RV College of Engineering®

Biotechnology

Bachelor of Engineering (B.E)

Scheme And Syllabus Of V & VI Semester
(2022 Scheme)

B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, ET, IM, IS, ME.
M. Tech (13) MCA, M.Sc. (Engg.)
Ph.D. Programs : All Departments are recognized as Research Centres by VTU Except AI & AS

2024

99TH
NIRF RANKING IN ENGINEERING (2024)

TIMES HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2023
1501+
TIMES HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2023 (ASIA)
501-600

EDUFUTURE EXCELLENCE AWARD
BEST PRIVATE ENGINEERING UNIVERSITY (SOUTH)
BY ZEE DIGITAL

1001+
SUBJECT RANKING (ENGINEERING)

801+
SUBJECT RANKING (COMPUTER SCIENCE)

IIRF 2023
ENGINEERING RANKING INDIA
NATIONAL RANK-10
STATE RANK - 2
ZONE RANK - 5

QS-IGUAGE DIAMOND UNIVERSITY RATING (2021-2024)

CURRICULUM STRUCTURE

61 CREDITS PROFESSIONAL CORES (PC)

23 CREDITS BASIC SCIENCE

22 CREDITS ENGINEERING SCIENCE

18 CREDITS PROJECT WORK / INTERNSHIP

12 CREDITS* OTHER ELECTIVES & AEC

12 CREDITS PROFESSIONAL ELECTIVES

12 CREDITS HUMANITIES & SOCIAL SCIENCE

160 CREDITS TOTAL

*ABILITY ENHANCEMENT COURSES (AEC), UNIVERSAL HUMAN VALUES (UHV), INDIAN KNOWLEDGE SYSTEM (IKS), YOGA.

17
Centers of Excellence

11
Centers of Competence

212
Publications On Web Of Science

669
Publications Scopus (2023 - 24)

1093
Citations

70
Patents Filed

39
Patents Granted

61
Published Patents

11
Skill Based Laboratories Across Four Semesters

MOUS: 90+WITH INSDUSTRIES / ACADEMIC INSTITUTIONS IN INDIA & ABROAD

EXECUTED MORE THAN RS.40 CRORES WORTH SPONSORED RESEARCH PROJECTS & CONSULTANCY WORKS SINCE 3 YEARS

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B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, ET, IM, IS, ME.
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2024

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 ethical 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 fundamentals that prepare them for a successful career in Biotechnology and allied fields

PEO2: Function at a technically competent level in formulating and solving problems in Biotechnology

PEO3: Organize and utilize the knowledge to develop Biological processes and gene manipulation techniques

PEO4: Exhibit professionalism, ethical attitude, oral and written communication skills, team work and develop an outlook for lifelong learning

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

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.	PY	Physics
9.	CY	Chemistry
10.	MA	Mathematics
11.	AS	Aerospace Engineering
12.	AI & ML	Artificial Intelligence & Machine Learning
13.	BT	Biotechnology
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	CV	Civil Engineering
17.	EC	Electronics & Communication Engineering
18.	EE	Electrical & Electronics Engineering
19.	EI	Electronics & Instrumentation Engineering
20.	ET	Electronics & Telecommunication Engineering
21.	IM	Industrial Engineering & Management
22.	IS	Information Science & Engineering
23.	ME	Mechanical Engineering

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4	BT354TA	Genomics, Proteomics and Nanotechnology	10
5	BT355TBX	Professional Core Elective-I (Group B)	12
6	BT256TCX	Professional Core Elective-II (Group C)	NA

VI Semester			
Sl. No.	**Course Code**	**Course Title**	**Page No.**
1	HS361TA	**Entrepreneurship & Intellectual Property Rights**	22
2	BT362IA	Kinectics of Reactions	25
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RV College of Engineering®
Mysore Road, RV Vidyaniketan Post,
Bengaluru - 560059, Karnataka, India

Go, change the world®

Bachelor of Engineering in
BIOTECHNOLOGY

V SEMESTER														
Sl. No.	**Course Code**	**Course Title**	**Credit Allocation**				**BoS**	**Category**	**CIE Duration (H)**	**Max Marks CIE**		**SEE Duration (H)**	**Max Marks SEE**	
			L	**T**	**P**	**Total**				**Theory**	**Lab**		**Theory**	**Lab**
1	HS251TA	Principles of Management & Economics	3	0	0	**3**	HSS	Theory	1.5	**100**	****	**3**	**100**	****
2	BT352IA	Bioinformatics	3	0	1	**4**	BT	(Theory and Practice)	1.5	**100**	**50**	**3**	**100**	**50**
3	BT353IA	Genetic Engineering	3	0	1	**4**	BT	(Theory and Practice)	1.5	**100**	**50**	**3**	**100**	**50**
4	BT354TA	Genomics, Proteomics and Nanotechnology	3	1	0	**4**	BT	Theory+Tutorial	1.5	**100**	***	**3**	**100**	***
5	BT355TBX	Professional Core Elective-I (Group B)	3	0	0	**3**	BT	Theory	1.5	**100**	****	**3**	**100**	****
6	BT256TCX	Professional Core Elective-II (Group C)	2	0	0	**2**	BT	NPTEL	1.5	**50**	****	**2**	**50**	****
Total						**20**								

GROUP-B		
Sl. No.	**Course Code**	**Course Title**
1	BT355TBA	Pharmaceutical Biotechnology
2	BT355TBB	Agricultural Biotechnology
3	BT355TBC	Plant Utilities And Biosafety In India
4	BT355TBD	Systems Biology
5	BT355TBE	Enzyme Technology

GROUP-C – NPTEL (NPTEL courses are subject to change based on the availability of the course on NPTEL platform)		
Sl. No.	**Course Code**	**Course Title**
1	BT256TCA	Introductory mathematical methods for biologists
2	BT256TCB	Bioreactor Design and Analysis
3	BT256TCC	Biointerface engineering
4	BT256TCD	Metabolic Engineering
5	BT256TCE	Health research fundamentals

Bachelor of Engineering in
BIOTECHNOLOGY

VI SEMESTER													
Sl. No.	**Course Code**	**Course Title**	**Credit Allocation**				**BoS**	**Category**	**CIE Duration (H)**	**Max Marks CIE**		**SEE Duration (H)**	**Max Marks SEE**	
			L	**T**	**P**	**Total**				**Theory**	**Lab**		**Theory**	**Lab**
1	HS361TA	Intellectual Property Rights & Entrepreneurship	3	0	0	**3**	HSS	Theory	1.5	**100**	********	**3**	**100**	********
2	BT362IA	Kinectics of Reactions	3	0	1	**4**	BT	(Theory and Practice)	1.5	**100**	**50**	**3**	**100**	**50**
3	BT363IA	Microbial Biotechnology	3	0	1	**4**	BT	(Theory and Practice)	1.5	**100**	**50**	**3**	**100**	**50**
4	BT364IA	OMICS Technology	3	0	1	4	BT	(Theory and Practice)	1.5	**100**	**50**	**3**	**100**	**50**
5	BT365TDX	Professional Core Elective – III (Group D)	3	0	0	**3**	BT	Theory	1.5	**100**	********	**3**	**100**	********
7	XX266TEX	Institutional Electives - I (Group E)	3	0	0	**3**	Respective BOS	Theory	1.5	**100**	********	**3**	**100**	********
8	BT367P	Interdisciplinary Project	0	0	3	**3**	BT	Practical	3		**100**	**3**		**100**
						24								

GROUP-D		
Sl. No.	**Course Code**	**Course Title**
1	BT365TDA	BioInstrumentation
2	BT365TDB	Food & Dairy Biotechnology
3	BT365TDC	Fermentation Technology
4	BT365TDD	Programming In Biotechnology
5	BT365TDE	Equipment Design And Drawing

GROUP-E			
Sl. No.	**Course Code**	**BoS**	**Course Title**
1	AS266TEA	AS	Fundamentals of Aerospace Engineering
2	BT266TEB	BT	Healthcare Analytics
3	CH266TEC	CH	Industrial Safety Engineering
4	CS266TED	CS	Robotics Process Automation
5	CV266TEE	CV	Intelligent Transport Systems
6	CV266TEF	CV	Integrated Health Monitoring of Structures
7	CM266TEG	Chemistry	Advanced Energy Storage for E-Mobility
8	EC266TEH	EC	Human Machine Interface (HMI)
9	EE266TEJ	EE	Energy Auditing and Standards
10	EI266TEK	EI	Biomedical Instrumentation
11	ET266TEM	ET	Telecommunication Systems
12	ET266TEN	ET	Mobile Communication Networks and Standards
13	IS266TEO	IS	Mobile Application Development
14	IM266TEQ	IM	Elements of Financial Management
15	IM266TER	IM	Optimization Techniques
16	ME266TES	ME	Automotive Mechatronics
17	MA266TEU	MA	Mathematical Modelling
18	MA266TEV	MA	Mathematics of Quantum Computing
19	HS266TEW	HS	Applied Psychology for Engineers
20	HS266TEY	HS	Universal Human Values -III

Semester :V						
PRINCIPLES OF MANAGEMENT & ECONOMICS **Category: Professional Core Course** **(Theory)**						
Course Code	**:**	**HS251TA**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45Hrs**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**06 Hrs**
Introduction to Management: Management Functions – POSDCORB – an overview, Management levels & Skills, Management History - **Classical Approach:** Scientific Management, Administrative Theory, **Quantitative Approach:** Operations Research, **Behavioral Approach:** Hawthorne Studies, **Contemporary Approach:** Systems Theory, Contingency Theory. **Caselets / Case studies**	
Unit – II	**10 Hrs**
Foundations of Planning: Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate strategies – types of corporate strategies, BCG matrix, Competitive Strategies – Porters Five force Model, types of Competitive Strategies. **Caselets / Case studies** **Organizational Structure & Design:** Overview of Designing Organizational Structure - Work Specialization, Departmentalization, Chain of Command, Span of Control, Centralization & Decentralization, Formalization, Mechanistic & Organic Structures. **Caselets / Case studies**	
Unit –III	**10 Hrs**
Motivation: Early Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Theory Y, Herzberg's Two Factor Theory. Contemporary Theories of Motivation: Adam's Equitytheory, Vroom's Expectancy Theory. **Caselets / Case studies** **Leadership:** Behavioral Theories: Blake & Mouton's Managerial Grid, Contingency Theories of Leadership: Hersey & Blanchard's Situational Leadership, Contemporary Views of Leadership: Transactional & Transformational Leadership. **Caselets / Case studies**	
Unit –IV	**10 Hrs**
Introduction to Economics: Microeconomics and Macroeconomics, Circular flow model of economics, An Overview of Economic Systems. **Essentials of Microeconomics:** Demand, Supply, and Equilibrium in Markets for Goods and Services, Price Elasticity of Demand and Price Elasticity of Supply, Elasticity and Pricing, Numericals on determining price elasticity of demand and supply. Changes in Income and Prices Affecting Consumption Choices, Monopolistic Competition, Oligopoly.	
Unit –V	**09 Hrs**
Macroeconomic Indicators: Prices and inflation, Consumer Price Index, Exchange rate, Labor Market, Money and banks, Interest rate. Gross Domestic product (GDP) - components of GDP, Measures of GDP: Outcome Method, Income method and Expenditure method, Numericals on GDP Calculations, ESG an overview. **Macroeconomic models**- The classical growth theory, Keynesian cross model, IS-LM-model, The AS-AD model, The complete Keynesian model, The neo-classical synthesis. National Budgeting process in India	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Elucidate the principles of management theory & recognize the characteristics of an organization.
CO2	Demonstrate the importance of key performance areas in strategic management and design appropriate organizational structures and possess an ability to conceive various organizational dynamics.
CO3	Compare and contrast early and contemporary theories of motivation and select and implement the right leadership practices in organizations that would enable systems orientation.
CO4	Demonstrate an understanding on the usage and application of basic economic principles.
CO5	Appreciate the various measures of macro-economic performance and interpret the prevailing economic health of the nation.

Reference Books:	
1.	Management, Stephen Robbins, Mary Coulter &NeharikaVohra, 15th Edition, 2021, Pearson Education Publications, ISBN: 13: 978-0-13-558185-8
2.	Management, James Stoner, Edward Freeman & Daniel Gilbert Jr, 6th Edition, 2009, PHI, ISBN: 81-203-0981-2.
3.	Principles of Microeconomics, Steven A. Greenlaw, David Shapiro, 2nd Edition, 2017, ISBN:978-1-947172-34-0
4.	Macroeconomics: Theory and Policy, Dwivedi D.N, 5th Edition, 2021, McGraw Hill Education; ISBN : 9789353163334

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Some of the Experiential learning topics may include Reading Leadership books and summarizing, Analysis and interpretation of various economic reports, Visit to various organizations to understand organizational mechanics. Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
BIOINFORMATICS **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	**BT352IA**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3.00 + 3.00 Hours**

Unit-I	**09 Hrs**
Molecular Sequencing: Introduction to Bioinformatics - Scope, Applications. DNA sequencing; Methods – Basic and Next Generation Sequencing methods - Maxam-Gilbert Method, Sanger Dideoxy method and Pyrosequencing. Next Generation Sequencing (NGS) and NGS Experimental Work Flow. NGS Platforms - Illumina Reverse Dye-Terminator, Ion Torrent Semiconductor sequencing, Pacific Biosciences Single Molecule Real-Time Sequencing and ONT's MinION sequencing.	
Unit – II	**09 Hrs**
Biological Databases and Cloud Platforms: Introduction – types; Nucleic acid Sequence databases, Protein Sequence Databases, Structural Databases, Special Databases – OMIM, Genome Databases. NGS databases – Zenodo, SRA, ENA,SRA and GEO. Databases of Medical Imaging. Accessing and Retrieval of NGS Data - SRA toolkit and Aspera connect. Sequence Analysis – Introduction, Overview of Cloud platforms available for Medical informatics.	
Unit –III	**09 Hrs**
Algorithms and Sequence analysis: Scoring matrices– BLOSSUM and PAM. Algorithms and Sequence analysis; Dynamic Programming Algorithms – Needleman and Wunch & Smith and Waterman, BLAST, FASTA, and Exon Chaining. Phylogenetic analysis; Multiple Sequence Alignment, Clustering Algorithms – UPGMA and NJ and Tree evaluation. Genome Assembly and Genome Mapping Algorithms – GoldRush and BWT. Machine Learning Algorithms for Gene prediction and Prediction of Secondary structure of Protein.	
Unit –IV	**09 Hrs**
NGS applications: Whole Genome Sequencing, Exome sequencing, Metagenomics, Transcriptome sequencing, ChIP Sequencing, smallRNA sequencing, Methylome sequencing, RAD Sequencing, Amplicon sequencing, RRL sequencing, Whole Mitochondrial Genome sequencing and Whole Chloroplast sequencing. NGS in Molecular diagnosis – Case studies related to above applications. Machine Learning Algorithms for Population studies, Linkage mapping, and Genome Mapping with NGS. Next Generation Sequencing in Cancer Research.	
Unit –V	**09 Hrs**
Molecular modelling and Drug designing: Introduction to Molecular Modelling and Simulation; brief introduction to protein structure hierarchy. Modelling 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, mechanics behind the molecular interactions – overview of molecular mechanics and quantum mechanics. Binding free energy calculations	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Utilize diverse bioinformatics tools and databases for in-depth sequence and structural analysis.
CO2	Apply cutting-edge sequencing technologies and analytical methods to tackle complex problems in Genomics and Proteomics.
CO3	Demonstrate proficiency in Next-Generation Sequencing (NGS) technologies for the analysis of Big-Data in the field Biotechnology.
CO4	Employ bioinformatics tools to model and simulate microscopic phenomenon at macroscopic level to understand the complex problems and design solutions.

Reference Books	
1.	Bioinformatics Database Systems By Kevin Byron, Katherine G. Herbert, Jason T. L. Wang, CRC Press, 2016. ISBN: 9781315388083.
2.	Next Generation Sequencing and Data Analysis by Melanie Kappelmann-Fenzl, Springer International Publishing, 2021. ISBN: 9783030624903.
3.	Next-generation Sequencing Data Analysis By Xinkun Wang, CRC Press, Taylor & Francis Group, 2024. ISBN: 9781032505701.
4.	Medical Imaging Systems An Introductory Guide by Andreas Maier, Joachim Hornegger, Stefan Steidl, Vincent Christlein, Springer International Publishing, 2018. ISBN: 9783319965208.

LABORATORY COMPONENT

Laboratory

1. Design, Implement and Execute Python based Workflow: Retrieval of Sequence, Structure and NGS Data from GenBank, PDB, Zenodo, SRA and ENA.
2. Design, Implement and Execute Python based Workflow: Retrieval of Medical Imaging Records from remote databases.
3. Design, Implement and Execute Python based Workflow: Sequence alignment – Global, Local and Multiple Sequence alignment.
4. Design, Implement and Execute Python based Workflow for Search, retrieve and parse PDB, KEGG and Microarray Records.
5. Design, Implement and Execute Python based Workflow: Restriction mapping and Primer Designing.
6. Design, Implement and Execute Python based Workflow for Phylogenetic Analysis.
7. Design, Implement and Execute Python based Workflow for Genome Assembly.
8. Design, Implement and Execute Python based Workflow for Exome Analysis.
9. Design, Implement and Execute Python based Workflow for Metagenomic Analysis.
10. Design, Implement and Execute Python based Workflow for Meta Transcriptomic Analysis.
11. Design, Implement and Execute Python based Workflow for Genome Annotation.
12. Design, Implement and Execute Python based Workflow for Medical Image Processing: Image processing and Analysis of Neuroimages.
13. Design and Execute Cloud Based Workflow for Functional annotation of protein sequences.
14. Design and Execute Cloud based Workflow for High Throughput Virtual Screening..
15. Design and Execute Python based Workflow of Variant Calling for Human Genome Data on Cloud Platform.

