SEE for 50 marksis executed by means of an examination. The Question paper for the course consists of five main questions, one from each unit for 10 marks adding up to 50 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.

SEMESTER – IV						
BIOSTATISTICS (Theory)						
Course Code	**:**	18BT41		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:1:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L+24T		**SEE Duration**	**:**	**3.00 Hours**

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

Unit-I	**09 Hrs**
Introduction and Data presentation: Basic concepts, definitions, formulae, common terms in statistics. Types of numerical data - Nominal data, Ordinal data, Ranked data, Discrete data and Continuous data. Tables - Frequency distribution and Relative frequency, Graphs - Bar charts, Box plots, Scatter plots, Histograms and Polygons. Parametric and non - parametric tests, Sampling Theory – Simple Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling. Determination of sample size, Experimental design strategies.	
Unit – II	**07 Hrs**
Measures of central tendency and dispersion: Mean, Median and Mode. Measures of dispersion, grouped data. Measures of variation- Dispersion, Range, Mean deviation and Standard deviation. Standarderror, Point estimation parameters. Missing data and its handling	
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). Joint Probability distribution, Hypothesis test, Analysis of Variance (ANOVA).	
Unit –IV	**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.	
Unit –V	**08 Hrs**
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. Quality control, control charts, tolerance limits and specification limits, Design thinking.	

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	Dr.K S. Chandrashekar, Engineering Mathematics-IV, Sudha publications, 2017, ISBN: 8193001087
2	Pranab Kumar Banerjee, Introduction to Biostatistics, S. Chand & Co. Ltd, 2011, ISBN:9788121923293
3	Khan and Khanum, Fundamentals of Biostatistics, Ukaaz publications, 2009, ISBN:9788190044103.
4	Marcello Pagano and Kimberlee Gauvreau, Principle of Biostatistics, Thomson Asia Pvt., Ltd., 2nd ed. 2010, ISBN:100538733497

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marksis executed by means of an examination. The Question paper for the 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 or IV						
ENVIRONMENTAL TECHNOLOGY (Theory)						
Course Code	**:**	18BT32A/18BT42A		**CIE**	**:**	50 Marks
Credits: L:T:P	**:**	2:0:0		**SEE**	**:**	50 Marks
Total Hours	**:**	26L		**SEE Duration**	**:**	02 Hours

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

Unit-I	**05 Hrs**
Introduction: Environment - Components of environment, Ecosystem. Impact of anthropogenic activities on environment (agriculture, mining and transportation), Environmental education, Environmental acts & regulations, role of non-governmental organizations (NGOs), EMS: ISO 14000, Environmental Impact Assessment. Environmental auditing.	
Unit – II	**06 Hrs**
Environmental pollution: Air pollution – point and non point sources of air pollution and their controlling measures (particulate and gaseous contaminants). Noise pollution, Land pollution (sources, impacts and remedial measures). **Water management**: Water conservation techniques, water borne diseases & water induced diseases, arsenic & fluoride problems in drinking water and ground water contamination, advanced waste water treatment techniques.	
Unit -III	**06 Hrs**
Waste management, Solid waste management, e waste management & biomedical waste management – sources, characteristics & disposal methods. Concepts of Reduce, Reuse and Recycling of the wastes. **Energy** – Different types of energy, conventional sources & non - conventional sources of energy, solar energy, hydro electric energy, wind energy, Nuclear energy, Biomass & Biogas Fossil Fuels, Hydrogen as an alternative energy.	
Unit –IV	**05 Hrs**
Environmental design: Principles of Environmental design, Green buildings, green materials, Leadership in Energy and Environmental Design (LEED), soilless cultivation (hydroponics), organic farming, use of biofuels, carbon credits, carbon foot prints, Opportunities for green technology markets, carbon sequestration.	
Unit –V	**04 Hrs**
Resource recovery system: Processing techniques, materials recovery systems, biological conversion (composting and anaerobic digestion). Thermal conversion products (combustion, incineration, gasification, pyrolysis, use of Refuse Derived Fuels). Case studies of Biomass conversion, e waste.	

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 analyze 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	Gilbert, M.M. Introduction to environmental engineering and science, Pearson Education. India: 3rd Edition (2015). ISBN: 9332549761, ISBN-13: 978-9332549760.
2	Howard S. Peavy, Donald R. Rowe and George Tchobanoglous. 2000. Environmental Engineering, McGraw Hill Education, First edition (1 July 2017). ISBN-10: 9351340260, ISBN-13: 978-9351340263
3	G. Tyler Miller (Author), Scott Spoolman (Author), (2012) Environmental Science – 15th edition, Publisher: Brooks Cole, ISBN-13: 978-1305090446 ISBN-10: 130509044
4	Vijay Kulkarni and T. V. Ramachandra 2009. Environment Management. 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). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks which will be reduced to 15marks. 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 CIE for theory is 15(Q) +30(T)+05(A) =50 marks

