RV College of Engineering®

Master of Technology (M.Tech) in BIOTECHNOLOGY (MBT)

Scheme And Syllabus Of I & IV Semester
(2022 Scheme)

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

2024

96TH
NIRF RANKING IN ENGINEERING (2023)

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)

17
Centers of Excellence

11
Centers of Competence

1381
Publications On Web Of Science

397
Publications On Web Of Science

1699
Citations

78
Patents Filed

38
Patents Granted

11
Skill Based Laboratories Across Four Semesters

58
Published Patents

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.

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

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

Go, change the world

Master of Technology in

BIOTECHNOLOGY

SCHEME & SYLLABUS of I TO IV SEMESTER

2022 SCHEME

Glossary of Abbreviations

1.	AS	Aerospace Engineering
2.	BS	Basic Sciences
3.	BT	Biotechnology
4.	CH	Chemical Engineering
5.	CHY	Chemistry
6.	CIE	Continuous Internal Evaluation
7.	CS	Computer Science & Engineering
8.	CV	Civil Engineering
9.	EC	Electronics & Communication Engineering
10.	EE	Electrical & Electronics Engineering
11.	EI	Electronics & Instrumentation Engineering
12.	ET	Electronics & Telecommunication Engineering
13.	GE	Global Elective
14.	HSS	Humanities and Social Sciences
15.	IM	Industrial Engineering & Management
16.	IS	Information Science & Engineering
17.	L	Laboratory
18.	MA	Mathematics
19.	MBT	M. Tech in Biotechnology
20.	MCE	M. Tech. in Computer Science & Engineering
21.	MCN	M. Tech. in Computer Network Engineering
22.	MCS	M. Tech. in Communication Systems
23.	MDC	M. Tech. in Digital Communication
24.	ME	Mechanical Engineering
25.	MHT	M. Tech. in Highway Technology
26.	MIT	M. Tech. in Information Technology
27.	MMD	M. Tech. in Machine Design
28.	MPD	M. Tech in Product Design & Manufacturing
29.	MPE	M. Tech. in Power Electronics
30.	MSE	M. Tech. in Software Engineering
31.	MST	M. Tech. in Structural Engineering
32.	MVE	M. Tech. in VLSI Design & Embedded Systems
33.	N	Internship
34.	P	Projects (Minor / Major)
35.	PHY	Physics
36.	SDA	Skill Development Activity
37.	SEE	Semester End Examination
38.	T	Theory
39.	TL	Theory Integrated with Laboratory
40.	VTU	Visvesvaraya Technological University

POSTGRADUATE PROGRAMS

Sl. No	Core Department	Program	Code
1.	BT	M. Tech in Biotechnology	MBT
2.	CS	M. Tech in Computer Science & Engineering	MCE
3.	CS	M. Tech in Computer Network Engineering	MCN
4.	CV	M. Tech in Structural Engineering	MST
5.	CV	M. Tech in Highway Technology	MHT
6.	EC	M. Tech in VLSI Design & Embedded Systems	MVE
7.	EC	M. Tech in Communication Systems	MCS
8.	EE	M. Tech in Power Electronics	MPE
9.	ET	M. Tech in Digital Communication	MDC
10.	IS	M. Tech in Software Engineering	MSE
11.	IS	M. Tech in Information Technology	MIT
12.	ME	M. Tech in Product Design & Manufacturing	MPD
13.	ME	M. Tech in Machine Design	MMD

DEPARTMENT OF BIOTECHNOLOGY

VISION

A premier department in Biotechnology Education, Research and Innovation with a focus on sustainable technologies for the benefit of society and environment.

MISSION

1. Create state-of-the-art infrastructure for research and training in Biotechnology.
2. Develop graduates who are ethical and socially concerned.
3. Promoting collaboration with academia, industries and research organizations at National and International level.
4. Contribute to socioeconomic development through sustainable and inclusive technologies

PROGRAMME OUTCOMES (PO)

M. Tech in **Biotechnology** graduates will be able to:

PO1: Independently carry out research/investigation and development work to solve problems related to biotechnological sector

PO2: Write and present a substantial technical report/document in the fields of health, pharma, bioprocess, food and Agriculture.

PO3: Apply advanced tools and techniques to design and formulate the solutions for various biotechnological challenges

PO4: Collaborate with the confluence of various domains of Biotech from academic, industry and research institutes of national or international repute, with the commitment to lifelong learning

PO5: Design and develop projects related to biotechnological and allied branches keeping performance and cost constraints into consideration.

PO6: Apply bioengineering solutions to societal and ethical needs with focus on sustainability

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19	MHS191	Professional Skills Development-II	-

M.Tech in Biotechnology: MBT

I SEMESTER M.Tech

Sl. No.	Course Code	Course Title	Credit Allocation L	T/ SDA	P	Total	BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
1	MMA201T	Computational Mathematics	3	1	0	4	MA	Theory	1.5	100	3	100
2	MBT401I	Molecular Biology and Genetic Engineering	3	0	1	4	BT	Theory+Lab	1.5	100	3	100
3	MBT301T	Computational Genomics and Proteomics	3	1	0	4	BT	Theory	1.5	100	3	100
4	MBT402L	Bioanalytical Laboratory	1	0	1	2	BT	Lab	1.5	50	3	50
5	MBTXXXAX	Elective A (Professional Elective)	3	0	0	3	BT	Theory	1.5	100	3	100
6	MBTXXXBX	Elective B (Professional Elective)	3	0	0	3	BT	Theory	1.5	100	3	100

Note: For the course code 22HSS42, Students need to select one ONLINE MOOC course as recommended by HSS BoS. This course can be selected anytime between I to III semester and it will be evaluated during IV semester.