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks),lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50MARKS	**50**
	MAXIMUM MARKS FOR THE CIE	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**

Semester: V

GENETIC ENGINEERING
Category: Professional Core Course
(Theory and Practice)

Course Code	**:**	**BT353IA**		**CIE**	**:**	**100+50 Marks**
Credits: L: T: P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3.00 + 3.00 Hours**

Unit-I **9Hrs.**

Introduction to Genetic Engineering: Isolation and purification of DNA (Plasmid DNA, genomic DNA and RNA (bacterial, plants and animals). Vectors used for gene cloning. Molecular tools for gene cloning: Restriction and Modification systems. Modifying enzymes.

Unit – II **9Hrs.**

Gene transfer techniques: Cloning Techniques: Ligase dependent and Ligase independent cloning. Physical, chemical and biological methods, Competent cells: Chemical and Electro- competent methods. Introduction of DNA into host cells. Screening and characterization of transformants; Selectable marker genes, reporter genes. Expression of recombinant proteins using bacterial, animal and plant vectors and their purification. Transformation/ transfection in plants and animals.

Unit –III **9Hrs.**

Methods of nucleic acid/ protein detection; Polymerase chain reaction (PCR) – Types of PCR and applications. Blotting techniques (Southern, Northern and Western), Radioactive and non-radioactive labelling of nucleic acids. High Throughput Screening (HTS) mode of hybridization: Microarray technique. Construction of genomic and cDNA libraries: Screening of genomic DNA and cDNA libraries.

Unit –IV **9Hrs.**

DNA and Protein interaction studies:
DNA-Protein interactions: Electrophoretic Mobility Shift Assay (EMSA), Chromatin Immunoprecipitation (ChiP), DNA foot printing, Yeast One Hybrid, Surface Plasmon Resonance (SPR), Fluorescence Resonance Energy Transfer (FRET).Protein- Protein Interaction Studies: Yeast two hybrid, Co-Immunoprecipitation, (Co-IP) Bimolecular Fluorescence Complementation (BiFC).

Unit –V **9Hrs**

Applications of Genetic Engineering / Gene editing technologies/MAGE technologies : Engineering microbes for the production of antibiotics, enzymes, insulin and monoclonal antibodies. Transgenic technology for plant and animal improvement: Over expression and knock out/ knock down studies, Bio pharming- Animals and plants as bioreactors for recombinant proteins. Case studies: Golden rice, Bt Cotton & Drought tolerant rice. GMOs with increased meat production. Applications of Knockout mice model system. Applications of Genome-Editing Technologies. Gene therapy and
CAR T therapy.
Ethics and regulatory bodies involved in GMOs and gene editing technologies; Regulation of Genome Engineering Technologies in India, U.S. Food and Drug Administration (FDA), U.S. Environmental Protection Agency (EPA), and U.S. Department of Agriculture (USDA).

Laboratory Component

1. Isolation of plasmid DNA from Bacteria
2. . Isolation of genomic DNA (plant/ animal blood)
3. Extraction of total RNA from plant species
4. Agarose Gel Electrophoresis and quantification of nucleic acids
5. Restriction digestion of Lambda DNA (with *EcoRI*, *HindIII* and *BamHI*)
6. Reverse transcriptase - PCR reaction and design of primers
7. Preparation of competent cells (*E.coli* / *Agrobacterium tumifaciens)*
8. Genetic transformation of *E.coli*
9. Screening techniques to select recombinants (Blue white selection)
10. Polymerase Chain Reaction (PCR) and design of primers
11. Isolation and Separation of Proteins - SDS-PAGE
12..Self-study/open ended experiment: Gene cloning: A. Cloning of gene fragment into a cloning vector

B. Genetic transformation in plants
C. Screening techniques to select transgenic plant through GUS histochemical assay

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the basic concepts of genetic engineering for augmentation of traits
CO2	Apply and comprehend the principles of gene manipulation, expression and interaction of genes and proteins.
CO3	Design the strategies for gene cloning and gene editing to generate GMOs following professional ethics
CO4	Evaluate the screening and interaction studies using classical/conventional and high through put methods.

Reference Books	
1	Desmond S. T. Nicholl. An Introduction to Genetic Engineering. Cambridge University Press. 4th Edition, 2023.ISBN: 9781009180610
2	T.A.Brown; Gene Cloning and DNA Analysis – An Introduction; Wiley-Blackwell Science; 7th edn;2018; ISBN: 9781405181730
3	B.R. Glick, J.J.Pasternak and C.L Patten; Molecular Biotechnology – Principles and applications of recombinant DNA; ASM Press; 6th edition; 2017; ISBN: 9781555814984
4	Andy B. Primrose and Richard Twyman. Principles of Gene Manipulation and Genomics. Blackwell Publisher. 7th edition. 2018.ISBN: 1405135441.

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY+LAB)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**

Semester: V						
GENOMICS, PROTEOMICS AND NANOTECHNOLOGY **Category: Professional Core** **(Theory)**						
Course Code	**:**	**BT354TA**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**3:1:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L+30T**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**9Hrs.**

Introduction to Eukaryotic genes and Polymorphisms: Organization of eukaryotic (microbial,plant and animal genomes) within nucleus, Extra chromosomal DNA genome, Polymorphism. C-Values of eukaryotic genomes. **Sequencing andgenome projects:** Early sequencing efforts, Methods of preparing genomic DNA for sequencing,**Sequencing strategies**: shot-gun approach, clone contig approach, **DNA sequencing methods:** Maxim and Gilbert, Sanger Dideoxy method, High throughput sequencing.Major genome sequencing projects.

Unit – II	**9Hrs.**

Genomics analysis: Expressed sequenced tags (ESTs), Single Nucleotide Polymorphisms (SNPs).
Functional genomics: Finding genes in the genome, assigning functions to the gene. DNA chips and diagnostics assays, RT-PCR, SAGE& DD-PCR. Importance of noncoding sequences – miRNA and RNAi. Molecular markers in genome analysis, principal classes of markers: Repetitive and coding sequences. DNA Fingerprinting - RFLPs & AFLPs. DNA amplification markers RAPDs, SCAR, microsatellites – simple sequences repeat (SSR) and inter simple sequence repeats (ISSR), Allozymes and Isozymes, Telomerase as molecular markers. Application of markers in plant and animal breeding. FISH-DNA amplification markers

Unit –III	**9Hrs.**

Introduction to proteomics: Basics of protein structure and function, Evolution from proteinchemistry to proteomics; Abundance-based proteomics: Sample preparation and prefractionation steps, Gel-based proteomics - two-dimensional gel electrophoresis (2-DE), two-dimensionalfluorescence difference in-gel electrophoresis (DIGE), Staining techniques, Image analysis of 2DE gels. Central role of mass spectrometry: ionization sources, mass analyzers, different types of mass spectrometers.

Unit –IV	**9 Hrs**

Quantitative proteomics - Stable isotope labelling by amino acids in cell culture (SILAC), isotope-coded affinity tag (ICAT), isobaric tagging for relative and absolute quantitation (iTRAQ); Interactomics - techniques to study protein-protein interactions, yeast two-hybrid, immunoprecipitation, protein microarrays, Label-free nanotechnologies in proteomics, Surface Plasmon Resonance (SPR); Modificomics: understanding post-translational modifications; Structural proteomics; Bioinformatics in proteomics; Challenges and future prospects of proteomics research

Unit –V	**9 Hrs**

Introduction to Nanotechnology: History, Types of nanomaterials: Fullerenes, Nanoshells, Quantum dots, Dendrimers. **Nanosynthesis.** Ballmilling, CVD, Sol gel, Plasma arching. **Top-Down and Bottom-up** approaches, methods of nanofabrication: soft- and hard-lithography. **Characterization of Nanomaterials: Spectroscopic methods**: UV-VIS, FTIR and Raman. **Microscopic method:** Scanning Electron Microscopy, Transmission Electron Microscopy, **Scanning probe methods**: Atomic Force Microscopy, ScanningTunneling Microscopy

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand and remember the concepts of various genes and their expression.
CO2	Apply various large-scale sequencing methods for sequencing various organisms' genome.
CO3	Acquire and evaluate the methods involved in analysis of genome and proteome.
CO4	Develop or create a diagnostic tool for plant, animal and human diseases.

Reference Books	
1	Principals of Genomics and Proteomics, Rakeeb Ahmad Mir, Sheikh Mansoor Shafi, Sajad Majeed Zargar 1st edition,2023, Elsevier, ISBN: 9780323990455
2	Genomics and Proteomics: Principles, Technologies, and Application Devarajan Thangadurai and Jeyabalan Sangeetha, 1st Edn, 2021, Apple Academic Press, ISBN 9781774635377.
3	Introduction to Genomics, 2Nd Edn by Lesk, Oxford University Press, 2015, Paperback, 9780198745891
4	Genome analysis and Genomics-S.B Primrose and R M Tayman, 3rd Ed.,2002 Wiley- Blackwell ISBN: 978-1-4051-0120.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
PHARMACEUTICAL BIOTECHNOLOGY **Category: Professional Core Elective (Group B)** **(Theory)**						
Course Code	**:**	**BT355TBA**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hours**

Unit-I	**09 Hrs**
INTRODUCTION: Current status and prospects for the Indian and global pharmaceutical industry. Drug development – Pre-formulation: structure determination, analytical development, salt form, chemical stability, physical-chemical properties, chiral properties, biopharmaceutical properties and excipient stability. Types of formulation: Liquids, semi-solids, solids and novel forms. Packaging and labelling. Clinical trials and quality assurance, Regulatory authority. Origin & development of the pharmacopoeia – IP/BP/USP, Introduction to monograph, parts of monograph. Introduction to biopharmaceutics	
Unit – II	**09 Hrs**
Facility design, unit operations and manufacturing: Structure Activity Relationship – QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs. Material flows considered, Floors, walls, and ceilings, Temperature and humidity controls, Air control, HEPA, Schedule M, Schedule Y layout setup, factory site, factory buildings, operation areas, facilities, GMP in solid dosage forms, liquids, parenteral. Scale-up considerations Large scale manufacturing of monophasic and biphasic liquids, semisolids and solids. Drug Delivery System: Oral, Sublingual, Buccal, Parenteral, Topical, Rectal and Inhalation. The pharmacokinetic implications of various routes of administration- Advantages and Disadvantage of various routes of administration.	
Unit –III	**09 Hrs**
Mechanisms of drug absorption through GIT, factors influencing drug absorption though GIT, absorption of drug from Non-per oral extra-vascular routes Drug metabolism, metabolic pathways, factors affecting metabolism, renal excretion of drugs, factors affecting renal excretion of drugs, renal clearance, Non- renal routes of drug excretion of drugs. Introduction to Pharmacokinetics, Pharmacokinetic models, One compartment open modelIntravenous Bolus Injection – Intravenous infusion - Extra vascular administrations. Determination of pharmacokinetics parameters and their significance - Absorption Rate Constant (ka), Elimination Rate Constant (K) & Elimination Hal- life (t½), AUC, Cmax, and tmax. Apparent Volume of Distribution (Vd) & Renal Clearance (Q).	
Unit –IV	**09 Hrs**
Pharmaceutical products and their action: Non-steroidal contraceptives, vitamins, gamma globulins, clinical dextran and absorbable haemostats. Nutraceuticals: Antioxidants, flavonoids, carotenoids, cholesterol lowering chemicals, nutritional importance and their functions, nutritional status evaluation Antihistaminic including anti-ulcer drugs, emetics, antiemetics, anti-inflammatory agents, antipyretics Anti-osteoporotic drugs.	
Unit –V	**09 Hrs**
Drugs and their sites of action: Drugs acting on the central nervous system, cardiovascular system, blood and blood-forming agents, diuretics, gastrointestinal system and respiratory system. Drugs acting on hormonal system (a) Antidiabetic agents (b) Steroid hormones-adrenocorticoids, (c) Sex steroids and antagonists, oral contraceptive, anabolic steroids (d) Thyroid and antithyroid agents (e) Drugs acting on calcium homeostatic, iron preparation	

Course Outcomes: After completing the course, the students will be able to	
CO1	Conceptualize the role of pharmaceutical products and their significance in modern society

CO2	Exercise better professionalism by incorporating manufacturing of pharmaceutical products and their uses
CO3	Describe types of diseases and their impact on human lives
CO4	Explain relationship between sprawling human population and related diseases

Reference Books	
1	Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications by Oliver Kayser, Heribert Warzecha, John Wiley & Sons, 2021, ISBN: 352765125X, 9783527651252
2	Goodman and Gilman's Manual of Pharmacology and Therapeutics by Laurence L. Brunton, Randa Hilal-Dandan. McGraw Hill Professional, 2022. ISBN: 007176917X, 9780071769174
3	J.P. Griffin and J. O'Grady; The text book of Pharmaceuutical medicine; New Age International; 5th Ed; 2022; ISBN: 140518035

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
AGRICULTURAL BIOTECHNOLOGY **Category: Professional Core Elective (Group B)** **(Theory)**						
Course Code	**:**	**BT355TBB**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction: History and Scope, Tissue culture as a tool in crop improvement: Introduction to tissue culture, sterilization of field grown tissues, callus induction, initiation of suspension cultures, role of hormones in plant morphogenesis, regeneration of shoots and roots from callus cultures, secondary plant products and their methods of production, Synthetic seeds. Germplasm preservation.	
Unit – II	**09 Hrs**
Application in crop improvement: Production of disease plants: shoot tip culture, grafting, Meristem culture and production of virus-free plants. Somatic embryogenesis, Tissue culture as a source of genetic variability – somoclonal and gametoclonal variant selection. Haploids in plant breeding; Anther and microspore culture. Embryo and ovary culture. Somatic hybridization; Protoplast isolation and fusion, cybrids. Somaclonal variation	
Unit –III	**09 Hrs**
Transgenic Technology in Agriculture: Agro-bacterium mediated gene transfer, Preparation and application of molecular probes. Techniques for the insertion of foreign genes into plant cells. Ti plasmid and vectors, production of transgenic plants: Bt herbicide and virus resistant plants. Radioactive labelling, Non-radioactive labelling, use of molecular probes, DNA fingerprinting. Application of molecular markers in plant breeding especially in varietal identification; markers assisted selection; QTL, mapping and map based cloning..	
Unit –IV	**09 Hrs**
Organic Farming: The potential of organic farming to mitigate the influence of agriculture on global warming. Roof top farming: for improved food and nutrition in urban environment. Integrating agriculture in urban infrastructure. Biofungicides, Bioinsecticides, Biological insecticide and larvicide. **Biofertilizers:** symbiotic Nitrogen fixing bacteria, loose association of N2-fixing bacteria**,** symbiotic Nitrogen -fixing cyanobacteria, Free living Nitrogen fixing bacteria, its importance and applications. Mode, applications and constraints. Biofungicides: Types, advantages, disadvantages and applications.	
Unit –V	**09 Hrs**
Recent technologies in Agriculture: Greenhouse technology, Types of Green house, Various component of green house, Design, criteria and calculation. Green house irrigation system. Application of AI & MLin agriculture. Alternative farming strategies: Hydroponics and aeroponics, Nanotechnology in Agriculture: Potential applications of nanotechnology in agriculture, Production aspects of Biofertilizers and Biopesticides. Sustainable Agriculture using Nanotechnology	

Course Outcomes: After completing the course, the students will be able to	
CO1	Remember and explain various fundamentals of Agricultural Biotechnology with reference to breeding techniques and tissue culture
CO2	Apply the knowledge of modern tools to analyse the improvement of agricultural practices and livestock
CO3	Evaluate and analyze various parameters of transgenics for crop and livestock improvement
CO4	Formulate and work on green house and other sustainable techniques

Reference Books	
1	Advanced technologies for smart Agriculture, Kalaiselvi K., A. Jose Anand, Poonam Tanwar, Haider Raza, 1st edition,2024, River publishers, ISBN: 978-1-03262-874-5
2	Crop Biotechnology, Genetic Modification and Genome Editing, Nigel G Halford 1st edn,2018,World scientific publishers, ISBN: 978-1-78634-530-1
3	Rooftop Urban Agriculture,Orisini, F., dubbeling, M., Zeeuw,H., Gianquinto, C., springer, 2017, ISBN 978-3-319-57720 -3
4	Agricultural Biotechnology, S Geetha, S Jebaraj and P Pandiyarajan, 2nd edn, 2010 Agrobios ,ISBN 10: 8177543245 / ISBN 13: 9788177543247.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
PLANT UTILITIES AND BIOSAFETY **Category: Professional Core Elective (Group B)** **(Theory)**						
Course Code	**:**	**BT355TBC**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**9 Hrs**
Water: Sources of water, Impurities in water, Define Hardness and its cause, types of hardness. Water Softening by Zeolite Process, Lime Soda Process, Ion Exchange Process. Water quality standards for bio processes. **Steam:** Brief introduction of steam, formation of steam at a constant pressure from water. Temperature vs total heat graph during steam formation. Steam nozzles, Condensate utilization, Steam traps, Flash tank analysis, Safety valves, Pressure reduction valves.	
Unit – II	**9 Hrs**
Air: Air compressors, Vacuum pumps, Air receivers, Distribution systems, Different types of ejectors, Air dryers, Air purification systems, Requirement of air for different biological reactions, Calculation of Dissolved oxygen. Air quality standards for bio processes.	
Unit –III	**9 Hrs**
Refrigerants and Cooling Water: Introduction, classification of refrigerants (primary, secondary) properties (thermodynamic, physical and safe working,), important refrigerants (ammonia, carbon dioxide, cryogeme, antifreeze). Selection of refrigerants. Construction and working of cooling towers (natural and forced draft).	
Unit –IV	**9 Hrs**
Bio Hazards and Safety: Bio hazards, General principles of industrial Bio safety. Biological Safety Cabinets, Study of various types of Bio safety cabinets. (Design of BSC 1). Biosafety levels using triangular diagram with organisms. Biosafety guidelines: Government of India; Definition of GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture. Overview of National Regulations and relevant International Agreements including; Cartagena Protocol.	
Unit –V	**9 Hrs**
Food safety: Food Hazards, Food Additives, Food Allergens Drugs, Hormones, and Antibiotics in Animals. Factors That Contribute to Foodborne Illness, Consumer Lifestyles and Demand, Food Production and Economics, History of Food Safety, The Role of Food Preservation in Food Safety.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the various utilities for bioprocess industries
CO2	Analyze the water, steam and air requirement for bioprocess industries.
CO3	Evaluate and apply the various risk assessment methods in industries.
CO4	Protect the national biosafety regulations and international agreements in bioprocess industries