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 08marks 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	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	1	2	2	-	-	-	-	-	-	-	-	1
CO4	-	1	1	3	-	-	-	-	-	-	-	1

High-3: Medium-2: Low-1

Semester: IV						
UNIT OPERATIONS (Theory and Practice)						
Course Code	**:**	18BT43		**CIE**	**:**	**100+50=150Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100+50=150Marks**
Total Hours	**:**	37L+35 P		**SEE Duration**	**:**	**3.00+3.00 Hours**

Course Learning Objectives:	
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	**07 Hrs**
Introduction to Fluid Mechanics: Fluid Statics-Hydrostaticequilibrium,Barometricequation, Pressure measurements- Manometers-U tube, Inclined tube and inverted U tube. Fluid dynamics - Shear stress, Shear strain, Newton's law of viscosity,NewtonianandNonNewtonianfluids.Fluidflow**:**Continuityequation,Bernoulli'sequation,Hagen-Poiseulle'sequation, simple numerical. **Dimensional Analysis**:Dimensionlessnumbers, Rayleigh'smethod,Buckingham's pi theorem.	
Unit – II	**07 Hrs**
Flow metering and measurement: Construction and working of Centrifugal pump, reciprocating pump, characteristics of centrifugal pumps, cavitation, NPSH. Applications of Bernoullis equation- Venturimeter, Orifice meter, Pitot tube, Rotameter. **Heat Transfer:** Modes of heat transfer. Steady state conductions through single-layer, composite-layer, slabs, cylinders, spheres with constant thermal conductivity. Simple problems. Natural and forced convection. Correlation equations for natural and forced convection. Film co- efficient, overall Heat transfer co-efficient. Log mean temperature difference (LMTD), simple problems	
Unit -III	**07 Hrs**
Heat Exchange Equipment: Construction and elementary design of double pipe pipe heat exchanger, shell and tube heat exchanger. Simple numerical to calculate heat transfer area in heat exchangers. **Evaporation**: Single effect and multiple effect evaporators, vapour recompression. Capacity and economy, types of feeding arrangements in multiple effect evaporators.	
Unit –IV	**09 Hrs**
Particle Size Analysis: Size reduction- Laws of Size reduction, Work Index, Equipment for size reduction- Ballmill, drop weight crusher. **Settling**: Drag, drag coefficient. Types of settling, Terminal settling velocity for one dimensional motion of spherical particle through gravitation force and external force. Motion of particles in Stoke's, Newton's and intermediate, centrifugal settling process. **Filtration:** Classification of filtration, Kozeny-Carman equation. Characteristics of filter media and filter aids, Industrial filters- rotary drum filter, leaf filter.	
Unit –V	**07 Hrs**
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. **Liquid – liquid Extraction:** Single stage and multistage extraction, Co-current, Cross current and continuous counter current multistage extraction. **Solid liquid extraction**: Single stage leaching, multistage cross current and counter current leaching.	

LAB EXPERIMENTS
1. Determination of percentage of extraction of biological compounds. 2. Determination of Frendulich and Langmiur isotherms for adsorption of biological compounds. 3. Determination of specific cake resistance 'α 'and filter medium resistance 'Rm' using a leaf filter for filtration of biological compounds 4. Verification of Rayleigh's equation for simple distillation of biological compounds. 5. Determine the discharge co-efficient (Cd) of Orifice meter. 6. Determine the discharge co-efficient (Cd) of Venturimeter. 7. Determination of the friction factor for the flow of water through a packed bed using Ergun's equation. 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 emissivity of a cylinder and sphere 12. Steam distillation for biological sample.
Note: Each student has to perform 12 experiments in semester.10 Experiments are guided experiments, 02 experiments are involving experiential learning.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic fluid flow principles and its applications in biochemical process
CO2:	Explain the various instruments used for the flow of fluids and heat transfer rate
CO3:	Apply the principles of conservation of mass and energy to calculate flow rates, head loss, pumping and power requirements in closed conduits.
CO4:	Develop the momentum and energy equations to calculate pressure variations in accelerating fluids and evaluate head loss in pipes and conduits.
Text Books	
1	W. L. McCabe, J. C. Smith and P. Harriott, Unit Operations in Chemical Engineering, McGraw-Hill, New York, 7th Edition, 2005,ISBN2005978-0071247108.
2	R.K.Bansal,FluidMechanicsandHydraulicsofMachines,LaxmiPublications,NewDelhi, 9th Edition. 2010. ISBN:978-81-318-0815-3.

Reference Books	
1	J.M.Coulsonand J.F.Richardson:ChemicalEngineeringVoI1.Fluidflow,Heat Transferrin MassTransfer.ButterworthHeinemann,animprintofElservier,6th Edition,IndianReprint,2006.ISBN: 13:978-0387-25116-5.
2	C. J. Geankoplis, Transport processes and Unit Operations, Prentice Hall India, 3rd Edition, 2007, ISBN-0205059392,9780205059393.