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Code	Elective A (Professional Elective)	Code	Elective B (Professional Elective)
MBT403A1	Stem Cell and Tissue Engineering	MBT302B1	Human Diseases and Diagnostics
MBT201A2	Enzyme Technology	MBT204B2	Principles of Bioprocess Engineering
MBT202A3	Insilico drug discovery	MBT303B3	Systems Biology
MBT203A4	Food Engineering	MBT304B4	Industrial Biotechnology

II SEMESTER M.Tech

Sl. No.	Course Code	Course Title	Credit Allocation L	T/ SDA	P	Total	BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
1	MIM431T	Research Methodology	3	0	0	3	IM	Theory	1.5	100	3	100
2	MBT431I	Upstream Process Technology	3	0	1	4	BT	Theory+Lab	1.5	100	3	100
3	MBT331T	Pharmaceutical Technology	3	0	0	3	BT	Theory	1.5	100	3	100
4	MBTXXXCX	Elective C (Professional Elective)	3	0	0	3	BT	Theory	1.5	100	3	100
5	XXXXXXGX	Elective G (Global Elective)	3	0	0	3	Res. BoS	Theory	1.5	100	3	100
6	MBT433P	Biopython Lab	1	0	1	2	BT	Lab	1.5	50	3	50
7	MHS131T	Professional Skills Development-I	2	0	0	2	HSS	Theory*	1.5	50	2	50

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Code	Elective C (Professional Elective)
MBT432C1	3D Bioprinting
MBT332C2	Fermentation Technology
MBT333C3	Parenteral Formulations
MBT334C4	Agriculture Biotechnology and Crop Improvement

Elective D (Global Elective)			
MBT331G	Bioinspired Engineering	MET331G	Tracking and Navigation Systems
MBT332G	Health Informatics	MIM331G	Project Management
MCS331G	Business Analytics	MIS331G	Database and Information Systems
MCV331G	Industrial and Occupational Health and Safety	MIS332G	Management Information Systems
MCV332G	Intelligent Transportation Systems	MMA331G	Statistical and Optimization Methods
MEC331G	Electronic System Design	MME331G	Industry 4.0
MEC332G	Evolution of Wireless Technologies		

III SEMESTER M.Tech

Sl. No.	Course Code	Course Title	Credit Allocation L	T/ SDA	P	Total	BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
1	MBT461T	Downstream Process Technology	3	1	0	**4**	BT	Theory	1.5	100	3	100
2	MBTXXXDX	Elective E (Professional Elective)	3	1	0	**4**	BT	Theory	1.5	100	3	100
3	MBT461N	Internship	0	0	6	**6**	BT	Internship	1.5	50	3	50
4	MBT461P	Minor Project	0	0	6	**6**	BT	Project	1.5	50	3	50

Code	Elective E (Professional Elective)
MBT361D1	Immunotechnology
MBT261D2	Next Generation Sequencing
MBT362D3	Design and drawing of bioreactors
MBT363D4	Toxicology in Life Sciences

IV SEMESTER M.Tech

Sl. No.	Course Code	Course Title	Credit Allocation L	T/ SDA	P	Total	BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
1	MBT491P	Major Project	0	0	18	**18**	BT	Project	1.5	100	3	100
2	MHS191	Professional Skills Development-II	2	0	0	**2**	HSS	NPTEL	--	50	ONLINE	50
Student need to submit the certificate for the evaluation of Course code 22HSS42												

SEMESTER: I						
Course Code	:	MMA201T	**COMPUTATIONAL MATHEMATICS**	CIE Marks	:	100
Credits L-T-P	:	3 - 1 - 0		SEE Marks	:	100
Hours	:	42L+28T	*Common Course (MPD, MMD, MPE, MBT, MST, MHT)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. A Sujatha			

UNIT - I	**09 Hrs**
Vector Spaces and Orthogonality: Vector spaces and subspaces, linear independence, basis and dimension, four fundamental subspaces, change of basis. Inner product, orthogonal vectors, orthogonal projections, orthogonal bases. Eigen subspaces, Gram-Schmidt orthogonalization process, QR factorization and singular value decomposition.	
UNIT - II	**09 Hrs**
Multiple Random variables: Joint probability mass functions and probability density functions, marginal density function, conditioning of random variables, statistical independence, correlation and covariance functions, covariance and correlation matrices, transformation of random variables, Markov and Chebyshev inequalities, Gaussian distribution-Multivariate normal density and its properties.	
UNIT - III	**08 Hrs**
Principal component analysis and Factor analysis: Overview of principal component analysis and factor analysis, eigen structure of covariance or correlation matrix. Principal component-standardized variables, covariance matrices. Factor model-principal component method, maximum likelihood method, factor scores, factor rotation.	
UNIT - IV	**08 Hrs**
Engineering optimization: Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, constraint qualification.	
UNIT - V	**08 Hrs**
Numerical solution of differential equations: Boundary value problems–finite difference method for linear and nonlinear problems, shooting method and Galerkin method. Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations.	