Reference Books	
1	Mujawar B.A., A Textbook of Plant Utilities, 3rd ed., Nirali Prakashan Publication, India, 2007. ISBN-13: 978-8185790729
2	Deepa Goel, Shomini Parashar, IPR, Biosafety and Bioethics, 1st Edition, Kindle Edition, Person publisher, 2013
3	Paul Knechtges, Food Safety: Theory and Practice, 1st Edition, Jones & Bartlett Learning, 2012. ISBN-13: 9780763785567

4	Hal King, Food Safety Management Systems, 1st Edition, Springer Cham, 2020, ISBN: 978-3-030-44734-2.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
SYSTEMS BIOLOGY **Category: Professional Core Elective (Group B)** **(Theory)**						
Course Code	**:**	**BT355TBD**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction to Systems Biology: Scope, Applications. Concepts, implementation of systems biology. Biological networks build and study models, characterizing dynamic states, Studying dynamic models. Databases for Systems Biology, Mass Spectrometry and Systems Biology. Cell-to-Cell variability, stochastic gene expression, stochastic simulation and modelling. Fick's law, Local excitation and Global inhibition theory in neurons.	
Unit – II	**09 Hrs**
Applications of Machine Learning and Artificial Intelligence- Natural Language Processing and Ontology enhanced Biomedical data mining, text mining. Single-cell analysis: Technological advancements leading to a deeper understanding of cellular heterogeneity and how variations at the single-cell level contribute to health and disease. AI Techniques used to analyse vast amounts of biological data from genomics, proteomics, and metabolomics and Drug Discovery.	
Unit –III	**09 Hrs**
Integrated Regulatory and Metabolic Models - Phosphorylation, Gene expression, and Metabolites. Estimation Modeling and Simulation - Circadian rhythms, Petri net. Circadian rhythms, Circadian oscillations. Gene Regulatory Networks, attractor, and Boolean functions. Mathematical models and Optimization methods for De Novo Protein design. Global Gene expression assays. Mapping Genotype – Phenotype relationship in cellular networks. Network motifs in biology**.**	
Unit –IV	**09 Hrs**
Multiscale representations of cells and Emerging phenotypes: Multistability and Multicellularity, Spatio-Temporal systems biology, Interactomics, Cytomics – from cell state to predictive medicine. Metagenomics-concept and application of systems biology in metagenomics study. Pathway modelling. Metabolism and Metabolic Control Analysis and flux balance analysis.	
Unit –V	**09 Hrs**
Experimental Techniques for Systems Biology: Handling and Interpreting Gene Groups, Functional Interpretation of Gene Groups, Multiple Testing, Softwares, Retrieval and Analysis of Sequences. **The Dynamic Transcriptome of Mice:** Mouse Encyclopedia Project, Technology Used for the Mouse cDNA Encyclopedia: Full-Length cDNA Library Construction, mRNA Elongation Strategies, Avoidance of Internal Cleavage, Selection of FL-cDNAs, Construction of a New Vector, Subtraction and NormalizationTechnology, Distribution Method for Transcriptome Resources: Full-Length cDNA Microarrays, CAGE Technology, GIS and GSC Technologies	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the significant components, emphasizing various software tools and computationalmethods for systems biology
CO2	Apply genetic networks and models currently used in systems biology.
CO3	Analyze modelling and simulation of various biological processes using bioinformatics tools.
CO4	Demonstrate successful biological models designed using systems biology and also learn aboutthe extend applications of the subject.

Reference Books	
1	Bernhard Ø. Palsson, 'systems biology: simulation of dynamic network states', CambridgeUniversity Press, 2011, ISBN: 9780511736179
2	Corrado Priami. Transactions on Computational Systems Biology I. Springer, Edition 2009.ISBN: 978-3-540-32126-2.

3	Sangdun Choi, Introduction to Systems Biology, Humana Press Inc, Edition 2007, ISBN: 978-1-59745-531-2.
4	Hiroaki Kitano, Foundations of Systems Biology, Massachusetts Institute of Technology, 2001,ISBN 0-262-11266-3.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
ENZYME TECHNOLOGY **Category: Professional Core Elective (Group B)** **(Theory)**						
Course Code	**:**	**BT355TBE**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Purification of Enzymes: Importance of Enzyme purification, Strategies of purification of enzymes, Assay of enzyme activity and specific activity, fold purification and % yield in purification, criteria of purity, Case studies, Determination of molecular weight of enzymes. Pitfalls in working with pure enzyme.	
Unit – II	**09 Hrs**
Enzyme Kinetics: Enzyme-Ligand interaction, Methods for investigating the kinetics of Enzyme catalyzed reactions – Initial velocity studies, End point, Steady state and Pre steady state Kinetics, Estimation of Michaelis-Menten parameters. Allostericity and cooperativity. Effect of pH and temperature on enzyme activity.	
Unit –III	**09 Hrs**
Enzyme inhibition: Types of inhibition: competitive, noncompetitive, uncompetitive inhibitions. Kinetic differentiation and graphical methods. Examples. Determination of inhibitor constant. Therapeutic applications of enzyme inhibitors. Case studies.	
Unit –IV	**09 Hrs**
Enzyme Immobilization: Introduction, Problems and Limitations Associated with Industrial Enzymes Immobilization Strategies (adsorption, encapsulation, entrapment, ionic bonding), support materials, Applications of Immobilized enzymes with case studies.	
Unit –V	**09 Hrs**
Applications of Enzymes: Textile industry, detergents, pulp and paper, leather, food and dairy industry - amylases, proteases, lipases, pectinases. Importance of enzymes in diagnostics, Enzyme pattern in diseases like Myocardial infarctions (SGOT, SGPT & LDH).	

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop strategy for isolation, its purification and measure its activity.
CO2	Measure its kinetic properties, and find the optimum values for parameters affecting enzyme activity.
CO3	Analyse and identify the best method of immobilizing enzymes that can solve the therapeutic challenge.
CO4	Comprehend the applications of enzymes

Reference Books	
1	Enzyme Biocatalysis: Principles and Applications, Andrés Illanes, Springer Netherlands, 2008, ISBN: 1402083602, 9781402083600
2	Advances in Enzyme Technology, A volume in Biomass, Biofuels, Biochemicals, 2019, ISBN: 978-0-444-64114-4
3	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
4	Enzymes, Biochemistry, Biotechnology, Clinical Chemistry, 2nd Edition - April 4, 2007, T Palmer, P L Bonner, eBook ISBN: 9780857099921

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI

ENTREPRENEURSHIP & INTELLECTUAL PROPERTY RIGHTS
Category: Professional Core Course
(Theory)

Course Code	**:**	**HS361TA**		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I — **08Hrs**

Introduction to Entrepreneurship: Definition and Scope of Entrepreneurship, Importance of Entrepreneurship in Engineering Innovation and Economic Growth, Techniques for Identifying Entrepreneurial Opportunities, Types of Entrepreneurs: Innovative, Imitative, Fabian, Characteristics and Traits of Successful Entrepreneurs.

Role in economic development- Emerging Trends in Entrepreneurship, Entrepreneur and Entrepreneurship, characteristics of Entrepreneur, Myths about Entrepreneurship, Entrepreneur vs Intrapreneur, Role of Entrepreneurial Teams

Activities: Case study on Entrepreneurship in Indian Scenario, Ideation Workshops and Hackathons,

Unit – II — **08 Hrs**

Entrepreneurial Opportunity Evaluation: Identifying Market Opportunities and Trends, Integration of Engineering Principles in Ideation Process, Cross-Disciplinary Collaboration for Technological Innovation, Assessing Market Feasibility and Demand Analysis, Evaluating Technical Feasibility: Prototype Development, Proof of Concept, Financial Feasibility Analysis: Cost Estimation, Revenue Projection, Break-Even Analysis**.**

Business Planning and Strategy Development: Elements of a Business Plan, Executive Summary, Company Description, Market Analysis, writing a Business Plan: Structure and Components, Strategic Planning: Vision, Mission, Goals, Objectives, SWOC Analysis, Competitive Strategy: Porter's Generic Strategies, Differentiation, Cost Leadership, Focus Strategy, Growth Strategies: Organic Growth, Mergers and Acquisitions, Strategic Alliances

Activities: Writing a Business Plan on given templates, Developing Business Models and Prototypes Based on Generated Ideas

Unit –III — **08Hrs**

Entrepreneurial Marketing and Sales: Basics of Marketing: Product, Price, Place, Promotion (4Ps), Market Segmentation, Targeting, and Positioning (STP), Branding and Product Development Strategies, Creating a Unique Value Proposition (UVP) Digital Marketing: Social Media Marketing, Content Marketing, SEO, SEM, Sales Techniques and Customer Relationship Management (CRM).

Entrepreneurial Finance and Resource Management: Sources of Financing: Equity Financing, Debt Financing, Venture Capital, Angel Investors, Crowdfunding, Financial Management: Budgeting, Cash Flow Management, Financial Statements Analysis, Risk Management and Insurance, Human Resource Management: Recruitment, Training, Performance Evaluation, Legal and Ethical Issues in Entrepreneurship: Intellectual Property Rights, Contracts, Corporate Governance

Activities: Case Studies and Practical Applications

Unit –IV — **09Hrs**

Introduction to IP : Types of Intellectual Property

Patents: Introduction, Scope and salient features of patent; patentable and non-patentable inventions, Patent Procedure - Overview, Transfer of Patent Rights; protection of traditional knowledge, Infringement of patents and remedy, Case studies, Patent Search and Patent Drafting, Commercialization and Valuation of IP.

Trade Marks: Concept, function and different kinds and forms of Trade marks, Registrable and non-registrable marks. Registration of Trade Mark; Deceptive similarity; Transfer of Trade Mark, ECO Label, Passing off, Infringement of Trade Mark with Case studies and Remedies.	
Unit –V	**09 Hrs**
Trade Secrets: Definition, Significance, Tools to protect Trade secrets in India. **Industrial Design:** Introduction of Industrial Designs Features of Industrial, Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies, Case studies. **Copy Right:** Introduction, Nature and scope, Rights conferred by copy right, Copy right protection, transfer of copy rights, right of broad casting organizations and performer's rights, Exceptions of Copy Right, Infringement of Copy Right with case studies.	

Course Outcomes: After going through this course, the student will be able to	
CO1	Understand the concepts of entrepreneurship and cultivate essential attributes to become an entrepreneur or Intrapreneur and demonstrate skills such as problem solving, team building, creativity and leadership.
CO2	Comprehend the process of opportunity identification of market potential and customers while developing a compelling value proposition solutions.
CO3	Analyse and refine business models to ensure sustainability and profitability and build a validated MVP of their practice venture idea and prepare business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture.
CO4	Apply insights into the strategies and methods employed to attain a range of benefits from these IPs and deliver an investible pitch deck of their practice venture to attract stakeholders
CO5	Knowledge and competence related exposure to the various Legal issues pertaining to Intellectual Property Rights with the utility in engineering perspectives.

Reference Books	
1.	Donald F. Kuratko ,"Entrepreneurship: Theory, Process, and Practice", South-Western Pub publishers, 10th edition, 2016,978-ISBN-13: 1305576247
2.	Eric Ries, "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses", Crown Currency Publishers,1st Edition, 2011, ISBN-13: 978-0307887894.
3	Dr B L Wadehra, Law Relating to Intellectual Property, universa Law publishers 05th edition, ISBN : 9789350350300 .
4	Intellectual Property Rights: Unleashing Knowledge Economy, Prabuddha Ganguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**

3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar / presentation / demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Fill in the blanks or descriptive for one or two marks type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only Small case lets and case example in one subdivision)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
KINETICS OF REACTIONS **Category: Professional Core Course** **(Theory & Practice)**						
Course Code	**:**	**BT362IA**		**CIE**	**:**	**100 +50Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3.00 Hrs**

Unit-I	**07Hrs**
Introduction: Classification of reactions, molecularity and order of reaction, rate equation and rate of reaction, elementary and non-elementary reactions, Arrhenius law (excluding mechanism of reactions).numericals.	
Unit – II	**10 Hrs**
Homogeneous reactions: Analysis of batch experimental reactor data: Evaluation of rate equation. Integral and differential analysis for constant and variable volume system (zero, 1st and 2nd order irreversible reactions).numericals.	
Unit –III	**10 Hrs**
Design of ideal reactors: Concept of ideality, Type of reactors, space time, mean residence time, development of design expressions for batch, tubular and stirred tank reactors for both constant and variable volume systems. numericals	
Unit –IV	**10 Hrs**
Multiple reactors: Size comparison of reactors, Analysis of different types of ideal reactors in series and parallel combination (Only irreversible reactions), Design of combination of reactors, optimum combination of reactors.	
Unit –V	**08 Hrs**
Non Ideal Flow: Interpretation of RTD curve: C, E and F curves, step and impulse input response for the non ideal reactors. Exit age distribution of fluid in reactors, RTD's for CSTR and PFR, calculation of conversion for first order reaction. Numericals.	
Lab Experiments	
1. Determination of order and rate constant for a reaction between non-equimolar quantities of reactants in a batch reactor 2. Determination of order and rate constant for a reaction between non-equimolar quantities of reactants in a CSTR 3. Determination of order and rate constant for a reaction between equimolar quantities of reactants in a batch reactor 4. Determination of order and rate constant for a reaction between equimolar quantities of reactants in a CSTR 5. To carryout RTD studies using PFR by introducing tracer in pulse input mode 6. To carryout RTD studies using PFR by introducing tracer in step input mode 7. To carryout RTD studies using CSTR by introducing tracer in pulse input mode 8. To carryout RTD studies using CSTR by introducing tracer in step input mode 9. Determination of order and rate constant for a reaction between non-equimolar quantities of reactants in a semi batch reactor 10. Estimation of rate constant of a reaction at different temperatures in a batch reaction	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the rate law and determine the parameters of rate expression for homogeneous reactions
CO2	Analyze the batch reactor data and interpret the results
CO3	Apply design equations for the three ideal reactors (batch, CSTR and plug flow) for single reactions

CO4	Analysis of different reactor combinations and design of multiple reactors involved in homogeneous reactions.
CO5	Analyze the RTD data, plot C,E,F curves and determine mean residence time, variance, skewness and conversion for ideal and real reactors

Reference Books	
2.	Octave Levenspiel; Chemical Reaction Engineering; John Wiley and Sons; 3rd Edition; 3rd ed; 1999. ISBN: 0-471-25424-X
2.	H.S Fogler; Elements of Chemical Reaction Engineering; Prentice Hall; 5th ed; 2015. ISBN: 978-0133887518
3.	P.M. Doran, Ross Carlson, Katte Morrissey, Bioprocess Engineering Principles; Academic Press; 3rd ed; 2024. ISBN:9780128221914
4.	M.E.Davis and R.E. Davis, Fundamentals of Chemical Reaction Engineering, McGraw Hill Education, 1st ed., 2003.ISBN: 0-07-119260-3

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. **THE FINAL MARKS WILL BE 50 MARKS**	**50**
	MAXIMUM MARKS FOR THE CIE(THEORY+LAB)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)

Q.NO.	CONTENTS	MARKS
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**

Semester: VI						
MICROBIAL BIOTECHNOLOGY **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	**BT363IA**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45T + 30L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**9 Hrs**
Introduction to Microbial Biotechnology: Scope and Applications of Microbial Biotechnology in Human Therapeutics, Agriculture, Food Technology, Environment, Bioreporters and Organic Chemistry. Microbial Production flow sheet for Enzymes, Microbial Metabolites and recombinant products- Production of antibodies in *E coli.*,	
Unit II	**9 Hrs**
Microbial production of Vaccine and Recombinants: Production of Covid Vaccine, BCG Vaccine, Rabbis, Human papillomavirus vaccine (Cervical Vaccine), Production of attenuated vaccines (for cholera). Case study: Development of HIV Vaccine, Malaria and Tuberculosis Vaccine	
Unit –III	**9 Hrs**
Microbial production in beverage and food industry: Single cell protein production (SCP eg. Yeast) Beverages-Beer and wine. Acids- Citric and lactic acid. Enzymes- Amylase, Lipase. Biopolymers (Xanthan gum). Fermented foods (yoghurt and cheese). Cultivation of Mushroom.	
Unit IV	**9 Hrs**
Microbial production of primary and secondary metabolites: Amino acids (glutamic acid and lysine), vitamins (B12, riboflavin and carotenoids), Antibiotics (β lactams, aminoglycosides, macrolides and tetracyclines)- Improving antibiotic production**.**	
Unit V	**9 Hrs**
Microbes in Environmental biotechnology: Biodegradation-Degradative capabilities of microorganisms, Degradation of xenobiotics. Microorganisms in mineral recovery and removal of metals from aqueous effluent, Production of Biofuels (ethanol, methane and hydrogen). Microbial insecticides- Cry (Bt) proteins (Biopesticides)	

Lab Experiments

1. Wine production and estimation of alcohol content.
2. Preparation of baker's yeast from molasses.
3. Cultivation of algae (Spirulina).
4. Production and estimation of citric acid.
5. Production and estimation of Lactic Acid.
6. Fungal amylase production and assay of amylase activity.
7. Production of ethanol by immobilized cells.
8. Production of Protease from Bacteria.
9. Production and Assay of Pectinases
10. Microbial Media Optimization-PCV

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

CO1	Remember the basic principles to identify and produce compounds from microbial culture using bioreactor.
CO2	Understand the genetics and biosynthetic pathways of microbes for sustainable solutions.
CO3	Create and evaluate genetically modified microorganisms for production of primary, secondary and recombinant metabolites.