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

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 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 marks (AM) over number of weeks is considered for 30

marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the 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.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

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: IV						
BIOINFORMATICS (Theory and Practice)						
Course Code	**:**	18BT44		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100 Marks**
Total Hours	**:**	36L+35 P		**SEE Duration**	**:**	**3.00+3.00 Hours**

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

Unit-I	**07 Hrs**
Overview of bioinformatics and Biological Databases: Introduction to Bioinformatics, Goals, Scope, applications in biological science and medicine. **Biological databases:** Types of Sequence Databases - The nucleotide and protein sequence databases, Primary and secondary databases. Structure Databases - PDB and MMDB records, molecular modeling databases at NCBI. Special Databases - Genome, Microarray, metabolic pathway, domain databases. Sequence retrieval from the databases.	
Unit – II	**07 Hrs**
Sequence analysis: Introduction, scope and applications of Computational biology. Molecular Biology databases. Analysis of single DNA sequence: shotgun sequencing, DNA modeling, Scanning long repeats, Analysis of patterns and Counting of overlaps. Analysis of Multiple DNA or Protein sequences: Frequency comparisons of two sequences. Simple tests for significant similarity in an alignment. Alignment algorithms for two sequences: Gapped global comparisons and Dynamic programming algorithms and linear affinity gap model for fitting one sequence into another and local alignment., Phylogenetic analysis.	
Unit -III	**07 Hrs**
Predictive and structural bioinformatics: Gene prediction programs – ab-initio and homology based approaches. ORFs and HMM for gene prediction. Detection of functional sites and codon bias in the DNA. Predicting RNA secondary structure, Protein structure basics, structure visualization, comparison and classification. Protein structure predictive methods using protein sequence, Protein identity based on composition. Primers and Restriction mapping.	
Unit –IV	**08 Hrs**
Genome analysis: Introduction Next Generation Sequencing (NGS), NGS Experimental Work Flow, Scope and Applications. NGS Platforms - Illumina Reverse Dye-Terminator, Ion Torrent Semiconductor sequencing and Pacific Biosciences Single Molecule Real-Time Sequencing. NGS Data Analysis; Base calling and quality score, Data Quality Control and Preprocessing, Reads Mapping – Mapping approaches and algorithms, and Tertiary analysis.	
Unit –V	**07 Hrs**
Introduction to Molecular modeling and Drug designing: Introduction to Molecular Modeling and Simulation; brief introduction to protein structure hierarchy. Modeling applications – prediction of secondary structure of Protein and RNA. Docking Process – Protein preparation, ligand building, Setting of boundary box, Prediction of Binding pockets, pocket analysis, running of docking calculations.	

LABORATORY EXPERIMENTS	
1. Introduction to database and sequence retrieval from nucleic acid databases. 2. Designing of primers and restriction mapping. 3. Protein databases and structure retrieval for macro and micro molecules. 4. Pairwise sequence alignment and multiple sequence alignment using BLAST and MSA with phylogenetic analysis. 5. Introduction to SRA database and perform conversion and quality check. 6. Perform whole genome alignment using BWA. 7. Variant calling/SNP analysis from WGS. 8. Prediction of protein 3D structure using homology modelling. 9. Protein ligand interaction studies. 10. Energy minimization and simulation studies.	

Course Outcomes: After completing the course, the students will be able to	
CO1 :	Demonstrate the knowledge of retrieval of the biological data in the essential formats and its analysis.
CO2 :	Analyze the gene, protein and RNA data to find the degree of similarities and identifying the patterns
CO3 :	Apply the drug designing methods for screening and inventing the new targets and drugs
CO4 :	Predict the structure of a compound and design the molecule.

Reference Books	
1	Paul M. Selzer ,Richard J. Marhöfer “Applied Bioinformatics: An Introduction”, Springer; 2nd ed. 2018 edition, ISBN-13: 978-3319682990
2	D.AndreasBaxevanis and B. F; Francis Ouellette. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins; Wiley-IEEE; 3rdedn; 2009; ISBN: 9788126521920; Units I & II
3	Aman Chandra Kaushik, Ajay Kumar, Shiv Bharadwaj, RaviChaudhary,ShaktiSahi, ”Bioinformatics Techniques for Drug Discovery: Applications for Complex Diseases”,AprilSpringer; 1st ed. 2018 edition, ISBN-13: 978-3319757315
4	Lloyd Low , Martti Tamm “Bioinformatics: A Practical Handbook of Next Generation Sequencing and Its Applications”, World Scientific Publishing Co (June 29, 2017), ISBN-13: 978-9813144743

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

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 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 marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

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

SEE for 100 marksis executed by means of an examination. The Question paper for the 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.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