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

CO1	:	Illustrate the fundamental concepts of distributions, linear algebra, differential equations and optimization arising in various fields engineering.
CO2	:	Derive the solution by applying the acquired knowledge and skills of statistical/numerical/optimization techniques to solve problems of probability distributions, linear algebra and differential equations.
CO3	:	Evaluate the solution of the problems using appropriate statistical numerical and optimization techniques to the real world problems arising in many practical situations.
CO4	:	Compile the overall knowledge of probability distributions, linear algebra and optimization methods gained to engage in life – long learning.

Reference Books

1. Richard A Johnson and Dean W Wichern, "Applied Multivariate Statistical Analysis", Pearson Prentice Hall, 6th Edition, 2007, , ISBN-13: 978-0-13-187715-3, ISBN-10: 0-13-187715-1.

2. Gilbert Strang, "Linear Algebra and its Applications", Cengage Learning, 4th Edition, 2006, ISBN 97809802327.

3. Edgar G. Goodaire "Linear Algebra: Pure & Applied Kindle Edition", World Scientific, 1st Edition, 2013, ISBN-13: 978-9814508360.

4. M K Jain, S. R. K. Iyengar, R. K. Jain; Numerical methods for scientific and engineering computation; New Age International Publishers; 6th edition; 2012; ISBN-13: 978-81-224-2001-2.

5. Singiresu S. Rao, Engineering Optimization Theory and Practice, New Age International (P)Ltd., 3rd edition, ISBN: 81-224-1149-5.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT401I	**MOLECULAR BIOLOGY & GENETIC ENGINEERING**	CIE Marks	:	100
Credits L-T-P	:	3-0-1		SEE Marks	:	100
Hours	:	42L + 28P	*Theory & Practice - (Professional Core - 1)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr H G Ashok kumar			

UNIT - I	**9 Hrs**
Central Dogma of Molecular Biology: Replication, Transcription and Translation: Molecular structure of genes and chromosomes, Replication: Mechanism of Initiation, elongation and termination in prokaryotes and eukaryotes. DNA damage and repair: Photoreactivation, Nucleotide excision repair, Mismatch repair, SOS repair. Recombination: Homologous and non- homologous, site-specific recombination. Transcription in prokaryotes and eukaryotes. Promoters and enhancers,Structure and function of different types of RNA and mRNPs. Processing and export of mRNA, Translation in prokaryotes and eukaryotes. Regulation of Translation: Global vs mRNA-specific. Translation inhibitors, Posttranslational modifications of proteins. Protein trafficking and transport.	
UNIT - II	**9 Hrs**
Gene regulation: Gene regulation and Operon concept, Constitutive, Inducible and Repressible systems; Operators and Regulatory elements; Positive and negative regulation of operon: lac, trp, ara, his, and gal. RNAi technology: siRNA and miRNA mediated gene silencing, antisense technology. Genome editing: Clustered regularly interspaced short palindromic repeats (CRISPR)/Cas systems, Zinc finger nucleases, Transcription activator-like effector nuclease (TALENS). Mechanism of action of synthetic Riboswitches. Omics, Interrelationships of omic disciplines. Identifying genes of interest through genomic studies. BioCyc databases.	
UNIT - III	**8 Hrs**
Components of rDNA technology: Isolation and purification of DNA (genomic and plasmid) and RNA. Chemical synthesis of DNA: Phosphoramidite method, use of synthesized oligonucleotides. Labelling nucleic acids: Radioactive and non-radioactive, end labelling, nick translation, primer extension. Nucleic acid hybridization, Gel electrophoresis. Restriction enzymes, DNA modifying enzymes (Nucleases, Polymerases), DNA ligases. Host cells: Prokaryotic and eukaryotic hosts. Vectors: plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, Ri plasmids, Yeast Episomal Plasmids (YEPs), Yeast integrative plasmids (Yips), Yeast replicative plasmids, Bacmids, Yeast Artificial Chromosome (YAC), mammalian and plant expression vectors, Gate-way vector,	
UNIT - IV	**8 Hrs**
Genetic Transformation and Cloning strategies:Genetic transformation and transfection, Alternative DNA deliver methods: Electroporation, microinjection, biolistic. Cloning from mRNA: synthesis of cDNA, cloning cDNA in plasmid vectors, cloning cDNA in bacteriophage vectors. Cloning from genomic DNA: Genomic libraries, preparation of DNA fragments for cloning, ligation, packaging, and amplification of libraries. Expression of cloned DNA molecules, Cloning large DNA fragments in BAC and YAC vectors.	
UNIT - V	**8 Hrs**
Selection, Screening, and analysis of Recombinants: Genetic selection and screening methods: Using chromogenic substrates, Insertional inactivation, Complementation of defined mutation, other genetic selection methods. Screening using nucleic acid hybridization: Nucleic acid probes, Screening clone banks. Screening using PCR, Immunological screening for expressed genes. Analysis of cloned genes: Characterization based on mRNA translation in vitro, Restriction mapping, Blotting techniques, DNA sequencing.	
LABORATORY	**28 Hrs**
1. Isolation and purification of genomic DNA from prokaryotic/ eukaryotic cells 2. Isolation and purification of plasmid DNA 3. Isolation and purification of total RNA 4. Restriction digestion of DNA 5. Preparation of competent cells of E.coli and genetic transformation of E.coli 6. Constructing recombinant DNA using gene of interest and vector 7. Agrobacterium mediated genetic transformation of plants 8. Amplification of DNA fragments using PCR 9. CRISPR/Cas9 genome editing technique. 10. SDS-PAGE for separation of proteins.	