CO4	Apply methodology for production and extraction of products from microbial cultures under controlled condition.

Reference Books	
1	Glazer, A. N. and H. Nikaido; Microbial Biotechnology; Fundamentals of Applied Microbiology. Cambridge University Press; 2 edition, 2023.ISBN-13: 978-0521842105.
2	Arumugam N, A Mani, Dulsy Fatima, V Kumaresan, A M Selvaraj, L M Narayanan. Microbial Biotechnology. Saras Publication., First Edition. 2012, ISBN-13: 978-8189941260.
3	Rajesh Arora., Microbial Biotechnology: Energy and Environment. CAB International., 2022. ISBN: 978-1845939564.
4	Glick, B.R. J.J.Pasternak and C.L Patten; Molecular Biotechnology – Principles and applications of recombinant DNA; ASM Press; 4th edn; 2023; ISBN: 978155581498.

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE(THEORY+LAB)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**

Semester: VI						
OMICS TECHNOLOGY **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	**BT364IA**		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	**03:00:01**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**8 Hrs.**
Functional Genomics and Epigenomics: Reverse and forward genetics, Structural genomics, Single cell technologies, Clinical genomics with case studies and data analysis , cBioportal for Cancer Genomics, TCGA Analysis. Epigenetic mechanisms of gene regulation, Epigenetics databases, Epitranscriptomics.	
Unit – II	**8 Hrs.**
Transcriptomics and Comprehensive Proteomics: Gene expression databases**,** RNA-Seq: a tool for transcriptomics. Protein- protein interaction, **Protein arrays,** Human protein atlas, clinical proteomics; affinity and antibody-based techniques. Sequence centric proteogenomics.	
Unit –III	**8 Hrs.**
Metabolomics and Lipidomics: Measuring the metabolome, sample preparation and Mass spectrometry and LCMS in metabolomics. Metabolic pathway analysis, Metabolomics data analysis – case studies, Lipidome, Spatial lipidomics, Tracer lipidomics and pathway analysis, Techniques, applications, and outcomes related to biomedical sciences	
Unit –IV	**10 Hrs.**
Metagenomics and Nutrigenomics: Metagenomics, metatranscriptomics and multiomics for microbial community studies. Taxonomics and strain profiling. Nutrigenomics from Molecular Nutrition to prevention of disease, Modulating the risk of diseases through nutrigenomics, Case Studies. nutrigenomics to the food industry.	
Unit –V	**9 Hrs.**
Interactomics : High through put platform of Interactomics –, OMICS data integration, antibody-based techniques (GSEA), Nucleic Acid Programmable Protein Arrays (*NAPPA*), Application of multi-omics approach for better understanding of cancers	

LABORATORY EXPERIMENTS

1 DNA - Protein interactions – Yeast two hybrid assay
2. Isolation of metabolites from Microbial and plant sources
3. Characterization of metabolites- GC MS
4. Relative gene expression of candidate genes (Treated and untreated) RT PCR
5. Quantitative and qualitative metabolite analysis of Plant metabolites – HPLC

Phyto chemical analysis of Plant bioactive compounds

6. – Total Phenolics
7. Total Flavonoids
8. Antioxidant assay
9. Comparative Anti-inflammatory analysis of noted metabolites
10. Pathway analysis
11. Open Ended experiment: A) Isolation of Bioactive compounds from microbial and plant sources B. Characterization of Bioactive compounds and insilico studies

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the concepts of high through put analysis through Omics technology
CO2	Apply and comprehend the principles of Functional genomic and , regulation through epigenomics

CO3	Apply the knowledge of omics to understand the relevance of lipidomics, and metabolomics interaction of genes and proteins.
CO4	Evaluate the high through put techniques to connect metagenomics, nutrigenomics and proteomics
CO5	Design the strategies for high through multi omics interaction studies

Reference Books	
1	Carolina Simó, Alejandro Cifuentes, Virginia García-Cañas.Fundamentals of Advanced Omics Technologies: From Genes to Metabolites.Elsevier.. 1st Edition,2014. .ISBN: 9780444626707.
2	Preeti Arivaradarajan, Gauri Misra; Omics Approaches, Technologies And Applications Springer Link. 1st edn ;2018; ISBN: 978-981-13-2924-1
3	Debmalya Barh and Vasco Azevedo; Omics Technologies and Bio-Engineering: Towards Improving Quality of Life Academic Press; 1st edition 2017; ISBN: 978-0-12-804659-3
4	**Syeda Marriam Bakhtiar, Erum Dilshad.Omics Technologies for Clinical Diagnosis and Gene Therapy: Medical Applications in Human Genetics. Bentham Science.. 1st edition. 2022 .ISBN: 978-981-5079-52-4**

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
BIOINSTRUMENTATION **Category: Professional Core Elective** **(Theory)**						
Course Code	**:**	**BT365TDA**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction to Medical Instrumentation: Sources of biomedical signals, basics of medical instrumentation systems, different bioelectrical signals. Transducers: Definition, classification and biomedical applications. Bio Electrodes, types, key Properties of Bio electrodes, Resting and Action potential, Propagation of Action potential. Ventilators and its importance	
Unit-II	**09 Hrs**
Cardiovascular Measurements: Anatomy of heart, cardiac cycle, Measurement of blood pressure, characteristics of Electrocardiogram (ECG), Block diagram, description, lead configuration and types of recorders. Blood flow meters, electromagnetic, ultrasonic, NMR and laser Doppler blood flow meters. **Biotelemetry**: Wireless telemetry, single channel / multi-channel telemetry, Applications and advantages of biotelemetry	
Unit-III	**09 Hrs**
Blood Gas Analysers: Acid–base Balance, pCO2, pO2, Complete blood gas analyser, Pulse oximeter, ear, fingertip oximetry, skin reflectance oximetry. Blood cells counters: methods – Microscopic, coulter counter. **Audiometers:** types of Audiometers, Mechanism of hearing, requirements of audiometer, calibration and applications of audiometer	
Unit-IV	**09 Hrs**
Diagnostic And Medical Imaging Systems: X-Ray: general principles of Imaging, Instrumentation Special imaging techniques for X-rays. Magnetic Resonance imaging (MRI): general principles of MRI, Instrumentation, Magnetic field gradient coils, radiofrequency coils, Clinical application of MRI. Computer Tomography (CT) Scan: Purpose, Procedure, Risks, and its Side-Effects, Ultrasonography , principle, instrumentation and applications.	
Unit-V	**09 Hrs**
Therapeutic Equipment: Cardiac pacemakers: External and Implantable pacemakers, Cardiac defibrillators: AC/DC and Implantable defibrillators. Nerve and muscle stimulator, Diathermy: shortwave, microwave and ultrasonic wave. Ultrasonic Imaging System: General principle of Ultrasonic Imaging and Instrumentation, , Diagnostic scanning modes, Biological effect of ultrasound	

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehend the necessity and sources of biomedical signals and instruments to measure them
CO2	Identify different parameters to measure the heart and brain functioning leading to diagnostic applications.
CO3	Use of potential non-invasive imaging systems in medical diagnosis.
CO4	Application of the bio medical instrumentation to diagnose and to treat human diseases

References Books	
1.	Anandanatarajan .R. Biomedical Instrumentation and Measurements. PHI Pub. 2011. ISBN: 978-81-203-4227-9.
2.	Khandpur R.S. Biomedical Instrumentation Technology and Applications McGraw –Hill Pub. First Edition, 2012.ISBN-9780071777469.
3.	Shakti. Chatterjee, Aubert Miller. Biomedical Instrumentation Systems. Delmar Cengage learning Pub.2011.ISBN:13-978-1418018-665

4.	Bernice B Capusten, Text book of diagnostic Ultrasonography, 4th edition, 1995, ISBN: 08016-7948-6

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
FOOD & DAIRY BIOTECHNOLOGY **Category: Professional Core Elective** **(Theory)**						
Course Code	**:**	**BT365TDB**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Food Processing and Preservation: Thermal Preservation: Mild and severe heat treatment, Effect of heat on microorganisms. Non thermal: Refrigeration, freezing, Dehydration. Food irradiation: irradiation, regulations, advantage and limitations of food irradiation, nutritional and microbiological changes in irradiated foods. High pressure processing of foods: principles, applications to food systems, effect on quality – textural, nutritional and microbiological quality – factors affecting the quality. High pressure freezing: principles and applications. Ultrasound processing of foods: principle of ultrasound, ultrasound as a processing and preservation aid, effect on properties of foods. Minimal processing and hurdle technology: Principle and applications.	
Unit – II	**09 Hrs**
Food Microbiology: Sources of microorganisms in foods and their effective control. Chemical changes caused by microorganisms: Changes in nitrogenous organic compounds, Non-nitrogenous organic compounds, organic acids, other compounds, lipids, pectic substances. Microbial toxins: Bacterial toxins, fungal toxins, algal toxins and mushroom toxins. Food borne intoxications and infections: types of food involved, toxicity and symptoms.	
Unit –III	**09 Hrs**
Food Additives, Preservatives, Packaging and quality standards: Food Additives: Definition, function, major additives used in processing, nutrient supplements. Food preservatives- types, effects on health. Packaging: Functions, packaging materials, Types of packaging, active packaging technologies. Post-harvest preservation of raw food materials.	
Unit –IV	**09 Hrs**
Introduction to Dairy technology: Components of milk: Lactose, salts, lipids, enzymes, natural components. Properties of milk: solution properties, acidity, redox potential, flavors, density, optical properties and viscosity Microbiology of milk: general aspects: bacteria yeast, mold, undesirable microorganisms: pathogenic and spoilage microorganisms. Hygienic measures against spoilage of milk. Methods and procedures for sampling and testing of milk and milk products. Laws and standards for milk and milk products.	
Unit –V	**09 Hrs**
Milk Processing: Cream separation, pasteurization, sterilization and homogenization. Technology for the manufacture of evaporated milk, condensed milk, dried milk, malted milk, infant and baby foods ice cream cheese butter fermented milk and indigenous dairy products. Butter, cheese and yoghurt: properties and manufacture. Packaging: properties and filling operation. Gas packaging and modified atmosphere packages. Quality control Product safety in food packaging	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the food components in detail for the healthier society
CO2	Analyse the various food preservation techniques and its effect.
CO3	Apply the techniques learnt for milk analysis and its preservation
CO4	Evaluate the milk processing and food packaging techniques

Reference Books	
1	Vaclavik VA and Christian EW. 2014 Essentials of food science,4th Edition NY, ISBN: 978-1461491378

2	Parker R 2003 Introduction to Food Science. Albany NY, Delmar. 1st Edition, ISBN: 9780766813144
3	Pieter Walstra, Jan T. M. Wouters and Tom J. Geurts. 2006. Dairy Science and Technology, Taylor Francis, 2nd ed., ISBN: 978-0-8247-2763-5
4	Selia, dos Reis Coimbra and Jose A. Teixeira. 2010. Engineering Aspects of Milk and Dairy Products , CRC Press, 1st ed., ISBN: 978-1-4200-9022-2

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
FERMENTATION TECHNOLOGY **Category: Professional Core Elective** **(Theory)**						
Course Code	**:**	**BT365TDC**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
INTRODUCTION: Background of fermentation- history, Fermentation as a Biochemical process, Microbial biomass, Enzymes, Metabolites recombinant products, General flow sheet for microbial fermentation. Isolation of industrially important microorganisms, preservation techniques of microbial cultures, Strain development for primary, secondary and recombinants, Mode of fermentation operation: batch, fed batch and Continuous.	
Unit – II	**09 Hrs**
FERMENTATION MEDIA: Raw Materials and Sterilization: Selection of typical raw materials, Different types of media fermentation, Optimization of media- Plackett and Burman method, Different sterilization methods batch sterilization, continuous sterilization, Air filter sterilization. **INOCULUM DEVELOPMENT**: Preparation of Inoculum: methods, Inoculum preparation from laboratory scale to pilot scale and large-scale fermentation, case study for fungal and bacterial cultures.	
Unit –III	**09 Hrs**
FERMENTER AND INSTRUMENTATION: Basic structure of fermenter, body construction and space requirements. Description of different parts of fermenter, impellers, types of fermenters-semi- automatic and automatic fermenters. Process Control: Instruments for the fermentation process: flow rate, temperature, pH, Dissolved oxygen and pressure measurements. Foam sensing and control. Online analysis for the substrate and biomass estimation. Computer based data acquisition-SCADA.	
Unit –IV	**09 Hrs**
AERATION AND AGITATION: Oxygen requirement and Supply of oxygen, fluid rheology, Estimation of Kla by sulphite oxidation technique, Static method of gassing out, Dynamic Methods of Gassing out and Oxygen balance technique (only final equations and graphical analysis), factors affecting Kla and aeration & agitation. **SCALE-UP**: Scale-up of fermentation process, Factors considered for the scale-up process. Scale-Down Process	
Unit –V	**09 Hrs**
FERMENTATION ECONOMICS AND CASE STUDIES: Understanding of Process economics, Beer manufacturing process, Streptomycin production, Vitamin B12, Lipase enzyme production and Recombinant human insulin production. Effluent treatment methods for fermentation industries.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Remember and understand the techniques for isolating the industrial important microorganism for production various biotechnological products
CO2	Implement the fermentation principles, Process and its parameters for optimized yield
CO3	Analyze the scale up techniques, process economics and effluents management
CO4	Execute the fermentation for small molecules through case studies

Reference Books	
1	P. Stanbury, A Whitaker. and S. Hall. Principles of Fermentation Technology; Aditya Books Pvt Ltd. New Delhi; 2ndedn; 2003. ISBN: 8185353425.
2	E. M. T. El-Mansi, C. F. A. Bryce., Fermentation Microbiology and Biotechnology, CRC Press. Third Edition, 12 Jan 2012 ISBN-13: 978-1439855799.
3	Br Ian McNeil, Linda Harvey., "Practical Fermentation Technology", John Wiley &Sons. 2008, ISBN: 0470725281.
4	Pauline M. Doran., "Bioprocess Engineering Principles", 2nd Edition, Academic press, 2012, ISBN: 978-0-12-220851-5.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
PROGRAMMING IN BIOTECHNOLOGY **Category: Professional Core Elective** **(Theory)**						
Course Code	**:**	**BT365TDD**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**

Introduction to Java:

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

Unit – II	**09 Hrs**

Multi-Threaded Programming, Event Handling:

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

Unit –III	**09 Hrs**

Java 2 Enterprise Edition:

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

Unit –IV	**09 Hrs**

Automation of NGS applications in JAVA:

Implementation of Major workflows in JAVA for Genomics, Genome Annotation, Functional Annotation of Proteins, Meta-genomics, Meta-transcriptomics, Meta-Proteomics, High-Throughput Virtual Screening, Variant Calling.

Unit –V	**09 Hrs**

BioJava:

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

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

Reference Books	
1	Peter Garst, Mastering Java Through Biology - A Bioinformatics Project Book, BookBaby 2014, ISBN: 9781483534404.
2	Jens Dörpinghaus, Vera Weil, Sebastian Schaaf, Computational Life Sciences - Data Engineering and Data Mining for Life Sciences, Springer International Publishing 2023, ISBN: 9783031084119.
3	Herbert Schildt, Java: The Complete Reference, Eleventh Edition, McGraw Hill LLC 2018, ISBN: 9781260440249
4	Perry Xiao, Practical Java Programming for IoT, AI, and Blockchain, Wiley 2019, ISBN: 9781119560012.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
EQUIPMENT DESIGN AND DRAWING **Category: Professional Core Elective** **(Theory)**						
Course Code	**:**	**BT365TDE**		**CIE**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	**09 Hrs**
Detailed Process Design and mechanical design of Fermenter using standard code book. The detailed dimensional drawings using CAED shall include sectional front view, Full Top/Side view depending on equipment and Major component drawing with dimensioning and Part Template.	
Unit – II	**09 Hrs**
Detailed Process Design and mechanical design of Jacketed vessel using standard code books. The detailed dimensional drawings using CAED shall include sectional front view, Full Top/Side view depending on equipment and Major component drawing with dimensioning and Part Template.	
Unit –III	**09 Hrs**
Detailed Process Design and mechanical design of packed bed distillation column using standard code book. The detailed dimensional drawings using CAED shall include sectional front view, Full Top/Side view depending on equipment and Major component drawing with dimensioning and Part Template.	
Unit –IV	**09 Hrs**
Detailed Process Design and mechanical design of Shell and Tube heat exchanger using standard code books. The detailed dimensional drawings using CAED shall include sectional front view, Full Top/Side view depending on equipment and Major component drawing with dimensioning and Part Template.	
Unit –V	**09 Hrs**
Detailed Process Design and mechanical design of Adsorption column using standard code book. The detailed dimensional drawings using CAED shall include sectional front view, Full Top/Side view depending on equipment and Major component drawing with dimensioning and Part Template.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Remember and understand the concepts of design and use of the IS 2825 code book and J H Perry hand book
CO2	Integrate the standard design parameters to design of bio equipment.
CO3	Evaluate the various parameters of distillation column, bio reactors and adsorption column
CO4	Generate drawings of distillation column, bio reactors and adsorption column.