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: IV						
THERMODYNAMICS (Theory)						
Course Code	**:**	18CH45		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:1:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L+24T		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Explain the principles of thermodynamics for ideal and non - ideal liquids,
2	Analyze the fundamental equations governing thermodynamics: e.g., the Maxwell equations, equations of state.
3	Perform energy balances on process systems recognizing the constraints implied by the second law
4	Perform feasibility studies on chemical engineering processes

Unit-I	**09 Hrs**
Introductory Concepts of Thermodynamic Systems and variables, Work, Heat, Internal Energy, Thermodynamic Equilibrium, Reversible and Irreversible Processes; Phase-Rule; Significance of Chemical Engineering Thermodynamics **First Law:** Closed and Open Systems **Equations of State** and Generalized Correlations for Prediction of Volumetric Properties of Fluids	
Unit – II	**08 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 Kelvin's inequality, Entropy balances for open systems, Calculation of ideal work, lost work. Maxwell Relations and Fluid Properties Estimation	
Unit -III	**08 Hrs**
Single Phase Mixtures and Solutions; Ideal Solutions; Partial molar quantities; Gibbs-Duhem Equation; Criteria for Thermodynamic Equilibrium; Phase Equilibrium Criteria, **Non-ideal Solutions**; Residual and Excess Properties; Fugacity and Activity Coefficient models. Pure Component Phase Equilibria, Vapour-Liquid Equilibria (VLE), Raoult's Law & Modified Raoult's Law; High-Pressure VLE; Henry's law	
Unit –IV	**07 Hrs**
Solution thermodynamics Applications, Liquid phase properties from VLE data, Models for excess Gibbsenergy, consistency test for VLE data, Property changes of mixing. **Chemical Reaction Equilibria:** The reaction coordinate, application of equilibrium criteria to chemicalreactions, 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, phase rule and Duhem's theorem for reacting system, multi reaction equilibria	
Unit –V	**07 Hrs**
Gibbs free energy Applications: Photosynthesis, glycolysis, oxidative phosphorylation and ATP hydrolysis, substrate cycling, Donnan equilibrium, Enzyme substrate interaction, Molecular pharmacology, Hemoglobin, ELISA, DNA, Polymerase chain reaction, free energy of transfer of amino acids, Protein solubality& stability, protein dynamics.	

Course Outcomes: After completing the course, the students will be able to	
CO1 :	Recall the Laws of thermodynamics and evaluate the heat, work, entropy, internal energy inter-conversions for various processes
CO2 :	Evaluate the thermodynamic properties for real gases using various equations of state and establish the thermodynamic relations
CO3 :	Evaluate the thermodynamic properties of pure substances, solutions (two phase) and mixtures involving reactions
CO4	Formulate the thermodynamic properties for equipment design

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Reference Books	
1	"Introduction to Chemical Engineering Thermodynamics" J Smith.M. and Vanness H.C., 7th Edition, 2005, McGraw Hill, New York, *ISBN:*978-0071247085
2	"Chemical Engineering Thermodynamics", Rao Y.V.C., 2nd Edition, 4th Reprint, 2009, New Age International Publication, Nagpur,.*ISBN*. 9788173714610
3	"Textbook of Chemical Engineering Thermodynamics", Narayanan K.V., 3rd Edition, 8th Reprint, 2006, Prentice Hall of India Private Limited, New Delhi, ISBN 978-8120347472
4	"Engineering Thermodynamics", Nag P.K., 3rd Edition, 2007, Tata McGraw Hill Book Co., New Delhi, ISBN: 978-125906256
5	Biological Thermodynamics, Donald T Hayne., 2nd edition, 2008, Cambridge University Press, ISBN:978-0-521-88446-4

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

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

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

SEE for 100 marksis executed by means of an examination. The Question paper for the 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 IV						
MOLECULAR BIOLOGY (Theory)						
Course Code	**:**	18BT46		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:1:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L+25T		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	Understand the life processes at sub-cellular and molecular level
2	Gain knowledge on molecular mechanisms of prokaryotes and eukaryotes
3	Interpret the various levels of gene regulation at genetic and epigenetic levels and disease related to perturbations.
4	Articulate the knowledge of molecular mechanisms of the cell, its regulation and disease related to perturbations. .