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

CO1	:	Elucidate the mechanism of central dogma of molecular biology, and recombinant DNA technology
CO2	:	Use recombinant DNA technology for genetic manipulation of prokaryotes and eukaryotes.
CO3	:	Analyze and evaluate recombinant proteins/compounds, and genetically modified organisms.
CO4	:	Design/develop suitable protocol/technique for production of genetically modified organisms or heterologous proteins/compounds in living system, and interpret the results.

Reference Books

1. Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Martin K, Yaffe A, and Amon A, Molecular Cell Biology,9th edition,W.H. Freeman, 2021, ISBN: 9781319208523.

2.Glick BR and Patten CL, Molecular Biotechnology – Principles and applications of recombinant DNA, 6th Edition, ASM Press, 2022. ISBN-1683673662

3. Brown TA, Gene Cloning and DNA Analysis – An Introduction, 8th Edition, Wiley-Blackwell Science,2020, ISBN: 978-1-119-64078-3.

4. Clark DP and Pazdernik NJ, Biotechnology, 2nd Edition, Academic Cell, 2015, ISBN-13: 978-0123850157

Scheme of Continuous Internal Evaluation (CIE): 10 + 30 + 30 + 30 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The average of two quizzes will be the Final Quiz marks.

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 30 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (10), Video based seminar /presentation /demonstration (20) adding upto 30 marks.

Laboratory: Conduction of laboratory exercises, Lab report & observation & analysis (30 Marks), Lab Test (10 Marks) & Innovative Experiment/Concept Design & Implementation (10 Marks) adding up to 50 Marks. The final marks will be reduced to 30 Marks.

Scheme of Semester End Examination (SEE) for 100 marks: Each unit consists of TWO Questions of 16 Marks each. Answer FIVE full questions selecting one from each unit (from 1 to 5). Question No. 11 is compulsory (Laboratory component) for 20 Marks.

Rubric for CIE & SEE for Integrated Theory courses with Laboratory

RUBRIC of CIE			***RUBRIC of SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	10	Each unit consists of TWO questions of 16 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5). Question No. 11 is compulsory (Laboratory component) for 20 Marks.		
2	Tests - T1 & T2	30			
3	Experiential Learning - EL1 & EL2	30	1 & 2	Unit-1: Question 1 or 2	16
4	Laboratory	30	3 & 4	Unit-2: Question 3 or 4	16
	Total Marks	100	5 & 6	Unit-3: Question 5 or 6	16
NO SEE for Laboratory			7 & 8	Unit-4: Question 7 or 8	16
			9 & 10	Unit-5: Question 9 or 10	16
			11	Laboratory Component (Compulsory)	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT301T	**COMPUTATIONAL GENOMICS & PROTEOMICS**	CIE Marks	:	100
Credits L-T-P	:	3 - 1 - 0		SEE Marks	:	100
Hours	:	42L + 28T	*(Professional Core - 1)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Shivandappa			

UNIT - I	**9 Hrs**
Introduction: Introduction to Computational Genomics & Proteomics. Structure, Organization and features of Prokaryotic & Eukaryotic genomes. Introduction to sequencing – DNA sequencing methods - Maxam-Gilbert Method, Sanger Dideoxy method, Fluorescence method, shot-gun approach and Microarray based sequencing. 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. NGS databases – Zenodo, SRA, ENA,SRA and GEO. Accessing and Retrieval of NGS Data - SRA toolkit and Aspera connect.	
UNIT - II	**9 Hrs**
Genome annotation: Computing Needs for NGS – Data storage, transfer, Computing power, Software needs and Bioinformatics Skills. NGS Data Analysis: Base calling and quality score, Data Quality Control and Preprocessing, Reads Mapping – Mapping approaches and algorithms - BWT. Basic sequence alignment algorithms – Needleman and Wunch, Smith and Waterman, BLAST and PSI-BLAST and FASTA. Gene prediction - Extrinsic, Intrinsic Signals. Algorithms - Exon chaining and Hidden Morkov Models.	
UNIT - III	**8 Hrs**
Introduction to proteomics, Clinical and biomedical applications of proteomics. Methods of Proteomics: Edman degradation, mass fingerprinting, protein synthesis and post translational modifications. Identification of phosphorylated proteins, characterization of multiprotein complexes, protein - protein interactions (Immunoprecipitation) and quantitative proteomics- Characterization of interaction clusters using two-hybrid systems. Protein arrays and applications of protein arrays - diagnostics, expression profiling, functional proteomics and Protein structure analysis.	
UNIT - IV	**8 Hrs**
Functional annotation of Proteins: Introduction, Protein sequence databases, UniProt, UniProtKB – Sequence curation, Sequence annotation, Functional annotation, annotation of protein structure, post-translational modification, protein-protein interactions and pathways, annotation of human sequences and diseases in UniProt and UniProtKB. Protein family classification for functional annotation – Protein signature methods and Databases, InterPro, InterProScan for sequence classification and functional annotation. Annotation from Genes & Protein to Genome & Proteome.	
UNIT - V	**8 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.	