Reference Books	
1	R.H. Perry & D.W. Green, Chemical Engineers Handbook, 7th Edition, McGraw Hill 2008;ISBN: 780071422949
2	IS 2825 Code: Unfired pressure vessels, BIS New Delhi.
3	M.V. Joshi and V.V. Mahajan, Design of Process Equipment Design, 4th Edition , McMillan India 2009; ISBA: 978-0230638105
4	J.M. Coulson & J.F. Richardson, Chemical Engineering Vol. 6, Pregman Press, 1993; ISBN 07506 65386

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**

2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	The SEE question paper contains two questions each for 100 marks. The student has to choose any one of the question.	**100**

Semester: VI						
FUNDAMENTALS OF AEROSPACE ENGINEERING **Category: Institutional Elective-I** **(Theory)**						
Course Code	**:**	**AS266TEA**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**
Basics of Flight Vehicles: History of aviation, International Standard atmosphere (ISA), Temperature, pressure and altitude relationships, Simple Problems on Standard Atmospheric Properties, Classification of aircrafts, Anatomy of an aircraft & Helicopters, Basic components and their functions.	
Unit – II	**10 Hrs**
Aircraft Aerodynamics: Bernoulli's theorem, Centre of Pressure, Lift and Drag, Types of Drag, Aerodynamic Coefficients, Aerodynamic Centre, Wing Planform Geometry, Airfoil Nomenclature, Basic Aerodynamic characteristics of Airfoil, Simple Numericals on Lift and Drag.	
Unit –III	**12 Hrs**
Aerospace Propulsion: Introduction, Turbine Engines: Brayton Cycle, Operation of Turbojet, Turboprop, Turbofan, Turboshaft, RAMJET and SCRAMJET Engines, Rocket Engines: Principles of operation of Solid, Liquid, Hybrid, Nuclear and Electric Rockets. **Introduction to Space Mechanics:** Basic Orbital Mechanics-Types of Trajectories, Escape and Orbital Velocities, Kepler's Laws of Planetary Motion, Simple Numericals.	
Unit –IV	**06 Hrs**
Aerospace Structures and Materials: General types of construction-Monocoque, Semi-Monocoque & Geodesic, Structure of Wing and Fuselage, Metallic and Composite Materials.	
Unit –V	**08 Hrs**
Aircraft Systems & Instruments: Instrument Displays, Basic Air data systems & Pitot Probes- Mach meter, Air speed indicator, Vertical speed indicator, Altimeter. **Basics of Aircraft Systems:** Hydraulic and pneumatic systems, Electrical System, Aircraft Fuel System, Environmental Control System.	

Course Outcomes: At the end of this course the student will be able to	
CO1	Identify the fundamental nuances of Aerospace Engineering and appreciate their significance on the Flight Vehicles design and performance
CO2	Interpret the design parameters that influence the design of the Aerospace Vehicles systems and its sub-systems
CO3	Evaluate critically the design strategy involved in the development of Aerospace vehicles
CO4	Categorically appraise the operation of the Aerospace Vehicles for different operating conditions

Reference Books	
1	Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2	Fundamentals of Aerodynamics, Anderson J .D, 5th Edition, 2011, McGraw-Hill International Edition, New York ISBN:9780073398105.
3	Rocket Propulsion Elements, Sutton G.P., 8th Edition, 2011, John Wiley, New York, ISBN: 1118174208, 9781118174203.
4	Aircraft structural Analysis, T.H.G Megson, 2010, Butterworth-Heinemann Publications, ISBN: 978-1-85617-932-4
5	Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**
RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	**20**
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	**16**
3 & 4	Unit 2: Question 3 or 4	**16**
5 & 6	Unit 3: Question 5 or 6	**16**
7 & 8	Unit 4: Question 7 or 8	**16**
9 & 10	Unit 5: Question 9 or 10	**16**
	TOTAL	**100**

Semester: VI					
HEALTHCARE ANALYTICS **Category: Institutional Electives-I** **(Theory)**					
Course Code	**:**	**BT266TEB**	**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**	**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**	**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**
Introduction to tools and databases: Introduction to Bioinformatics, Goals, Scope, Applications, Sequence databases, Structure databases, Special databases – genome and microarray, Applications of these databases, examples, Database similarity search: Unique requirements of database searching, Heuristic Database Searching, Basic Local Alignment Search Tool (BLAST), FASTA, Comparison of FASTA and BLAST, Database Searching with Smith-Waterman Method	
Unit – II	**09 Hrs**
Sequence Analysis: Types of Sequence alignment -Pairwise and Multiple sequence alignment, Alignment algorithms, Scoring matrices, Statistical significance of sequence alignment. Multiple Sequence Alignment: Scoring function, Exhaustive algorithms, Heuristic algorithms, Profiles and Hidden Markov Models: Position-Specific scoring matrices, Profiles, Markov Model and Hidden Markov Model, Scoring matrices – BLOSSUM and PAM **Molecular Phylogenetics:** Introduction, Terminology, Forms of Tree Representation. Phylogenetic Tree Construction Methods - Distance-Based, Character-Based Methods and Phylogenetic Tree evaluation.	
Unit –III	**09 Hrs**
Introduction to Next-Generation Sequencing (NGS) analysis: Sanger sequencing principles - history and landmarks, of Sequencing Technology Platforms, A survey of next-generation sequencing technologies, A review of DNA enrichment technologies, Base calling algorithms, Base quality, phred values, Reads quality checks, Interpretations from quality checks. Adapter and primer contamination. Processing reads using clipping of reads-Advantages and disadvantages of processing of reads, automation in NGS analysis and advantages (shell scripting)	
Unit –IV	**09 Hrs**
Structural analysis & Systems Biology: Gene prediction programs – ab initio and homology-based approaches. ORFs 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. Structure prediction - Prediction of secondary structure, tertiary structure prediction methods, Scope, Applications. Concepts, implementation of systems biology, Mass spectrometry and Systems biology, Flux Balance analysis.	
Unit –V	**09 Hrs**
Drug Screening: Introduction to Computer-aided drug discovery, target selection, ligand preparation and enumeration, molecular docking, post-docking processing, molecular dynamics simulations, applications and test cases, AI/ML in Drug discovery	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Gain proficiency in utilizing a range of bioinformatics tools and databases for comprehensive sequence and structural analysis.
CO2	Investigate and apply innovative sequencing technologies and analytical methods to solve complex biological questions and advance research in genomics and molecular biology.

CO3	Demonstrate expertise in NGS technologies, including performing data quality assessments, read processing, and managing large-scale data.
CO4	Apply bioinformatics tools for modeling and simulating biological processes, with a focus on gene prediction using both ab initio and homology-based approaches.

Reference Books	
1.	Xiong J. Essential bioinformatics. Cambridge University Press; 2006 Mar 13.
2.	Buehler LK, Rashidi HH, editors. Bioinformatics basics: applications in biological science and medicine. CRC Press; 2005 Jun 23.
3.	Ghosh Z, Mallick BM. Bioinformatics principles and Applications. Oxford University Press; 2018 Jun 13.
4.	Low L, Tammi MT. Introduction to next generation sequencing technologies. Bioinformatics. WORLD SCIENTIFIC. 2017 Jul 26:1-21.
5.	Bioinformatics: Sequence and Genome Analysis; D W Mount; 2014; CSHL Press; 2nd edn; ISBN: 9780879697129.
6.	Computational Systems Biology; A Kriete and R Eils; 2006; Academic Press; Illustrated edn; ISBN: 978-01-208-87866.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI					
INDUSTRIAL SAFETY ENGINEERING **Category: Institutional Elective** **(Theory)**					
Course Code	**:**	**CH266TEC**	**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**	**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**	**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**08 Hrs**
Introduction Safety: Introduction to industrial safety engineering, major industrial accidents, safety and health issues, key concepts and terminologies, Hazard theory, Hazard triangle, Hazard actuation, Actuation transition, Causal factors, problems on OSHA	
Unit – II	**08 Hrs**
Risk assessment and control: Risk assessment, Risk perception, acceptable risk, problems on net present value, internal rate of return, payback period concepts including real life examples. **Hazard Identification Methods:** Preliminary Hazard List (PHL), worksheets, case study. Preliminary Hazard Analysis (PHA), Fault tree and Event tree analysis. Design and development of fault tree and event tree for high pressure reactor system.	
Unit –III	**08 Hrs**
Hazard analysis: Hazard and Operability Study (HAZOP): Guide words, HAZOP matrix, Procedure, HAZOP studies on reactors, heat exchanger, design of HAZOP table, Failure Modes and Effects Analysis (FMEA) concept, methodology, problems of FMEA, examples.	
Unit –IV	**08 Hrs**
Risk analysis on capital budgeting: Risk adjusted discount rate (RADAR) method, certainty equivalent approach, scenario analysis, probability distribution, quantification of risk using statistical parameters and associated problems.	
Unit –V	**08 Hrs**
Safety in process industries and case studies: Personnel Protection Equipment (PPE): Safety glasses, face shields, welding helmets, absorptive lenses, hard hats, types of hand PPE, types of foot PPE, types of body PPE. Bhopal gas tragedy, Chernobyl nuclear disaster, Chemical plant explosion and fire.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the risk assessment techniques used in process industry
CO2	Interpret the various risk assessment tools.
CO3	Use hazard identification tools for safety management.
CO4	Analyze tools and safety procedures for protection in process industries.

Reference Books	
1.	Functional Safety in the Process Industry: A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North corolina,Lulu publication, ISBN:1291187235.
2.	Safety Instrumented Systems Verification Practical probabilistic calculations, Goble and William M., 2005, Pensulvania ISA publication, ISBN:155617909X.
3.	Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition, 2003,The University of alberta press,Canada, ISBN: 0888643942.

4.	ndustrial Safety, Health and Environment Management Systems, R K Jain, Sunil S Rao, 4th Edition, 2005, Khanna Publishers, New Delhi, ISBN: 8174092102.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ROBOTIC PROCESS AUTOMATION **Category : Institutional Elective-I** **(Theory)**						
Course Code	**:**	**CS266TED**		**CIE**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100**
Total Duration	**:**	**36L**		**SEE Duration**	**:**	**3.00 Hrs**

Unit – I	**8 Hrs**
RPA Concepts: RPA Basics, History of Automation, what is RPA? RPA vs Automation, Processes & Flowcharts, Programming Constructs in RPA, What Processes can be Automated? Types of Bots, Workloads that can be automated. **RPA Advanced Concepts**: Standardization of processes, Setting up the Centre of Excellence, RPA Development methodologies, Difference from SDLC, RPA journey, RPA business case, RPA Team, Process Design Document/Solution Design Document, Industries best suited for RPA, Risks & Challenges with RPA, RPA and emerging ecosystem.	
Unit – II	**7 Hrs**
RPA Tool Introduction: Introduction to UiPath - the User Interface, Types of Variables, Variables in UiPath, Managing Arguments, The Arguments Panel, Namespaces; Control flow statements in UiPath, Sequences and Flowcharts, Control Flow Activities Data Manipulation Introduction, Data Manipulation Operations, Types of data storing variables, Text Manipulation, main string methods. **UiPath Recording:** Basic, Desktop and Web Recording, Image and Native Citrix Recording, Input/output methods, Types of OCR, Data Scraping, Advanced Scraping techniques.	
Unit – III	**7 Hrs**
Advanced Automation Concepts: Selectors, Types of Selectors (Full, partial, dynamic), Defining and Assessing Selectors, Customization, Debugging. Image, Text & Advanced Citrix Automation – Introduction, Keyboard based automation, Information Retrieval, Best Practices Excel Data Tables & PDF, Data Tables in RPA, Excel and Data Table, Extracting Data from Data Table, Anchors, Using anchors in PDF	
Unit – IV	**7 Hrs**
Email Automation, Exceptions and Deploying Bots: Introduction to Email Automation, Key concepts of email, email protocols, email automation in UiPath, email as input and output. Debugging and Exception Handling, Types of exception, Debugging Tools, Strategies for solving issues, Catching errors. Overview of orchestration Server, orchestrator functionalities, Connecting Bot to orchestrator	
Unit – V	**7 Hrs**
Hyperautomation: Components and application of Hyperautomation, Automation versus hyperautomation, Benefits and challenges of hyperautomation, use cases, Phases (Integration, Discover, Orchestration and Governance), Trends in Hyperautomation (low-code/no-code platform, HaaS)	

	Course Outcomes: After completing the course, the students will be able to
CO1	Understand RPA principles, its features and applications
CO2	Demonstrate proficiency in handling variables and decision making inside a workflow and data manipulation techniques

CO3	Gain insights into recording, Email Automation and exception handling and orchestrator.
CO4	Analyze the trends in automation and chose business strategy to design a real-world automation workflow.

Reference Books:	
1.	Alok Mani Tripathi, "Learning Robotic Process Automation, Publisher: Packt Publishing, Release Date: March 2018 ISBN: 9781788470940
2.	PASCAL BORNET, Intelligent automation: Welcome to the world of hyperautomation, World Scientific Publishing Company, ISBN-13: 978-9811235481 December 2020
3.	UiPath pdf manuals
4.	https://www.uipath.com/rpa/robotic-process-automation
5.	https://www.ibm.com/topics/hyperautomation
6.	https://www.pega.com/hyperautomation

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
INTELLIGENT TRANSPORTATION SYSTEMS **Category: Institutional Elective-I** **(Theory)**						
Course Code	**:**	**CV266TEE**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**08 Hrs**
Introduction to Intelligent Transportation Systems (ITS): Historical background, Urbanisation, Motorisation, Transport system characteristics, Transport problems and issues, Challenges and opportunities in ITS: ITS-Today and tomorrow, ITS training and education needs, Role and importance of ITS in context of Indian Transport system and opportunity for sector growth of ITS.	
Unit – II	**08 Hrs**
ITS Architecture: introduction, Functionalities required for User service, Logical architecture, Physical architecture, Equipment and Market packages, Need of ITS Architecture to solve problems in Urban area. Technology building blocks for ITS: Introduction, Data acquisition, Communication tools, Data analysis and Traveller information. Various detection, Identification and collection methods for ITS.	
Unit –III	**08 Hrs**
Traffic management system components and ITS: Introduction, objectives, traffic management measures, ITS for traffic management, Development of traffic management system, Traffic Management Centre, Advance Traffic Management System, Advanced Traveller Information System, Advance Vehicle Control Systems, Advance Public Transport System, Commercial Vehicle Operations, ITS For Intermodal Freight Transport.	
Unit –IV	**08 Hrs**
ITS Evaluation – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines. ITS for Law Enforcement: Introduction, Enhance and support the enforcement traffic rules and regulations, ITS Funding options.	
Unit –V	**08 Hrs**
ITS Standards-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing. ITS for smart cities and Case studies.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Identify and apply ITS applications at different levels
CO2	Illustrate ITS architecture for planning process
CO3	Examine the significance of ITS for various levels
CO4	Compose the importance of ITS in implementations

Reference Books	
1.	Pradip Kumar Sarkar and Amit Kumar Jain, “Intelligent Transport Systems”, PHI Learning Private Limited, Delhi,2018, ISBN-9789387472068
2.	Choudury M A and Sadek A, “Fundamentals of Intelligent Transportation Systems Planning” Artech House publishers (31 March 2003); ISBN-10: 1580531601
3.	Bob Williams, “Intelligent transportation systems standards”, Artech House, London, 2008. ISBN-13: 978-1-59693-291-3
4.	Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola “Intelligent Transport Systems: Technologies and Applications” Wiley Publishing ©2015, ISBN:1118894782 9781118894781,

5	R.P Roess, E.S. Prassas, W.R. McShane. Traffic Engineering, Pearson Educational International, Third Edition, 2004, ISBN-13: 978-0-13-459971-7.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
INTEGRATED HEALTH MONITORING OF STRUCTURES **Category: Institutional Electives - I** **(Theory)**						
Course Code	**:**	**CV266TEF**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**08 Hrs**
Structural Health: Factors affecting Health of Structures, Causes of Distress, Regular Maintenance, Importance of maintenance **Structural Health Monitoring**: Concepts, Various Measures, Analysis of behavior of structures using remote structural health monitoring, Structural Safety in Alteration.	
Unit – II	**08 Hrs**
Materials: Piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique, Sensor technologies used in SHM **Structural Audit**: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures, SHM using Artificial Intelligence	
Unit –III	**08 Hrs**
Static Field Testing: Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.	
Unit –IV	**08 Hrs**
Dynamic Field Testing: Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.	
Unit –V	**08 Hrs**
Remote Structural Health Monitoring: Introduction, Hardware for Remote Data Acquisition Systems, Advantages, Case studies on conventional and Remote structural health monitoring **Case studies:** Structural Health Monitoring of Bridges, Buildings, Dams, Applications of SHM in offshore Structures- Methods used for non-destructive evaluation (NDE) and health monitoring of structural components	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Diagnose the distress in the structure understanding the causes and factors.
CO2	Understand safety aspects, components and materials used in Structural Health Monitoring.
CO3	Assess the health of structure using static field methods and dynamic field tests.
CO4	Analyse behavior of structures using remote structural health monitoring

Reference Books	
1	Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes,2006, John Wiley and Sons, ISBN: 978-1905209019
2	Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, 2007,John Wiley and Sons, ISBN:9780470033135
3	Structural Health Monitoring and Intelligent Infrastructure, J. P. Ou, H. Li and Z. D. Duan, Vol1,2006,Taylor and Francis Group, London, UK. ISBN: 978-0415396523
4	Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, 2007,Academic Press Inc, ISBN: 9780128101612

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ADVANCED ENERGY STORAGE FOR E-MOBILITY **Category: Institutional Electives - I** **(Theory)**						
Course Code	**:**	**CM266TEG**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**07 Hrs**
Energy storage in electric vehicles Introduction to E-mobility, background of alternative energy sources and sustainability. Types of electric vehicles and their salient features along with their energy requirement. Fundamentals of advanced battery technology. Battery characteristics. Specification of advanced battery for e mobility.	
Unit – II	**08 Hrs**
Advanced lithium-ion batteries Basic concepts of lithium batteries. Types of advanced cathode and anode materials employed in lithium batteries. Construction, working and future applications of lithium cobalt oxide, lithium iron phosphate, Lithium air, lithium sulfur and lithium polymer batteries with their advancement in vehicle electrification.	
Unit –III	**09 Hrs**
Non lithium batteries for e mobility Limitations of lithium batteries. Overview of non-lithium battery technology. Construction and working of advanced non-Lithium batteries such as Lead acid, Nickel Metal Hydride, Redox flow, Zebra, Sodium and Magnesium batteries. Electrode materials and electrolyte considerations in non lithium batteries. Performance comparison with lithium-ion batteries. Battery requirement in charging infrastructure.	
Unit –IV	**09 Hrs**
Chemistry of alternative storage devices Introduction to super capacitor. Construction, working and applications of supercapacitors along with the materials used in electrodes. Types of advanced supercapacitors. Application of supercapacitors in regenerative braking. Advancement in battery-supercapacitor hybrid, Battery-fuel cell hybrid, and Battery-solar cell hybrid electric vehicles with their advantages and limitations.	
Unit –V	**09 Hrs**
Battery management and recycling: Battery management systems (BMS): Fundamentals of battery management systems and controls, State-of-charge (SoC), state-of-health (SoH) and Cell balancing techniques. Battery Thermal Management: Passive and active cooling systems. Safety mechanisms, thermal runaway and thermal management. Battery recycling: Economic aspects, environmental safety and process of recycling of advanced batteries.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Implement the fundamentals of chemistry in advanced energy storage and conversion devices.
CO2	Apply the chemistry knowledge used for hybridization of various energy storage and conversion devices.
CO3	Analyze the different battery system for achieving maximum energy storage for vehicle electrification
CO4	Evaluation of efficiency of a battery with respect to cost, environmental safety, material, energy consumption and recycling.