Unit-I	**07 Hrs**
Macromolecular organization of Nucleic acids: Structural organization of chromatin. Genome organization. Structure of DNA - Double Helix, Features of Watson and Crick model. Mobile genetic elements: Transposons. Overview of prokaryotic and eukaryotic genome, Cancer: Oncogenes,Tumor suppressor genes and their functions, signalling pathways involved in tumorigenesis.	
Unit – II	**08 Hrs**
DNA Replication Repair and Recombination: Replication in prokaryotes and eukaryotes, Mechanism of action of telomerase, Plasmid replication, Replication of chloroplast DNA and Mitochondrial DNA, DNA damage and repair: Nucleotide excision repair, base excision repair, Mismatch repair, photo-reactivation, recombination repair and SOS repair. DNA Repair perturbation (Case Study: Xeroderma pigmentosum and Ataxia telangiectasia). Mutagenesis. DNA recombination: homologous (Holliday model) and site-specific recombination. Genome editing (CRISPR/Cas9, Zinc Finger Nucleases, TALENs). .	
Unit -III	**08 Hrs**
Transcription and post transcriptional modifications: Mechanism of transcription in prokaryotes and eukaryotes, Enhancers, Activators, Repressors Transcription inhibitors. Reversal of Central Dogma, Post transcriptional processing of mRNA, Alternative splicing. mRNA nuclear export,RNAediting,mRNA surveillance mechanism: NMD pathway and diseases (case study Beta thalassemia, Cystic Fibrosis) .	
Unit –IV	**08 Hrs**
Translation and post translational processing: Genetic code. Translation machinery, Amino acylation, Role of ribosomes in translation. Translation in prokaryotes and eukaryotes; Initiation, elongation and termination. Fidelity and proofreading. Inhibitors of Protein Synthesis, Protein Folding, diseases related to protein misfolding (case study: Alzheimer's **disease**, Huntington's disease). Post translational modifications, Protein Targeting and Degradation; Protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast, and nucleus	
Unit –V	**08 Hrs**
Principles of gene regulation: Regulation of gene expression in prokaryotes (Operon-*lac* operon and trp-operon), Positive and negative gene regulation, riboswitches. Regulation of gene expression in eukaryotes: Transcriptional level, Role of transcriptional factors, **Transcriptional Activation:** The Role of Enhancers, Promoters, and Coactivators, Transcriptional Repression. Processing level control; Translational level control; The Control of mRNA Stability, Role of MicroRNAs. Posttranslational level and protein stability. Non coding RNAs. Gene silencing: chromatin remodelling, RNA interference; Types and its relevance. Epigenetic regulation. CpG islands, histone modification. Epigenetic changes in diseases (case study:Rheumatoid arthritis).	

Course Outcomes: After completing the course, the students will be able to	
CO1 :	Understand the concept of central dogma of molecular biology.
CO2 :	Explain the mechanism of replication, transcription and translation.
CO3 :	Compare and contrast between prokaryotic and eukaryotic molecular mechanisms and its regulation at various levels and disease related to perturbations.
CO4 :	Ability to think critically in reading, analysing and articulating the biological information and the diseases related of the mis-expression from research journals.

Text Books	
1	Molecular Biology, David P. Clark, Nanette J. Pazdernik. Michelle R. McGehee, 3rd Edition, 2018, Academic Press, ISBN-10: 0128132884, ISBN-13: 978-0128132883,
2	Molecular Biology, Lodish H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H, 8thedn, 2016, W H Freeman, ISBN-10: 1464183392, ISBN-13: 978-1464183393.
3	Karp's Cell and Molecular Biology: Concepts and Experiments , 8thedn , 2015, John Wiley & Sons Inc, ISBN-10: 1118886143, ISBN-13: 978-1118886144
4	Lewin's GENES XII, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2017, Jones and Bartlett Publishers, Inc., ISBN-10: 1284104494, ISBN-13: 978-1284104493

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). 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 experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marksis executed by means of an examination. The Question paper for the 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 and IV						
PROFESSIONAL PRACTICE – I COMMUNICATION SKILLS (Common to all Programmes)						
Course Code	**:**	**18HS49**		**CIE**	**:**	**50**
Credits: L:T:P	**:**	0:0:1		**SEE**	**:**	**50**
Total Hours	**:**	18 hrs /Semester		**SEE Duration**	**:**	**2 Hours**

Course Learning Objectives: The students will be able to

1	Understand their own communication style, the essentials of good communication and develop their 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	**6 Hrs**
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.	
	6 Hrs
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.	
	6 Hrs
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.	
IV Semester	**6 Hrs**
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.	
	6Hrs
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-	
	6 Hrs
Professional Practice - Professional Dress Code, Time Sense, Respecting People & their Space, Relevant Behavior 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	