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

CO1	:	Understand the construction concepts of various genome maps and large scale sequencing
CO2	:	Develop diagnostic tools for plant, animal and human diseases.
CO3	:	Understand how proteomics application in biological research can benefit in solving the complex biological and biochemical processes regardless of the type of organism
CO4	:	Analyse dynamic models to understand the regulatory networks at cellular level

Reference Books

1. Choi. S, Systems Biology for Signaling Networks, kindle edition, Springer, New York,2010. ISBN 978-1-4419-5796-2

2. Kriete A, Eils R. Computational Systems Biology: From Molecular Mechanisms to Disease:, 2nd Edition , Academic Press, 2013. ISBN 978-0-12-405926-9

3. Klipp E, HerwigR,Kowald A, Wierling C, Lehrach H, Systems biology in practice: concepts, implementation and application, 1st edition, Wiley-VCH Verlag GmbH &Co.KGaA,Weinhein, 2005,ISBN 978-3-527-31078-4

4. Rowe G. Theoretical Models in Biology, 1st edition, Oxford University Press, Oxford 1994. ISBN 0 19 859687 1.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT402L	**BIOANALYTICAL LABORATORY**	CIE Marks	:	50
Credits L-T-P	:	1-0-1		SEE Marks	:	50
Hours	:	14L + 28P	*(Coding / Skill Laboratory)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Ashwani Sharma, Dr A V Narayan and Dr Sumathra M			

Content	**28 Hrs**
1)Detection of adulterants in different food products 2)Identification of biomolecules in any biological sample using HPLC 3)Identification of biomolecules in any sample using GC 4)Sensory Evaluation- Organoleptic analysis Identification Test 5)Detection of non-permitted food additives in market food samples 6)Synthesis of Silver Nanoparticle and its Particle Size Analysis 7)Identifying hair as evidence in forensics 8)Blood sample analysis: microscopic to molecular analysis 9) Analysis of macro and micronutrients (NPK) in soil ash 10) kinetic analysis of enzyme	

Course Outcomes:

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

CO1	:	Understand the basic principles and mechanism of Bioanalytics
CO2	:	Apply the knowledge of various principles in day to day life
CO3	:	Sustain and comprehend various principle for the varied application
CO4	:	Adapt and inculcate to the fast changing technology for better future

Reference Books

1. Keith Wilson and John Walker,Principles and techniques of biochemistry and molecular biology.7th Edition,Cambridge University Press, Cambridge, UK., 2009,ISBN:978-0-521-51635-8

2. Ghosal, Sabari and Avasthi Anupama Sharma, Fundamentals of Bioanalytical Techniques and Instrumentation, 2nd edition, PHI Learning Pvt. Ltd., 2018, 938747240X, 789387472402

3. Rajan Katoch, Analytical Techniques in Biochemistry and Molecular Biology, 1st edition, Springer, 2011, ISBN 978-1-4419-9784-5

4. Vasudevan Ramesh, Biomolecular and Bioanalytical Techniques, 1st edition, Wiley, 2019, , ISBN: 9781119483960

Scheme of Continuous Internal Evaluation (CIE- Laboratory) : Only LAB Course 30 + 10 + 10 = 50. The Laboratory session is held every week as per the timetable and the performance of the student is evaluated in every session. The average of marks over number of experiments conducted over the weeks is considered for 30 Marks i.e (Lab Report, Observation & Analysis). The students are encouraged to implement additional innovative experiments in the lab (10 marks). At the end of the semester a test is conducted for 10 Marks (Lab Test). This adds to 50 Marks.

Scheme of Semester End Examination (SEE- Laboratory) : Only LAB Course 40 + 10 =50. Students will be evaluated for Write-up, Experimental Setup, Experiment Conduction with Results, Analysis & Discussions for 40 Marks and Viva will be conducted for 10 Marks adding to 50 Marks.

Only LAB Courses with 50 Marks

RUBRIC FOR CIE			RUBRIC FOR SEE	
Sl.No	Content	Marks	Content	Marks
1	Write Up, Setup, Conduction Results, Analysis & Discussions	30	1. Write Up, Setup, Conduction 2. Results, Analysis & Discussions	40
2	Innovative Experiment/Concept Design & Implementation	10		
3	Laboratory Internal	10	Viva Voce	10
	Total Marks	50	Total Marks	50

SEMESTER: I						
Course Code	:	MBT403A1	**STEM CELL and TISSUE ENGINEERING**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*(Professional Elective A)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Raju H			

UNIT - I	**9 Hrs**
Stem Cells: Concepts and Types of Stem cells: Embryonic, Adult and Induced stem cells. Embryonic stem cells: Pluripotent, Totipotent and Multipotent cells. Adult stem cells: Hematopoietic, Neural stem cells, Epidermal and Epithelial stem cell.	
UNIT - II	**9 Hrs**
Growth and applications of stem cells: Cell culture methods, Cell isolation, selection, maintenance of primary and early passage cultures. Clinical potential of stem cells: Organ and tissue regeneration, cardiovascular treatment, Cell deficiency therapy, treatment of any brain related defects.	
UNIT - III	**8 Hrs**
Introduction to Tissue Engineering: History and scope of tissue engineering. The isolation and handling of human and animal tissue. The major methods of preparing a primary culture. Introduction to cell adhesion: cell–cell adhesion, cell–matrix adhesion and signalling, cell proliferation, and differentiation.	
UNIT - IV	**8 Hrs**
Basic growth and Differentiation of Tissues: Morphogenesis and tissue engineering-gene expression, cell determination and differentiation. In vitro control of tissue development: In vitro culture parameters, growth factors, mechanobiology, tissue development and organ engineering. In vivo synthesis of Tissue and Organs.	
UNIT - V	**8 Hrs**
Tissue engineering for tissue regeneration: Using bone marrow mesenchymal stem cells (MSCs) and adipose derived stem cells (ASCs). Therapeutic strategy for repairing the injured spinal cord using stem cells. Wound and Disc repair using stem cells. Engineering of tissues: cartilage, bone and skin. Biomaterials in tissue engineering.	