Reference Books	
1	Battery reference book, T. R. Crompton., 3rd edition, NEWNES Reed Educational and Professional Publishing Ltd 2000, ISBN: 07506 4625 X.

2	Batteries for Electric Vehicles, D. A. J. Rand, R. Woods, and R. M. Dell, Society of Automotive Engineers, Warrendale PA, 2003. ISBN 10: 0768001277.
3	Lithium Batteries, Science and Technology, GA. Nazri and G. Pistoa, Kluwer Academic Publisher, 2003, ISBN 978-0-387-92675-9.
4	Battery Technology Handbook, H. A. Kiehne, Marcel Dekker, NYC, 2003. ISBN: 0824742494 9780824742492.
5	Electric Vehicle Technology Explained, James Larminie and John Lowry. 2nd Edition, Wiley, ISBN-13: 978-1118505429.
6	Electric Vehicle Technology and Design, Antoni Gandia. CRC Press, ISBN-13: 978-1138551912.
7	Sustainable Transportation: Problems and Solutions. William R. Black, The Guilford Press, ISBN-13: 978-1462532072.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
HUMAN MACHINE INTERFACE **Category- Institutional Elective – I** **Industry Assisted Elective-BOSCH**						
Course Code	**:**	**EC266TEH**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**

Foundations of HMI: The Human: History of User Interface Designing, I/O channels, Hardware, Software andOperating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving. The computer: Devices, Memory, Processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms.

Introduction to HMI and Domains: Automotive, Industrial, CE, Medical, ECUs within car and their functionalities. Interaction between ECUs. Communication protocols for ECUs(CAN, LIN, Most, FlexRay,
Ethernet etc)

Unit – II	**09 Hrs**

Automotive Human-Machine Interfaces: Automotive infotainment system - Evolution road map, Feature sets,System architecture, Trends, Human factors and ergonomics in automotive design, Automotive User Experience(UX) Design Principles, In-Vehicle Information Systems (IVIS), Driver-Assistance Systems (DAS) Interfaces, HMI design for adaptive cruise control, Voice and Gesture Recognition in Automotive HMIs, Touchscreen Interfaces and Controls, Usability Testing and Evaluation in Automotive HMIs, Safety Considerations and Regulations in Automotive HMIs, Emerging Technologies in Automotive HMIs, Human-Machine Interfaces for
Autonomous Vehicles

Unit –III	**09 Hrs**

UX and Guidelines: Introduction to UX design - stages, theory, Design thinking, UX Study, Interaction concepts,Graphic design tools - Adobe Photoshop, Adobe XD, Blender, GIMP, Asset Design - Overview, Guidelines and
norms, 2D/3D rendering, OpenGL, OSG.

Unit –IV	**09 Hrs**

HMI User Interface: User-centered HMI development process,Basics of Web-Server.Web-based HMI: Basics of TwinCAT and HTML, CSS, JavaScript.
HMI on Mobile: Four Principles of Mobile UI Design, Benefits of Mobile HMIs, Mobile HMI DevelopmentSuites.

Unit –V	**09 Hrs**

HMI Control Systems: Introduction to Voice-Based HMI, Gesture-Based HMI, Sensor-Based UI controls. **Haptics in Automotive HMI**: Kinesthetic Feedback Systems, Tactile Feedback Systems, Haptics in MultimodalHMI, Automotive Use-Cases
HMI Testing: Limitations of Traditional Test Solutions, Case - Study: Bosch's HMI validation tool - GraphicsTest Systems (GTS).
UI analytics: Usage patterns, Debugging, Performance Profiling, Use Cases.

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understanding the application of HMIs in various domain.
CO2	Comparison of various communication protocols used in HMI development.
CO3	Apply and analyse the car multimedia system free software and hardware evolution.
CO4	Design and evaluate the graphic tools and advanced techniques for creating car dashboard multimedia systems.

Reference Books	
1.	Touch based HMI; Principles and Applications, Shuo gao, Shuo Yan, Hang Zhao, Arokia Nathan, Springer Nature Switzerland AG, 1st Edition.
2.	Unity 2020 by Example: A Project based guide to building 2D, 3D augmented reality and Virtual reality games from sratch, Robert Wells, Packt Publishing ltd, 2020.
3.	GUI Design and Android Apps, Ryan Cohen, Tao Wang, Apress, Berkley, CA,2014.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ENERGY AUDITING & STANDARDS **Category: Institutional Elective-I** **(Theory)**						
Course Code	**:**	**EE266TEJ**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**06 Hrs**
Types of Energy Audit and Energy-Audit Methodology: Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training. **Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data Acquisition System, **Energy Audit of a Power Plant:** Indian Power Plant Scenario, Benefit of Audit, Types of Power Plants, Energy Audit of Power Plant.	
Unit – II	**10 Hrs**
Electrical-Load Management: Electrical Basics, Electrical Load Management, VariableFrequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses. **Energy Audit of Motors:** Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling. **Energy Audit of Pumps, Blowers and Cooling Towers:** Pumps, Fans and Blowers, Cooling Towers	
Unit –III	**09 Hrs**
Communication & Standards: **Wireless technologies:** WPANs, LAN, Wireless metropolitan area network, cellular network, satellite communication, Zigbee, Bluetooth, LAN, NAN **Wireline communication:** Phone line technology, powerline technology, coaxial cable technology; Optical communication, TCP/IP networks	
Unit –IV	**09 Hrs**
Energy Audit of Boilers: Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods. **Energy Audit of Furnaces:** Parts of a Furnace, classification of Furnaces, Energy saving Measures in Furnaces, Furnace Efficiency **Energy Audit of Steam-Distribution Systems :** S team as Heating Fluid, Steam Basics, Requirement of Steam, Pressure, Piping, Losses in Steam Distribution Systems, Energy Conservation Methods	
Unit-V	**09 Hrs**
Energy Audit of Lighting Systems: Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities. **Energy Audit Applied to Buildings:** Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.	

Course Outcomes: After completing the course, the students will be able to: -	
CO 1	Explain the need for energy audit, prepare a flow for audit and identify the instruments needed.
CO 2	Design and perform the energy audit process for electrical systems.
CO 3	Design and perform the energy audit process for mechanical systems
CO 4	Propose energy management scheme for a building

Reference Books	
1.	Handbook of energy audit, Sonal Desai, Kindle Edition, 2015, McGraw Hill Education, ISBN: 9339221346, 9789339221348.
2.	Energy management handbook, Wayne C Turner and Steve Doty, 6th Edition, 2015, CRC Press, ISBN: 0-88173-542-6.
3.	Energy management, Sanjeev Singh and Umesh Rathore, 1st Edition, 2016, Katson Books, ISBN 10: 9350141019, ISBN 13: 9789350141014.
4.	Energy audit of building systems, Moncef Krarti, 2nd Edition, 2010, CRC Press ISBN: 9781439828717

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
BIOMEDICAL INSTRUMENTATION **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**EI266TEK**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Fundamentals: Sources of Biomedical signals, Basic medical instrumentation system, General constraints in design of medical instrumentation systems. **Bioelectric Signals and Electrodes**: Origin of bioelectric signals, Types of bioelectric signals, Recording electrodes, Electrode-tissue interface, Polarization, Skin contact impedance, Silver-silver chloride electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes.	
Unit – II	**09 Hrs**
Electrocardiograph: Electrical activity of heart, Genesis and characteristics of Electrocardiograph (ECG), Block diagram description of an Electrocardiograph, ECG lead systems, Multi-channel ECG machine. **Electroencephalograph:** Genesis of EEG, Block diagram description of an EEG, 10-20 Electrode system, Computerized analysis of EEG.	
Unit –III	**09 Hrs**
Patient Monitoring System: Bedside monitors, Central Monitors, Measurement of Heart Rate, Average Heart Rate meter, Instantaneous heart rate meter, Measurement of pulse rate, Blood Pressure measurement, Direct and indirect method, Automatic blood pressure measuring apparatus using Korotkoff's method. **Oximeters:** Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter.	
Unit –IV	**09 Hrs**
Blood Flow Meters: Electromagnetic blood flow meter, Types of electromagnetic blood flow meters, Ultrasonic blood flow meters, NMR blood flow meters, Laser Doppler blood flow meters. **Cardiac Pacemakers and Defibrillators:** Need for Cardiac pacemaker, External Pacemaker, Implantable Pacemaker, Types of Implantable Pacemaker, Ventricular Synchronous Demand Pacemaker and Programmable Pacemaker. Need for a defibrillator, DC defibrillator, Defibrillator electrodes, DC defibrillator with synchronizer.	
Unit –V	**09 Hrs**
Advances in Radiological Imaging: X-rays-principles of generation, Conventional X-ray radiography, Fluoroscopy, Angiography, Digital radiography, Digital subtraction angiography (DSA). Basic principle of computed tomography, magnetic resonance imaging system and Ultrasonic imaging system.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the sources of biomedical signals and basic biomedical instruments.
CO2	Apply concepts for the design of biomedical devices
CO3	Analyze the methods of acquisition and signal conditioning to be applied to the physiological parameters
CO4	Develop instrumentation for measuring and monitoring biomedical parameters.

Reference Books

1.	Handbook of Biomedical Instrumentation, R. S. Khandpur,3rd Edition, Reprint 2016, Tata McGraw-Hill, ISBN: 9780070473553.
2.	Biomedical Instrumentation and Measurements, Leslie Cromwell & others, 2nd Edition, Reprint 2015, ISBN: 9780130771315.
3.	Medical instrumentation: Application and Design, J. G. Webster, 3rd Edition, Reprint 2015, Wiley Publications, ISBN: 9788126511068.
4.	Principles of Medical Imaging, K.Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 2016, ISBN: 978-0126409703.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **Two tests will be conducted**. Each test will be evaluated for **50 Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**). Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
TELECOMMUNICATION SYSTEMS **Category: Institutional Elective Course-I** **(Theory)**						
Course Code	**:**	**ET266TEM**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**8 Hrs**
Introduction to Electronic Communication: The Significance of Human Communication, Communication Systems, Types of Electronic Communication, Modulation and Multiplexing, Electromagnetic Spectrum, Bandwidth, A Survey of Communication Applications. **The Fundamentals of Electronics:** Gain, Attenuation, and Decibels. **Radio Receivers:** Super heterodyne receiver.	
Unit – II	**10 Hrs**
Modulation Schemes: Analog Modulation: AM, FM and PM- brief review. **Digital Modulation:** PCM, Line Codes, ASK, FSK, PSK & QAM (Architecture). **Wideband Modulation:** Spread spectrum, FHSS, DSSS. **Multiple Access:** FDMA, TDMA, CDMA.	
Unit –III	**10 Hrs**
Satellite Communication: Satellite Orbits, Satellite Communication Systems, Satellite Subsystems, Ground Stations, Satellite Applications, Global Positioning System.	
Unit –IV	**9 Hrs**
Optical Communication: Optical Principles, Optical Communication Systems, Fiber-Optic Cables, Optical Transmitters and Receivers, Wavelength-Division Multiplexing, Passive Optical Networks.	
Unit –V	**8 Hrs**
Cell Phone Technologies: Cellular concepts, Frequency allocation, Frequency reuse, Internet Telephony. **Wireless Technologies:** Wireless LAN, PANs and Bluetooth, Zig Bee, Mesh Wireless Networks, WiMax, and Wireless Metropolitan Area Networks.	

Course Outcomes: After completing the course, the students will be able to :-	
CO1	Describe the basics of communication systems.
CO2	Analyze the importance of modulation and multiple access schemes for communication systems.
CO3	Analyze the operational concept of cell phone and other wireless technologies.
CO4	Justify the use of different components and sub-system in advanced communication systems.

Reference Books

1.	Principles of Electronic Communication Systems, Louis E. Frenzel, 4th Edition, 2016, Tata McGraw Hill, ISBN: 978-0-07-337385-0.
2.	Electronic Communication Systems, George Kennedy,3rd Edition, 2008, Tata McGraw Hill, ISBN: 0-02-800592-9.
3.	Introduction to Telecommunications, Anu A. Gokhale, 2nd Edition, 2008, Cengage Learning ISBN: 981-240-081-8

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
Mobile Communication Networks and Standards **Category: Institutional Elective Course-I** **(Theory)**						
Course Code	**:**	**ET266TEN**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**9 Hrs**
Principle of Cellular Communication: Cellular Terminology, Cell Structure and Cluster, Frequency Reuse Concept, Cluster size and System Capacity, Method of Locating Co-channel cells, Frequency Reuse distance, Co-channel Interference and Signal Quality, Co-channel interference Reduction Methods.	
Unit – II	**9 Hrs**
Basic Cellular system: Consideration of components of a cellular system- A basic cellular system connected to PSTN, Main parts of a basic cellular system, Operation of a Cellular system, Performance criteria- Voice quality, Trunking and Grade of Service, Spectral Efficiency of FDMA and TDMA systems	
Unit –III	**9 Hrs**
Second generation Cellular Technology: GSM: GSM Network Architecture, Identifiers used in GSM System, GSM channels, Authentication and Security in GSM, GSM Call Procedure, GSM Hand-off Procedures.	
Unit –IV	**9 Hrs**
3G Digital Cellular Technology: GPRS: GPRS technology, GPRS NetworkArchitecture, GPRS signalling, Mobility Management in GPRS. **UMTS:** UMTS Network Architecture, UMTS Interfaces, UMTS Air Interface Specifications, UMTS Channels**.**	
Unit –V	**9 Hrs**
Wireless Personal Area Networks: Network architecture, components, Bluetooth, Zigbee, Applications. **Wireless Local Area networks:** Network Architecture, Standards, Applications. Wireless Metropolitan Area Networks: IEEE 802.16 standards, advantages, WMAN Network architecture, Protocol stack	

Course Outcomes: After completing the course, the students will be able to :-	
CO1	Describe the concepts and terminologies for Cellular Communication.
CO2	Analyze the Architecture, Hand-off and Security aspects in 2G and 3G Networks.
CO3	Compare the performance features of 2G and 3G Cellular Technologies.
CO4	Analyze and Compare the architectures of various Wireless technologies and standards.

Reference Books	
1.	Wireless Communications, T.L. Singal, 2nd Reprint 2011,Tata McGraw Hill Education Private Limited, ISBN: 978-0-07-068178-1
2.	Wireless and Mobile Networks Concepts and Protocols, Dr.Sunil Kumar SManvi, 2010, Willey India Pvt. Ltd., ISBN: 978-81-265-2069-5.
3.	Wireless Communication, Upena Dalal, 1st Edition, 2009, Oxford higher Education, ISBN-13:978-0-19-806066-6.
4	Wireless Communications Principles and practice, Theodore S Rappaport, 2nd Edition, Pearson, ISBN 97881-317-3186-4

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
MOBILE APPLICATION DEVELOPMENT **Category: Institutional Elective Course-I** **(Theory)**						
Course Code	**:**	**IS266TEO**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hours**

Unit-I	**09 Hrs**
Introduction: Smart phone operating systems and smart phones applications. Introduction to Android, Installing Android Studio, creating an Android app project, deploying the app to the emulator and a device. UI Design: Building a layout with UI elements, Layouts, Views and Resources, Text and Scrolling Views. Activities and Intents, The Activity Lifecycle, Managing State, Activities and Implicit Intents, The Android Studio Debugger, Testing the Android app, The Android Support Library.	
Unit–II	**09 Hrs**
User experience: User interaction, User Input Controls, Menus, Screen Navigation, Recycler View, Delightful user experience, Drawables, Styles, and Themes, Material Design, Testing app UI, Testing the User Interface	
Unit–III	**09 Hrs**
Working in the background: Async Task and Async Task Loader, Connect to the Internet, Broadcast Receivers and Services. Scheduling and optimizing background tasks – Notifications, Scheduling Alarms, and Transferring Data Efficiently	
Unit–IV	**09 Hrs**
All about data: Preferences and Settings, Storing Data, Shared Preferences. Storing data using SQLite, SQLite Database. Sharing data with content providers. Advanced Android Programming: Internet, Entertainment and Services. Displaying web pages and maps, communicating with SMS and emails, Sensors.	
Unit–V	**09 Hrs**
Hardware Support & devices: Permissions and Libraries, Performance and Security. Fire base and AdMob, Publish and Polish, Multiple Form Factors, Using Google Services.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Comprehend the basic features of android platform and the application development process. Acquire familiarity with basic building blocks of Android application and its architecture.
CO2:	Apply and explore the basic framework, usage of SDK to build Android applications incorporating Android features in developing mobile applications.
CO3:	Demonstrate proficiency in coding on a mobile programming platform using advanced Android technologies, handle security issues, rich graphics interfaces, using debugging and troubleshooting tools.
CO4:	Create innovative applications, understand the economics and features of the app marketplace by offering the applications for download.