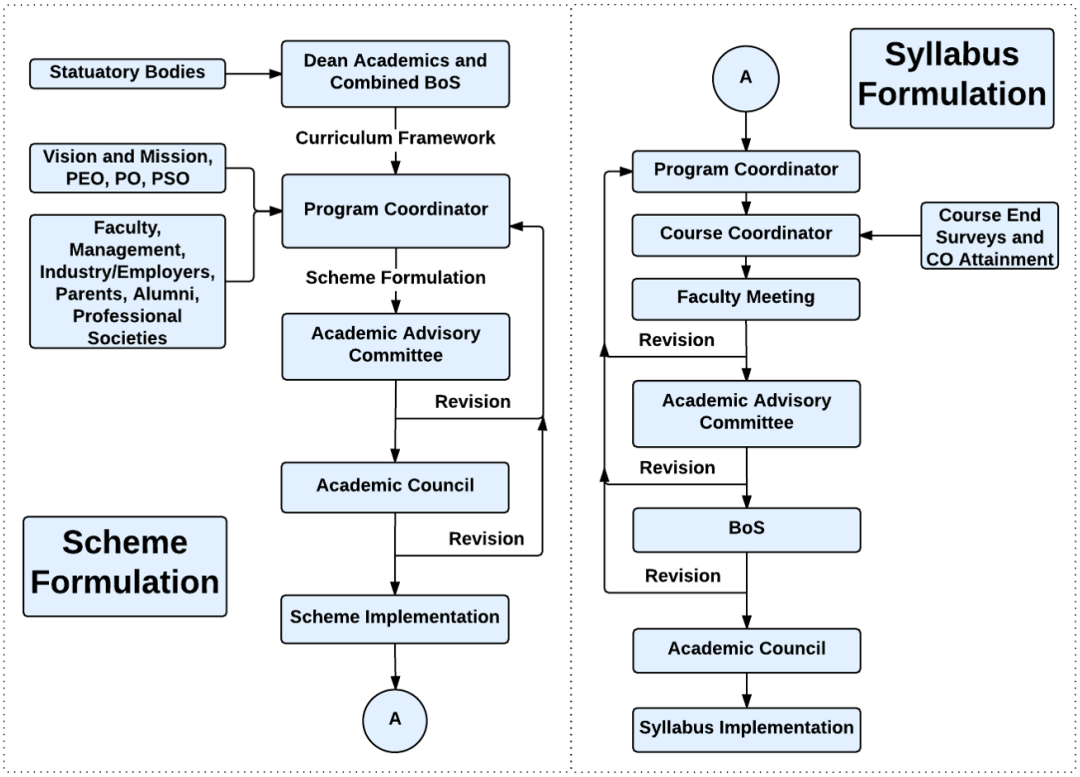
Course Outcomes: After completing the course, the students will be able to	
CO1:	Inculcate skills for life, such as problem solving, decision making, stress management
CO2:	Develop leadership and interpersonal working skills and professional ethics.
CO3:	Apply verbal communication skills with appropriate 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, McGraw-Hill Publication, 2012 Edition, ISBN: 9780071772204
4.	Aptimithra: Best Aptitude Book, Ethnus,Tata McGraw Hill, 2014 Edition, ISBN: 9781259058738

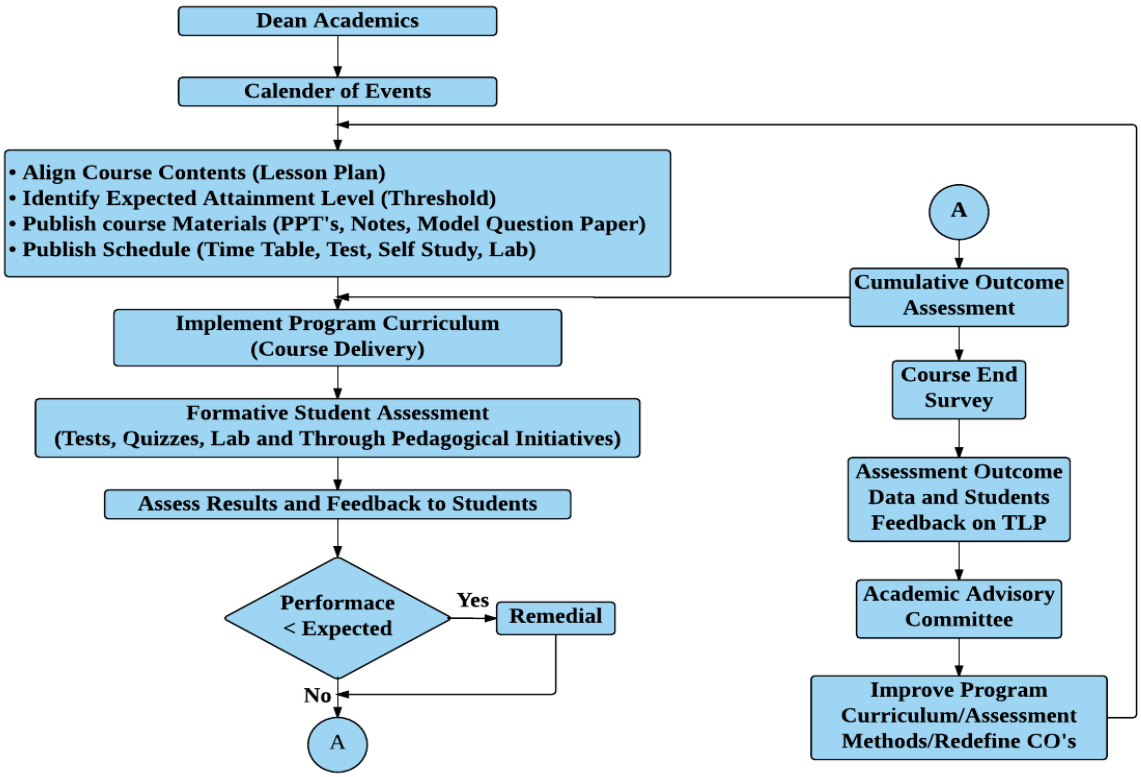
Scheme of Continuous Internal Examination and Semester End Examination