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

CO1	:	Understand the importance of stem cell, characteristics and tissue functions for specialized applications
CO2	:	Compare various kinds of stem cells and tissues used for regeneration purpose.
CO3	:	Interpret the methods used in organ regeneration.
CO4	:	Apply techniques for growth of stem cells, and repairing various kinds of tissues.

Reference Books

1. Song Li, Nicolas L' Heureux and Jennifer Elisseeff, Stem cell and Tissue Engineering, 1st edition, World Scientific Publications, 2011, ISBN-13: 978-981-4317-05-04

2. R Lanza, Langer R and Vacanti J, Principles of Tissue Engineering, 5th edition, Elsevier, 2020. ISBN: 9780128184226

3. John P. Fisher, A G Mikos and Joseph D Bronzino, Tissue Engineering. 1st edition, CRC Press. 2019. ISBN: 9780367389055

4. JD Bronzino, Taylor and Francis, Tissue Engineering and Artificial organs, 4th edition, CRC Press, 2016, ISBN: 0849321239.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT201A2	**ENZYME TECHNOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*(Professional Elective A)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Trilokchandran B			

UNIT - I	**9 Hrs**
Introduction to Enzymes- Nomenclature and classification, Application of enzymes in process industriesand health care. Enzymes as biocatalysts: advantages and disadvantages over chemicalcatalysts and characteristics, microbial production and purification of enzymes, Assay of enzyme activity and specific activity, Coenzymes, Cofactors	
UNIT - II	**8 Hrs**
Principles of enzyme catalysis; activation energy, mechanisms of enzyme action, Michaelis-Menten kinetics; enzymes: methods, mass transfer considerations; Production of Industrial enzymes.	
UNIT - III	**9 Hrs**
Enzyme Immobilization: methods, Activity & kinetics of immobilized enzymes; applications of immobilized enzyme technology-: Enzyme sensors for clinical analysis, therapeutic medicine, Environmental applications. Economic argument for immobilization,therapeutic, diagnostic and industrial applications of enzyme inhibitors.Large scale extraction and purification of enzymes	
UNIT - IV	**8 Hrs**
Enzyme Immobilization: methods, Activity & kinetics of immobilized enzymes; applications of immobilized enzyme technology-: Enzyme sensors for clinical analysis, therapeutic medicine, Environmental applications. Economic argument for immobilization,therapeutic, diagnostic and industrial applications of enzyme inhibitors.Large scale extraction and purification of enzymes	
UNIT - V	**8 Hrs**
Enzyme Engineering, Improved kinetic properties, Elimination of allosteric regulation,Enhanced substrate and reaction specificity, Increasedthermostability, Alteration in optimal pH, Suitability for use inorganic solvents,(vii) increased/decreased optimal temperature, etc.	

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

CO1	:	Understand the importance of enzymes and its applications
CO2	:	Apply the principles and properties involved in enzymatic actions
CO3	:	Interpret the large scale industrial applications of enzymes
CO4	:	Design and devlop enzymes for diagnostic applications

Reference Books

1. S. Shanmugam,Enzyme Technology, 1st Edition,I. K. International Pvt Ltd,2009, ISBN: 9789380026053

2. Klaus Buchholz, Uwe Theo Bornscheuer, and Volker Kasche, Biocatalysts and Enzyme Technology, 2nd edition,Wiley, 2012,ISBN: 978-3-527-32989-2

3. Prasad Nooralabettu Krishna,Enzyme Technology: Pace maker of Biotechnology,1st edition, PHI Learning Pvt., 2011, ISBN:9788120342392

4. Mohammed Kuddus, Cristobal AguilarValue-Addition in Food Products and Processing Through Enzyme Technology,1st Edition, Elsevier,2021, ISBN:9780323899291

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT202A3	**INSILICO DRUG DISCOVERY**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*(Professional Elective A)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Vidya Niranjan			

UNIT - I **9 Hrs**

Computer - Assisted Drug Discovery: Drug Discovery and Development process. Compound searching, Target Identification, Target characterisation, Study of molecular interactions between target and compound (docking), ADMET Studies and Study of drug resistance. Drug design process for a known protein target – Structure based drug design process, Finding initial hits, Compound refinement, ADMET Studies and Study of drug resistance. Drug design process for unknown protein target – Ligand based drug design process, Finding initial hits and Compound refinement.

UNIT - II **9 Hrs**

Structure Generation, Retrieval, Structure Visualization. Homology modeling - Constructing an initial model, Refining the model, Manipulating the model,
Navigation of the model. Model evaluation – Model evaluation techniques, Concept of energy minimization and Energy minimization techniques. Conformation generation, Deriving bioactive conformations, Molecular superposition and alignment, Deriving the Pharmacophoric pattern, Receptor mapping and estimating biological activities. Structural similarities and Superimposition techniques.
Rational Drug Design and Chemical Intuition, Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition.

UNIT - III **8 Hrs**

Molecular Mechanics and Docking Force fields for drug design. Study of protein folding: Algorithms, Conformation analysis. Docking: Introduction, Search algorithms, Scoring functions, Docking Process – Protein Preparation, Building the ligand, Setting the bounding box, Running the docking calculations. Building the Pharmacophore Models: Components of Pharmacophore model, Creating a Pharmacophore model from active compounds, Creating Pharmacophore model from Active site and Searching compound databases.