Reference Books	
1	Android Programming, Phillips, Stewart, Hardyand Marsicano, Big Nerd Ranch Guide, 2nd Edition, 2015, ISBN-13 978-0134171494
2	AndroidStudioDevelopmentEssentials-Android6, NeilSmyth,2015, Create space Independent Publishing Platform, ISBN:9781519722089
3	Android Programming–Pushing the limits, EricHellman,2013, Wiley, ISBN-13:978-1118717370
4	Professional Android2ApplicationDevelopment,RetoMeier, Wiley India Pvt. Ltd, 1st Edition, 2012, ISBN-13:9788126525898
5	BeginningAndroid3, Mark Murphy, A press Springer India Pvt Ltd,1st Edition,2011, ISBN-13:978-1-4302-3297-1
6	AndroidDeveloperTraining-https://developers.google.com/training/android/ AndroidTestingSupportLibrary-https://google.github.io/android-testing-support-library/

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ELEMENTS OF FINANCIAL MANAGEMENT **Category: Institutional Elective-I** **(Theory)**						
Course Code	**:**	**IM266TEQ**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**
Unit-I						**06 Hrs**
Financial Management-An overview: Financial Decisions in a firm, Goals of a firm, Fundamental principle of finance, Organization of finance function and its relation to other functions, Regulatory framework. **The financial System:** Functions, Assets, Markets, Market returns, Intermediaries, regulatory framework, Growth and trends in Indian financial system.						
Unit – II						**10 Hrs**
Financial statements, Taxes and cash flow: Balance sheet, statement of profit and loss, items in annual report, manipulation of bottom line, Profits vs Cash flows, Taxes. **(Conceptual treatment only)** **Time Value of Money:** Future value of a single amount, future value of an annuity, present value of a single amount, present value of an annuity. **Valuation of securities:** Basic valuation model, bond valuation, equity valuation-dividend capitalization approach and other approaches.						
Unit –III						**10 Hrs**
Risk and Return: Risk and Return of single assets and portfolios, measurement of market risk, relationship between risk and return, implications. **Techniques of Capital Budgeting:** Capital budgeting process, project classification, investment criteria, Net present value, Benefit-Cost ratio, Internal Rate of return, Payback period, Accounting rate of return. **(Conceptual and Numerical treatment)**						
Unit –IV						**10 Hrs**
Long term finance: Sources- Equity capital, Internal accruals, preference capital, term loans, debentures. Raising long term finance- Venture capital, Initial Public Offer, Follow on Public Offer, Rights Issue, Private Placement, Term Loans, Investment Banking **Securities Market:** Primary market vs Secondary market, Trading and Settlements, Stock market quotations and Indices, Govt. securities market, Corporate debt market.						
Unit –V						**09 Hrs**
Working Capital – Policy and Financing: Factors influencing working capital requirements, Current assets financing policy, operating cycle and cash cycle. Accruals, trade credit, banks, public deposits, inter-corporate deposits, short term loans, right debentures, commercial paper, Factoring **(Conceptual treatment only)**						

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the features and elements of a financial system.
CO2	Recognize the relevance basic principles of financial management in decision making.
CO3	Describe the processes and techniques of capital budgeting and working capital financing by organizations.
CO4	Demonstrate an understanding of various sources of finance.

Reference Books:	
1.	Fundamentals of Financial Management, Prasanna Chandra, 6th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 978-93-392-0313-9, 93-392-0313-5
2.	Financial Management ,I M Pandey, 12th edn, 2021, Pearson, ISBN-939057725X, 978-9390577255

3.	Financial Management-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 9353162181 , 9789353162184
4.	Fundamentals of Financial Management, Eugene F Brigham, Joel F Houston, 8th Edition, 2014, Cengage Learning, ISBN : 9781285065137, 1285065131.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9z or 10	16
	TOTAL	**100**

Semester: VI						
OPTIMIZATION TECHNIQUES **Category: Institutional Elective-I** **(Theory)**						
Course Code	**:**	**IM266TER**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**03 Hours**

UNIT – I	**08 Hrs**
Introduction: OR Methodology, Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR. **Linear Programming:** Definition, Mathematical Formulation, Standard Form, Solution Space, Types of solution – Feasible, Basic Feasible, Degenerate, Solution through Graphical Method. Problems on Product Mix, Blending, Marketing, Finance, Agriculture and Personnel. **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables.	
UNIT – II	**09 Hrs**
Simplex Algorithm: How to Convert an LP to Standard Form, Preview of the Simplex Algorithm, Direction of Unboundedness, Why Does an LP Have an Optimal basic feasible solution, The Simplex Algorithm, Using the Simplex Algorithm to Solve Minimization Problems, Alternative Optimal Solutions, Degeneracy and the Convergence of the Simplex Algorithm, The Big M Method, The Two-Phase Simplex Method.	
UNIT – III	**09 Hrs**
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems. **Assignment Problem:** Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	
UNIT – IV	**08 Hrs**
Project Management Using Network Analysis: Network construction, CPM & PERT, Determination of critical path and duration, floats. Crashing of Network. Usage of software tools to demonstrate N/W flow problems	
UNIT – V	**08 Hrs**
Game Theory: Introduction, Two person Zero Sum game, Pure strategies, Games without saddle point - Arithmetic method, Graphical Method, The rules of dominance	

Course Outcomes: After going through this course the student will be able to	
CO1	Understand the characteristics of different types of decision – making environments and the appropriate decision making approaches and tools to be used in each type.
CO2	Build and solve Transportation Models and Assignment Models.
CO3	Design new simple models, like: CPM, PERT to improve decision –making and develop critical thinking and objective analysis of decision problems.
CO4	Implement practical cases, by using TORA, WinQSB, Excel, GAMS.

Reference Books:	
1.	Operation Research An Introduction, Taha H A, 10th Global Edition, 2017, Pearson Education Limited, ISBN 13: 978-1-292-16554-7
2.	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg, 2nd Edition, 2007, John Wiley & Sons (Asia) Pvt Ltd, ISBN 13: 978-8126512560

3.	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 10th Edition, 2017, McGraw Hill Education, ISBN 13: 978-9339221850
4.	Operations Research Theory and Application, J K Sharma, 6th Edition, 2009, Trinity Press, ISBN : 978-93-85935-14-5

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9z or 10	16
	TOTAL	**100**

Semester: V						
AUTOMOTIVE MECHATRONICS **Category: Institutional Elective Course-I** **(Theory)**						
Course Code	**:**	**ME266TES**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**03 Hours**

Unit-I	**09 Hrs**
Automobile Engines Classifications of Internal Combustion Engines**.** Engine nomenclature and mechanics. Mixture formation – External, internal, quality and quantity control – homogeneous and stratified injection. Thermodynamic principles of Otto and Diesel cycle. Characteristics – pressure curve and energy yield, engine speed, torque, and power	
Unit-II	**10 Hrs**
Engine Auxiliary Systems: Turbocharger, Intercooler, Exhaust manifold, 3-way catalytic convertor, Exhaust Gas Recirculation system. **Common Rail Fuel Injection system**- Low pressure and high pressure fuel systems, Return line, Quantity control valve and Injectors.	
Unit-III	**10 Hrs**
Vehicular Auxiliary Systems: Vehicle frame and body classification- Hatchback, Sedan, SUV, Coupe, Roadster. Adaptive Brakes - Disc and drum brakes, Antilock Braking Systems, ESP, TCS. Wheels and Tyres- Toe-In, Toe-Out, Caster and Camber angle. Classification of tyres, Radial, Tubeless. **Supplemental Restraint System**: Active and passive safety, Vehicle structure, Gas generator and air bags, Belt Tensioner, Acceleration sensor, Rollover sensor, Seat occupancy recognition.	
Unit-IV	**09 Hrs**
EV Technology: Types of EV's, ICE vs EV torque output, Architecture and Working of EV's. Battery Thermal Management System, Regenerative braking, Safety system and Impacts of EV on the environment.	
Unit-V	**07 Hrs**
Telematics in vehicles – Radio Transmission, Exchange of information, signal path & properties, Concept of radio waves. **Sensors:** Oxygen sensors, Crankshaft/Cam shaft Sensor, Boost Pressure Sensor, Coolant Temperature Sensor, Hot Film Air Mass flow Sensor, Throttle Position Sensor, Rain/Light sensor	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe the functions of Mechatronic systems in a modern automobile
CO2:	Evaluate the performance of an engine by its parameters
CO3:	Analyse the automotive exhaust pollutants as per emission norms
CO4:	Demonstrate communication of control modules using a On-Board Diagnostic kit

Reference Books	
1.	Automotive Technology – A systems approach, Jack Erjavec, 5th Edition, Delamr Cengage Learning, ISBN-13: 978-1428311497
2.	Automotive Engineering Fundamentals, Richard Stone and Jeffrey K. Ball, 2004, SAE International, ISBN: 0768009871
3.	Bosch Automotive Handbook, Robert Bosch, 9th Edition, 2004, ISBN: 9780768081527
4.	Understanding Automotive Electronics, William B Ribbens, 5th Edition, Butterworth–Heinemann, ISBN 0-7506-7008-8

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: VI						
MATHEMATICAL MODELLING **Category: Institutional Elective Course-I** **(Theory)**						
Course Code	**:**	MA266TEU		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**
Introduction to Mathematical Modelling: Basic concepts, steps involved in modelling, classification of models, assorted simple mathematical models from diverse fields.	
Unit – II	**09 Hrs**
Mathematically Modelling Discrete Processes: Difference equations - first and second order, Introduction to Difference equations, Introduction to discrete models-simple examples, Mathematical modelling through difference equations in economics, finance, population dynamics, genetics and other real world problems.	
Unit –III	**09 Hrs**
Markov modelling: Mathematical foundations of Markov chains, application of Markov Modelling to problems.	
Unit –IV	**09 Hrs**
Modelling through graphs: Graph theory concepts, Modelling situations through different types of graphs.	
Unit –V	**09 Hrs**
Variational Problem and Dynamic Programming: Optimization principles and techniques, Mathematical models of variational problem and dynamic programming, Problems with applications.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explore the fundamental concepts of mathematical models arising in various fields engineering.
CO2:	Apply the knowledge and skills of discrete and continuous models to understand various types of analysis.
CO3:	Analyze the appropriate mathematical model to solve the real-world problem and to optimize the solution.
CO4:	Distinguish the overall knowledge gained to demonstrate the problems arising in many practical situations.

Reference Books	
1	Mathematical Modeling, J. N. Kapur, 1st Edition, 1998, New Age International, New Delhi, ISBN: 81-224-0006-X.
2	Mathematical Modeling: Models, Analysis and Applications, Sandip Banerjee, 2014, Chapman and Hall/CRC Textbook, ISBN 9781439854518.
3	Case studies in mathematical modeling, D. J. G. James and J. J. Mcdonald, 1981, Stanly Thames, Cheltonham, ISBN: 0470271779, 9780470271773.
4	Modeling with difference equations, D. N. Burghes, M. S. Borrie, Ellis Harwood, 1981, ISBN 13: 9780853122869.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
	COMPONENTS	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
MATHEMATICS OF QUANTUM COMPUTING (Category: Institutional Elective Course-I (Theory)						
Course Code	**:**	MA266TEV		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**
Introduction to Quantum Computing: Quantum superposition, Qubits, Linear algebra for quantum computing, Inner products and Tensor products of vector spaces, Quantum states in Hilbert space, The Bloch sphere, Generalized measurements, No-cloning theorem.	
Unit – II	**09 Hrs**
Quantum Gates: Universal set of gates, quantum circuits, Dirac formalism, superposition of states, entanglement Bits and Qubits. Qubit operations, Hadamard Gate, CNOT Gate, Phase Gate, Z-Y decomposition, Quantum Circuit Composition, Basic Quantum circuits.	
Unit –III	**09 Hrs**
Quantum Algorithm - I: Deutsch Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazarani Algorithm, Simon periodicity algorithm, Phase estimation algorithm, Quantum Fourier transform.	
Unit –IV	**09 Hrs**
Quantum Algorithm - II: Grover search algorithm, Shor's quantum factoring algorithm, Harrow-Hassidim-Lloyd (HHL) algorithm for solving linear system problems.	
Unit –V	**09 Hrs**
Applications of Quantum Computing: Application to: order-finding, discrete logarithm, quantum counting, Boolean satisfiability problem (SAT), graph theory problems.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explore the fundamental concepts of quantum computing.
CO2:	Apply the knowledge and skills of quantum computing to understand various types of problems arising in various fields engineering.
CO3:	Analyze the appropriate quantum algorithm to solve the real-world problem and to optimize the solution.
CO4:	Distinguish the overall knowledge gained to demonstrate the problems arising in many practical situations.

Reference Books	
1	An introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, 2007, Oxford University press.
2	Quantum Computing for Everyone, Chris Bernhardt, 2020, The MIT Press, Cambridge.

3	Quantum Computation and Quantum Information, M. A. Nielsen & I. Chuang, 2013, Cambridge University Press.
4	Quantum Computing for the quantum curious, Cirian Hughes et. al., 2021, Springer, ISBN 978-3-030-61600-7.
5	Concise guide to quantum computing, Sergei Kurgalin, Sergei Borzunov, 2021, Springer, ISBN 978-3-030-65051-3, ISBN 978-3-030-65052-0 (eBook).

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
	COMPONENTS	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
APPLIED PSYCHOLOGY FOR ENGINEERS **Category: Institutional Electives – I** **(Theory)**						
Course Code	**:**	**HS266TEW**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**08 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology- Clinical, Industrial). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit – II	**08 Hrs**
Intelligence and Aptitude: Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence.	
Unit –III	**10 Hrs**
Personality: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio-Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment.	
Unit –IV	**10 Hrs**
Learning: Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning.	
Unit –V	**09 Hrs**
Application of Psychology in Working Environment: The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. **Psychological Stress**: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress.Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control. Type A and Type B.**Psychological Counseling** - Need for Counseling, Types – Directed, Non-Directed, Participative Counseling.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Describe the basic theories, principles, and concepts of applied psychology as they relate to behaviors and mental processes.
CO2	Define learning and compare and contrast the factors that cognitive, behavioral, and Humanistic theorists believe influence the learning process.
CO3	Develop understanding of psychological attributes such as intelligence, aptitude, creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement.
CO4	Apply the theories into their own and others' lives in order to better understand their personalities and experiences.
CO5	Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment.

Reference Books	
1.	Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill India
2.	Psychology Robert A. Baron, III edition (1995) Prentice Hall India.
3.	Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3
4.	Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5
5	Psychology-themes and variations , Wayne Weiten, IV edition, Brooks / Cole Publishing Co.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
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	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
UNIVERSAL HUMAN VALUES - III **Category: Institutional Electives – I** **(Theory)**						
Course Code	**:**	**HS266TEY**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**10 Hrs**
Introduction-Basic Human Aspiration, its fulfillment through All-encompassing Resolution. The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution are the activities of the Self, Self is central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.	
Unit – II	**10 Hrs**
Right Understanding (Knowing)- Knower, Known & the Process. The domain of right understanding starts from understanding the human being (the knower, the experiencer and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	
Unit –III	**08 Hrs**
Understanding Existence (including Nature). A comprehensive understanding (knowledge) about the existence, which certainly includes the Nature. The need and the process of inner evolution (through self-exploration, self-awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).	
Unit –IV	**08 Hrs**
Understanding Human Being. Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body, the activities and potentialities of the self, Reasons for harmony/contradiction in the self.	
Unit –V	**08 Hrs**
Understanding Human Conduct, All-encompassing Resolution & Holistic Way of Living. Understanding Human Conduct, Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence.	

Course Outcomes: After completion of the course the students will be able to	
CO1	Understand the basic human aspiration with program of its fulfilment and meaning of resolution in the complete expanse of human living.
CO2	Understand human being in depth and see how self is central to human being
CO3	Understand existence in depth and see how coexistence is central to existence
CO4	Understand human conduct and the holistic way of living leading to human tradition

Reference Books

1	A foundation course in human values and professional ethics, R. R. Gaur, R Asthana, G P Bagaria, 2nd revised Edition, excel books, New Delhi – 2019, ISN 978-93-87034-47-1
2	Avartansheel Arthshastra, A Nagraj, Divya Path Sansthan, Amarkantak, India, ISBN 978-8-174-46781-2
3	Economy of Performance- a quest for social order based on non – violence, J C Kumarappa, 2010, Sarva-Seva-Sangh-Prakashan, Varanasi, India

4	Energy and Equity, Ivan Illich, 1974, The Trinity Press, Worcester & Harper Collins, USA, ISBN, 0060803274, 9780060803278

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
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2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester VI						
INTERDISCIPLINARY PROJECT						
Course Code	**:**	**BT367P**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:3**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**15 P**		**SEE Duration**	**:**	**2 Hours**

Major Project Guidelines:

- The project topic, title and synopsis have to be finalized and submitted to their respective internalguide(s) before the beginning of the VI semester.

- The detailed Synopsis (approved by the department ***Project Review Committee***) has to be submitted during the 1st week after the commencement of VI semester.

Batch Formation:

- Students are free to choose their project partners from any other program.
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house only.
- ***The project work is to be carried out by a team of two to four students.***

Project Topic Selection:

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

Interdisciplinary Project Evaluation:

Continuous monitoring of project work will be carried out and cumulative evaluation will be done.

- The students are required to meet their guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Guide regularly.
- For CIE assessment the project groups must give a final presentation with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.

Course Outcomes:	
1	Identifying critical thinking and problem-solving abilities by analyzing and addressing interdisciplinary challenges, utilizing creative approaches and innovative solutions.
2	Exhibit proficiency in conducting comprehensive research, including literature review, data collection, modelling, simulation, and analysis, to address significant technical challenges and propose innovative solutions.
3	Demonstrate the ability to do effective teamwork, leadership, project management, and communication skills, while adhering to ethical standards and professional responsibility in delivering the project outcomes within time and budget constraints.
4	Utilize appropriate engineering tools, technologies, and software to design, test, and implement project solutions, ensuring adherence to technical specifications, safety standards, and industry best practices.