Phase	Activity	Weightage
Phase I III Sem	CIE will be conducted during the 3rd semester and evaluated for 50 marks. The test will have two components. The Quiz is evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks. The test & quiz will assess the skills acquired through the training module. SEE is based on the test conducted at the end of the 3rd semester The test will have two components a Quiz evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks.	50%
Phase II IV Sem	During the 4th semester a test will be conducted and evaluated for 50 marks. The test will have two components a Short Quiz and Questions requiring descriptive answers. The test & quiz will assess the skills acquired through the training module. SEE is based on the test conducted at the end of the 4th semester The test will have two components. The Quiz evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks	50%
Phase III At the end of IV Sem	At the end of the IV Sem Marks of CIE (3rd Sem and 4th Sem) is consolidated for 50 marks (Average of Test1 and Test 2 (CIE 1+CIE2)/2. At the end of the IV Sem Marks of SEE (3rd Sem and 4th Sem) is consolidated for 50 marks (Average of CIE 1 and CIE 2 (CIE 1+CIE2)/2.	

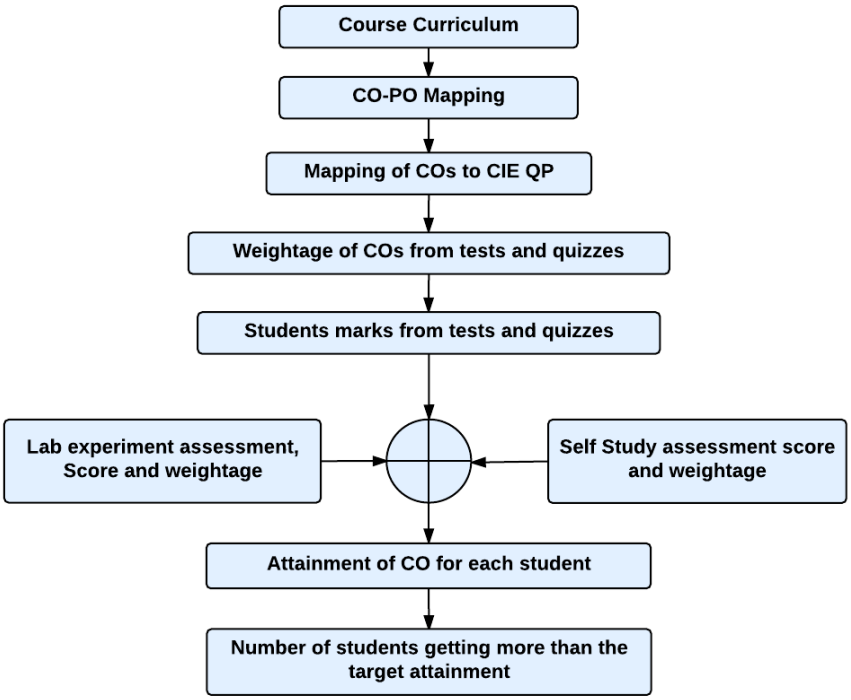
Curriculum Design Process



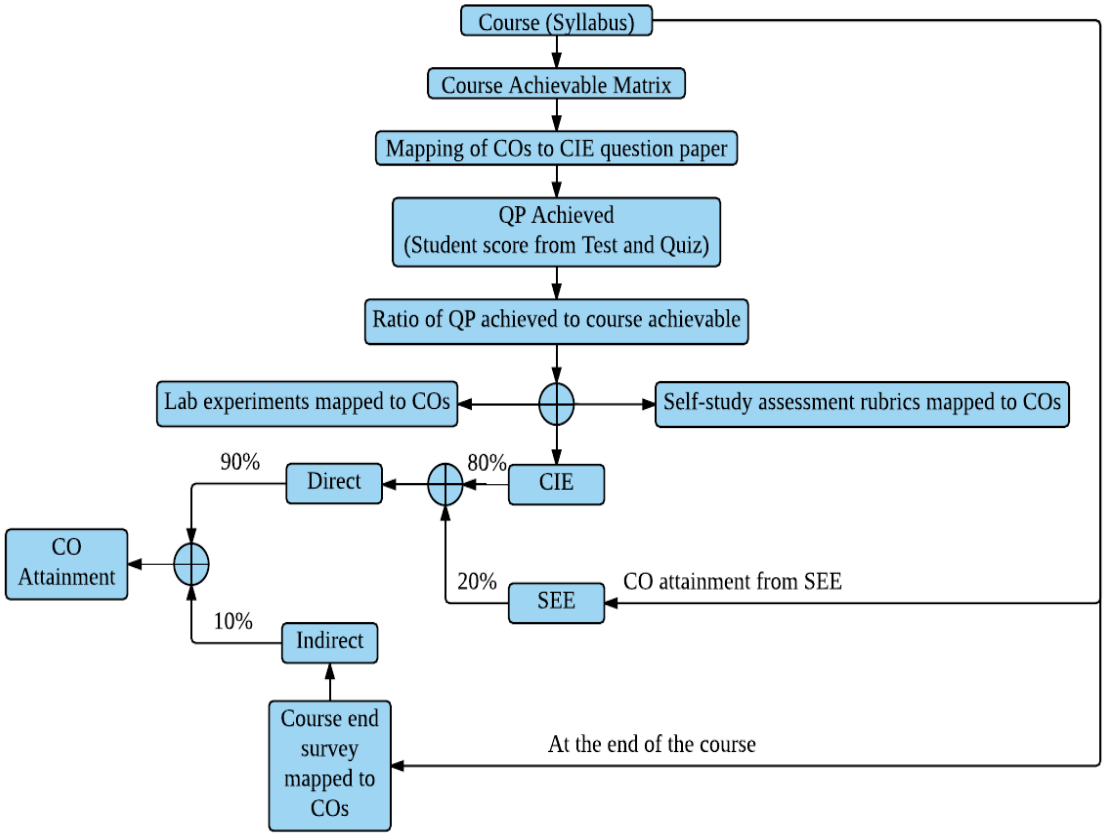
Academic Planning And Implementation



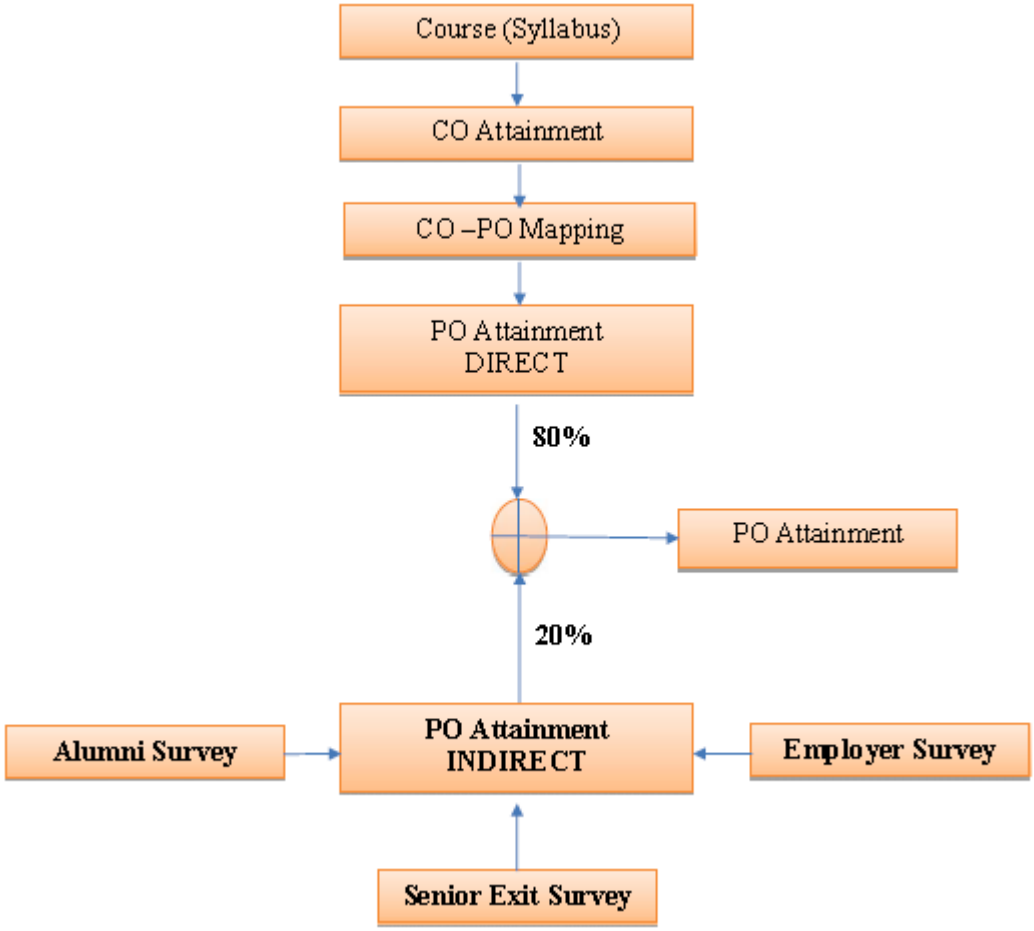
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



PROGRAM OUTCOMES (POs)

1**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet t h e specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

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