UNIT - IV **8 Hrs**

Molecular dynamic simulations. Force field and minimization, classical thermodynamics, thermal equilibrium, probability distributions and thermodynamic averaging, statistical ensembles and fluctuations, Hamiltonian and sampling, Integrators. numerical integration, accuracy, and stability, classical potentials and force fields and periodic , implementation of thermo stats and barostats. Sampling for different ensembles, thermodynamic properties: free energy, heat capacity estimation . MMGBSA and free energy calculations. Applications and case studies

UNIT - V **8 Hrs**

QSAR: Conventional QSAR vs 3D-QSAR, QSAR Process, Molecular descriptors, Automated QSAR Programs. 3D-QSAR – 3D-QSAR Process. Quantum Mechanics algorithms in Drug design, ADMET and Toxicity studies. New Lead Discovery Strategies. Composition of Drug Discovery teams, Current Practice of CADD in the Pharmaceutical industry,
Management structures of CADD groups, Contributions and achievements of CADD groups, Limitations of CADD support, Inherent Limitations of CADD support. State of Current Computational Models, Software and Hardware constraints

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

CO1	:	Demonstrate the knowledge of physical and chemical properties of pharmacological compounds
CO2	:	Apply the drug designing methods for screening and inventing the new targets and drugs.
CO3	:	Estimate the relevant drug capabilities of known and unknown compounds
CO4	:	Equip with the drug design skills and patenting ability and spread awareness about the compounds

Reference Books

1. Kristian Stromgaard, Povl Krogsgaard-Larsen, Ulf Madsen,Textbook of Drug Design and Discovery, 5th Edition,Taylor and Francis, 2017, ISBN 9781032339948

2. Mohane S. Coumar, Molecular Docking for Computer-Aided Drug Design Fundamentals, Techniques, Resources and Applications, Academic Press, 1st edition, 2021, ISBN 978-0-12-822312-3

3. Kun Zhou, Bo Liu, Molecular Dynamics Simulation, Fundamentals and Applications, Elsevier,1st edition, 2022, ISBN: 9780128164198

4. Kunal Roy Supratik Kar Rudra Narayan Das, Understanding the Basics of QSAR for Applications in Pharmaceutical Sciences and Risk Assessment, 1st edition, Academic Press, 2015, ISBN: 9780128016336

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT203A4	**FOOD ENGINEERING**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*(Professional Elective A)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr A V Narayan			

UNIT - I	**8 Hrs**
Fluid flow in Food Processing: Properties of liquid, Handling systems for Newtonian fluids, Energy equations for steady state flow of fluids, flow measurement, viscosity measurement, Flow characteristics of non-newtonian fluid	
UNIT - II	**9 Hrs**
Heat and mass transfer in food processing: modes of heat transfer, unsteady state heat transfer, mass transfer-Diffusion: steady state diffusion of gases and liquids through solids: laminar and turbulent flow over flat plate and pipe, mass transfer for flow over spherical objects.Unsteady state mass transfer: transient state diffusion and diffusion through gases	
UNIT - III	**8 Hrs**
Resource sustainability: Generation of steam, Fuel utilization, Electric power utilization, energy, water and environment	
UNIT - IV	**8 Hrs**
Food Preservation: Pasteurization and blanching systems, commercial sterilization systems, ultra high pressure systems, pulsed electric systems. Microbial survivor curves, influence of external agents, thermal death time, spoilage probability, general method for process calculation. numericals	
UNIT - V	**9 Hrs**
Food Freezing: Feezing systems: direct and indirect contact systems, frozen food properties: density, thermal conductivity, enthalpy, apparent specific heat, apparent thermal diffusitivity. Freezing time calculations: Plancks equation, Phams method. Factors influencing freezing time. numericals	

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

CO1	:	Understand and remember the principles of food processing and preservation methods
CO2	:	Apply the knowledge of heat and mass transfer in food processing systems
CO3	:	Analyze the importance of basic utilities used in food processing systems
CO4	:	Evaluate the food freezing time and to understand the different food freezing systems

Reference Books

1.R.Paul Singh and Dennis R Heldman, Introduction to Food Engineering, 5th Edition, Academic Press, Elsevier, 2017, ISBN:9780123985309

2.Zeki Berk, Food Process Engineering and Technology 1st edition, Academic Press 2009, ISBN: 978-0-12-373660-4

3.George D. Saravacos and Zacharias B. Maroulis, Food Process Engineering Operations, , 1st ed. , CRC press, Taylor and Francis, 2011, ISBN- 13: 978-1-4200-8354-5

4. Stavros Yanniotis, Solving problems in Food Engineering, 1st Edition, Springer, 2008, ISBN: 978-0-387-73513-9

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT302B1	**HUMAN DISEASES and DIAGNOSTICS**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*(Professional Elective B)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Raju H & Dr. B.G.Sudarshan			