CIE Assessment:

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

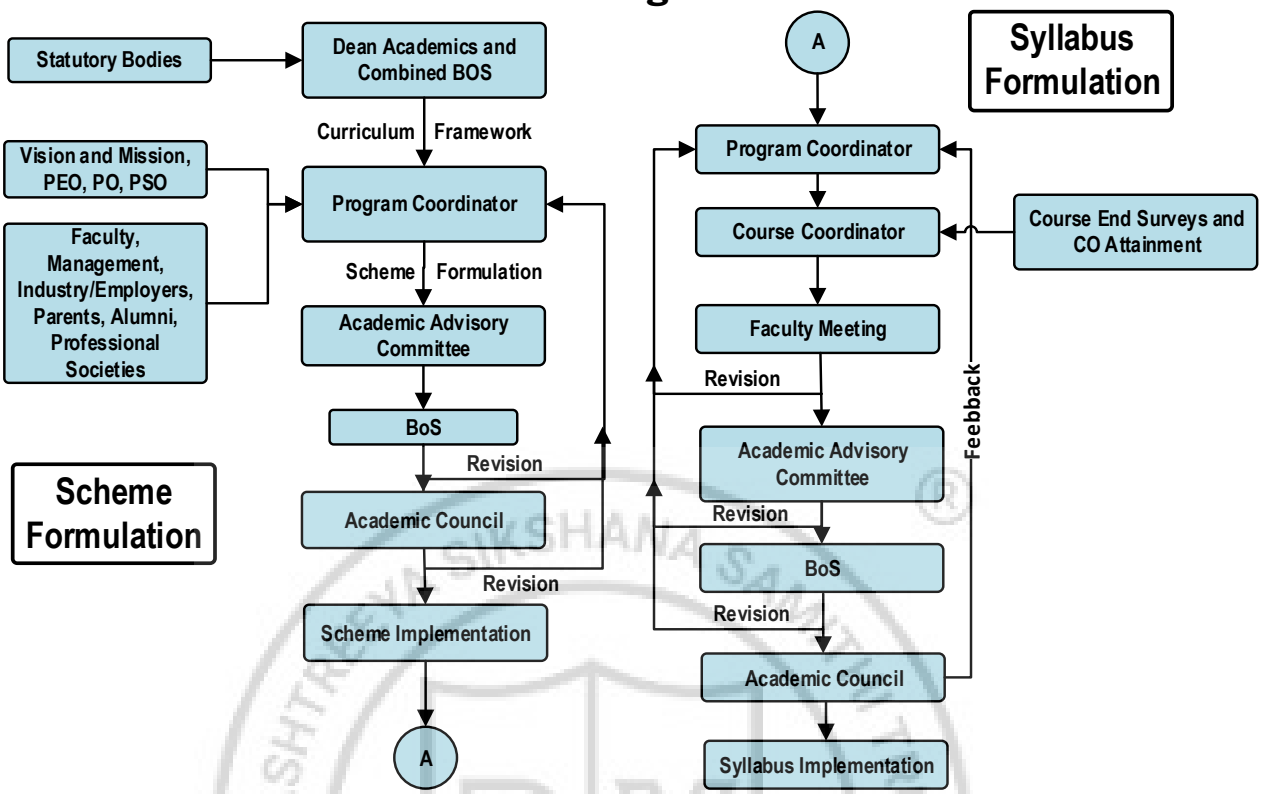
1.	Selection of the topic and formulation of objectives	10%
2.	Design and Development of Project methodology	25%
3.	Execution of Project	25%
4.	Presentation, Demonstration and Results Discussion	30%
5.	Report Writing & Publication	10%

SEE Assessment:

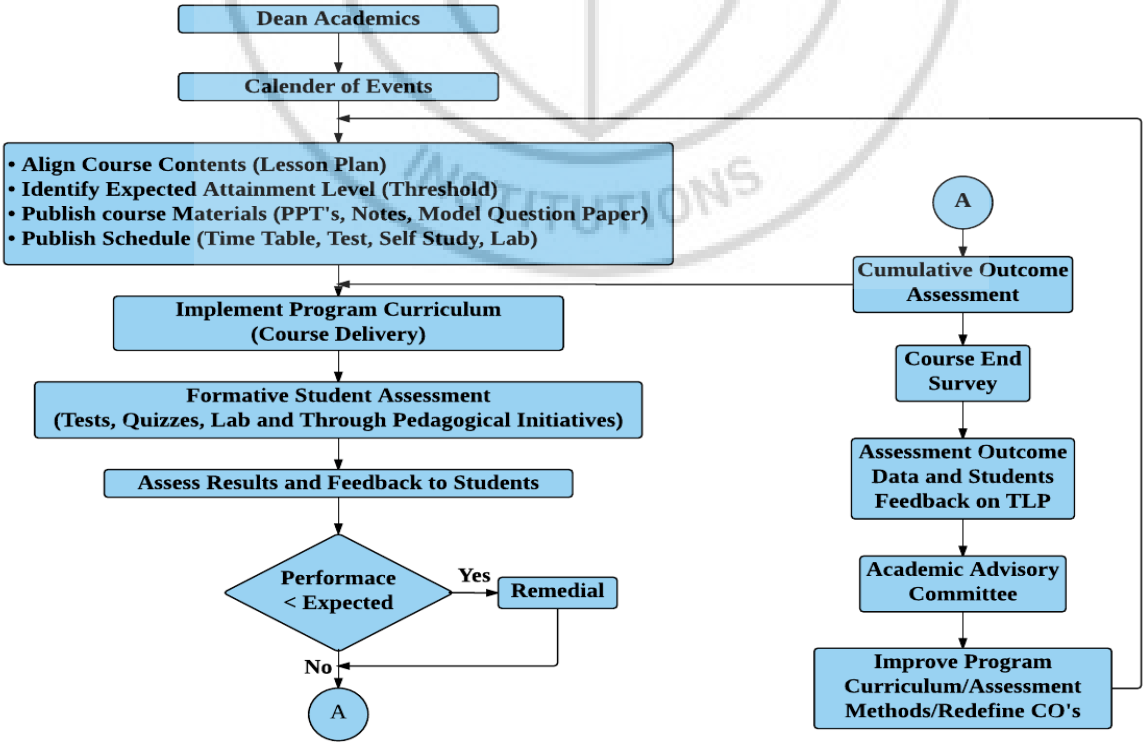
The following are the weightages given during Viva Examination.

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

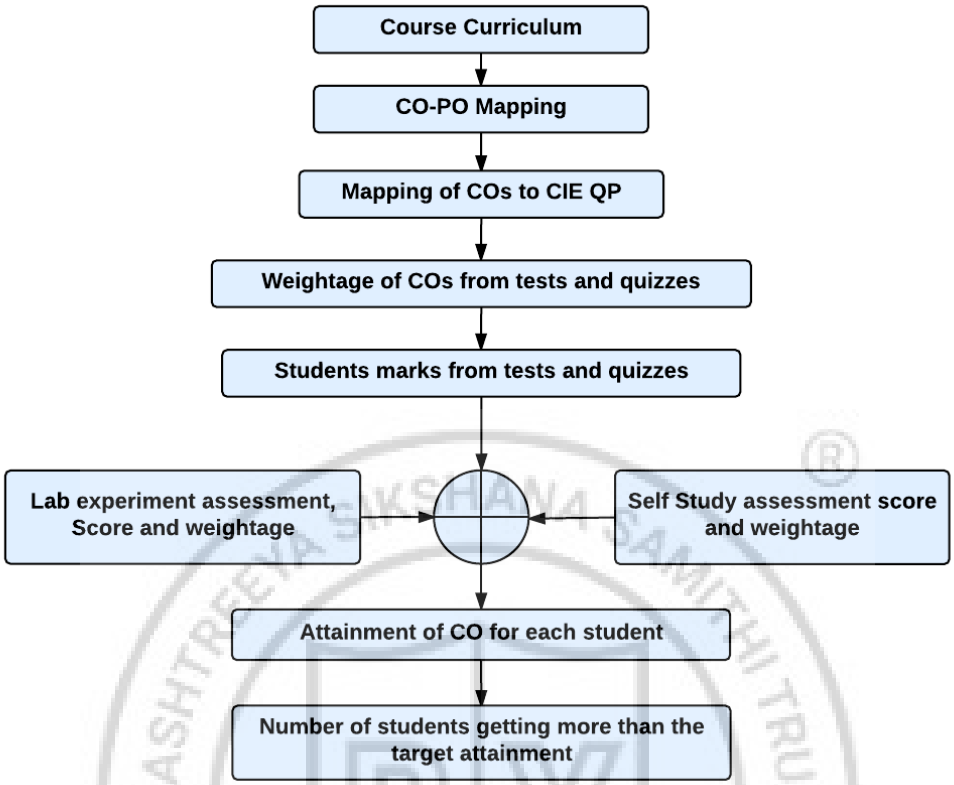
Curriculum Design Process



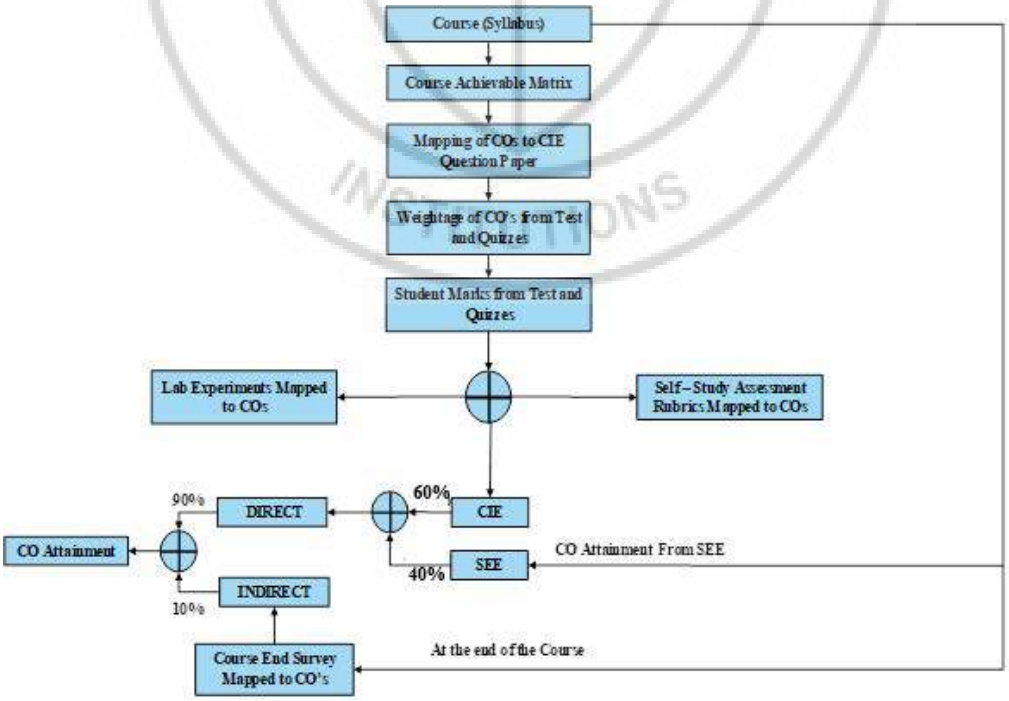
Academic Planning and Implementation



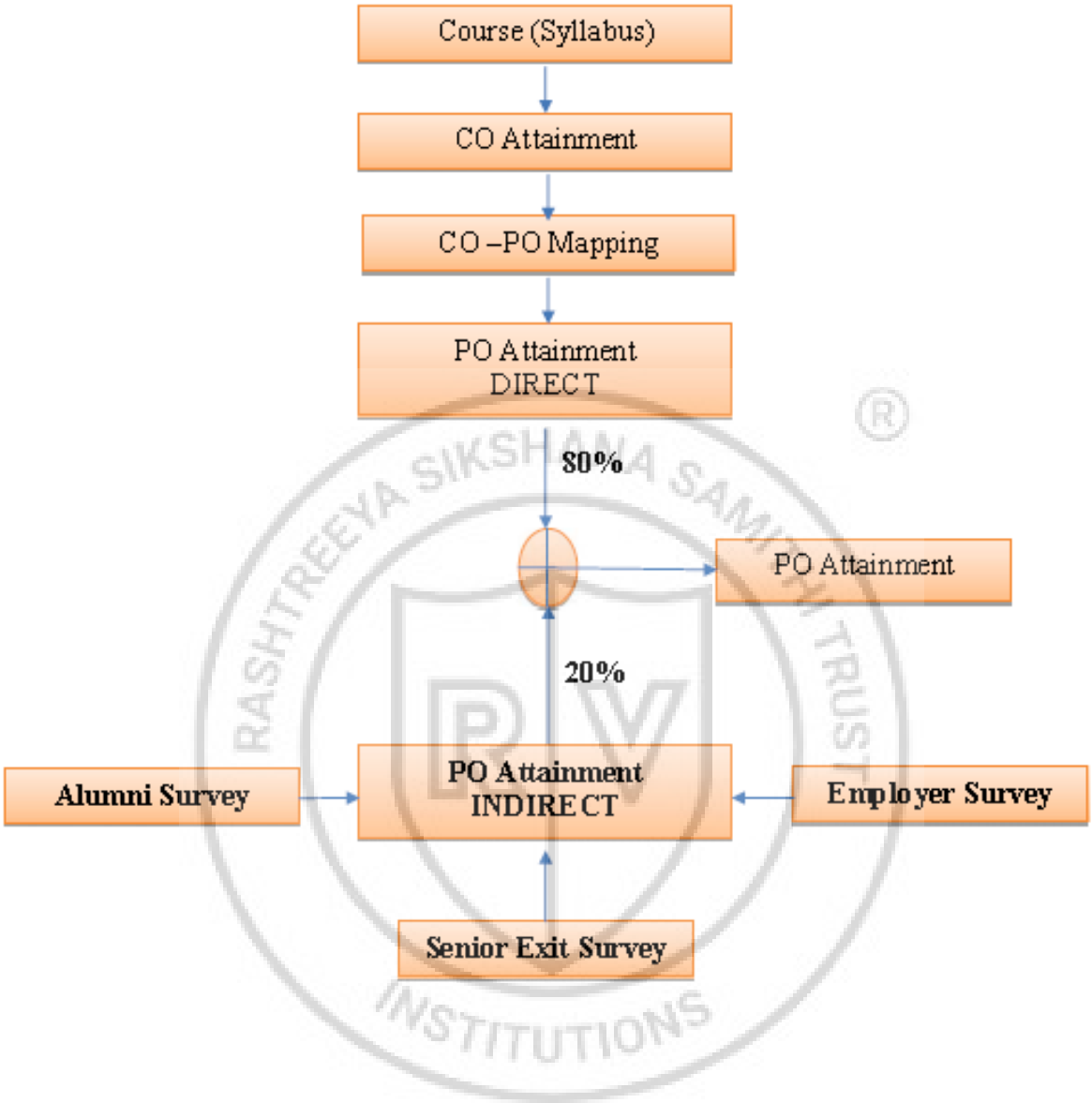
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



KNOWLEDGE & ATTITUDE PROFILE

- **WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- **WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- **WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- **WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- **WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
- **WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
- **WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
- **WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
- **WK9:** Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAM OUTCOMES (POs)

- **PO1:** Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- **PO2:** Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- **PO3:** Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- **PO4:** Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- **PO5:** Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- **PO6**: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- **PO7:** Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- **PO8:** Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- **PO9:** Communication: Communicate effectively and inclusively within the community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
- **PO10:** Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- **PO11:** Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

INNOVATIVE TEAMS OF RVCE

Ashwa Mobility Foundation (AMF): Designs and fabricates Formula-themed race cars and mobility solutions to address urban transportation issues.

Astra Robotics Team: Focuses on designing and building application-specific robots.

Coding Club: Helps students gain coding skills and succeed in competitions like GSoC and ACM-ICPC.

Entrepreneurship Development Cell (E-Cell): Promotes entrepreneurship through workshops, speaker sessions, and mentoring for startups.

Frequency Club Team: Works on software and hardware, emphasizing AI and Machine Learning.

Team Garuda: Develops a supermileage urban concept electric car and E-mobility products.

Team Jatayu: Builds low-cost UAVs with autonomous capabilities for various tasks.

Solar Car Team: Aims to create a solar electric vehicle for sustainable transportation.

Team Antariksh: Focuses on space technology and the development of operational rockets.

Team Chimera: Builds a Formula Electric Car through R&D in E-Mobility.

Helios Racing Team: Designs and tests All-Terrain Vehicles, participating in SAE's BAJA competitions.

Team Hydra: Develops autonomous underwater vehicles for tasks like water purification.

Team Krushi: Creates low-cost farming equipment to assist farmers in cultivation and harvesting.

Team Vyoma: Designs and tests radio-controlled aircraft and UAVs.

Team Dhruva: Engages in astronomy-related activities and collaborates on projects with organizations like ICTS and IIA.

Ham Club: Promotes Amateur Radio and explores technical innovations in communications, especially for disaster response.

Cultural Activity Teams

1. AALAP (Music club)
2. DEBSOC (Debating society)
3. CARV (Dramatics club)
4. FOOTPRINTS (Dance club)
5. QUIZCORP (Quizzing society)
6. ROTARACT (Social welfare club)
7. RAAG (Youth club)
8. EVOKE (Fashion team)
9. f/6.3 (Photography club)
10. CARV ACCESS (Film-making

NSS of RVCE

NCC of RVCE

VISION

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

MISSION

- To deliver outcome based Quality education, emphasizing on experientiallearning with the state of the art infrastructure.
- To create a conducive environment for interdisciplinary research and innovation.
- To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
- To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
- 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