UNIT - I	**9 Hrs**
Introduction to human diseases: Communicable disease and non-communicable disease. Genetic and congenital disease: sickle-cell anemia, hemophilia, colorblindness, down's syndrome. Deficiency disease: vitamin, hormone and mineral. Common screening methods of disease diagnosis. Environmental Health Hazards.	
UNIT - II	**9 Hrs**
Infectious Diseases: Overview of infectious diseases. Etiology, diagnosis and therapeutics of infectious diseases: Bacterial disease: pneumonia, typhoid, tuberculosis, leprosy and cholera. Viral disease: influenza, dengue, chickenpox, human immunodeficiency virus, Covid. Protozoan disease: malaria and leishmaniasis. Fungal disease: ringworm and athlete's foot.	
UNIT - III	**8 Hrs**
Diabetes Mellitus: Glucose metabolism. Type I and type II diabetes: genetic and environmental predisposition, metabolic disturbances, symptoms, diagnosis and management. Gestational diabetes. Complications of diabetes-neuropathy, retinopathy and nephropathy. Lipid metabolism, Obesity and Health Complications.	
UNIT - IV	**8 Hrs**
Cardiovascular diseases: Physiology of cardio vascular system. Causes, symptoms, diagnosis and therapeutics for ischaemic heart disease (IHD), hypertension, Coronary artery disease, atherosclerosis, rheumatic heart disease and congenital heart disease.	
UNIT - V	**8 Hrs**
Cancer: Genome instability and mutation, regulation of cell growth/proliferation, oncogenes, tumor suppressor genes, metastasis and complications. Cancer biomarkers. Diagnosis and therapeutics for cancer. Role of Virus in cancer.	

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

CO1	:	Understand the etiological factors of diseases
CO2	:	Apply the knowledge of various principles of pathophysiology of diseases
CO3	:	Illustrate techniques of diagnosis for various human diseases
CO4	:	Discuss the causes and therapeutics of various diseases

Reference Books

1. Ian Penman, Stuart H. Ralston, Mark Strachan, Richard Hobson, Davidson's Principles and practice of medicine, 24th edition, Elsevier, 2022, ISBN-13 : 978-0702083488

2. Park and Park, Textbook of Preventive and Social Medicine, 4th Edition, Jaypee Brothers, 2013, ISBN: 978-93-5090-187-8.

3. Harsh Mohan, Textbook of Pathology, 6th Edition, Jaypee Brothers Medical Publishers., 2013, ISBN 978-81-8448-702-2.

4. John Firth, Timothy Cox, Christopher Conlon, Oxford Textbook of Medicine, 6th Edition, Oxford University Press, 2020, ISBN-13 : 978-0198853435

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT204B2	**PRINCIPLES OF BIOPROCESS ENGINEERING**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*(Professional Elective B)*	SEE Duration	:	3 Hrs
Faculty Coordinator:			Dr A V Narayan and Dr Rajeswari M			

UNIT - I	**9 Hrs**
Momentum transfer: Classification of fluids, fluids in motion: Streamlines, Shear Stress, Reynolds Number. Viscosity, Non-newtonian fluids, Two-Parameter Models, Time-Dependent Viscosity, Viscoelasticity, Viscosity measurement: cone and plate viscometer, Coaxial Cylinder Viscometer, Impeller Viscometer, Use of Viscometers with Fermentation Broths, Rheological properties of fementation broth, factors affecting broth viscosity.	
UNIT - II	**8 Hrs**
Heat transfer: mechanism of heat transfer: conduction, convection, radiation, heat transfer between fluids: thermal boundary layers, individual heat transfer coefficients, Overall heat transfer coefficient, fouling factors, design equations for heat transfer system and applications of design equation. heat transfer equipments: Bioreactors, double pipe heat exchanger, shell and tube heat exchanger.	
UNIT - III	**8 Hrs**
Mass transfer: Molecular diffusion, role of diffusion in bioprocessing, oxygen uptake in cell cultures, factors affecting cellular oxygen demand, oxygen transfer from gas bubble to cell, oxygen transfer in fermenters, measuring dissolved oxygen concentrations, estimating oxygen solubility, measurement of kLa, oxygen transfer in larger vessels	
UNIT - IV	**9 Hrs**
Thermodynamics: Basic energy concepts, General energy balance equations, enthalpy calculation procedures, enthalpy change in nonreactive process, Procedure for energy balance calculatons without reacton, enthalpy change due to reaction, heat of reaction for processes with biomass production, energy balance equation for cell culture. numericals	
UNIT - V	**8 Hrs**
Reaction Engineering: Yield in cell culture, cell growth kinetics, Production kinetics in cell culture, Kinetics of substrate uptake in cell culture, determining cell kinetics parameters from batch data, effect of maintenance on yields, kinetics of cell death, numericals	

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

CO1	:	Remember the basic principles of fluid mechanics
CO2	:	Apply the principles of heat transfer to predict heat transfer coefficients and for the design of equipments
CO3	:	Analyze and solve the problems of mass transfer
CO4	:	Evaluate the enthalpy and entropy changes calculations, energy and mass balance in biological reactions

Reference Books

1. P.M. Doran; Bioprocess Engineering Principles; 2nd ed, Academic Press; 2012, ISBN:978012220851
2. Warren L. McCabe, Peter Harriott, Julian C. Smith, Unit Operations of Chemical Engineering, 7th ed, McGrawHill, 2017, ISBN: 9789355321084
3. R.K.Bansal, A Textbook of Fluid Mechanics, 2nd ed, Laxmi Publications, 2020, ISBN: 9788131802946
4. Christie John Geankoplis, Allen Hersel, Daniel H. Lepek, Transport Processes and Separation Process Principles, 5th ed, Pearson, 2018, 978-0134181028

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT303B3	**SYSTEMS BIOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*(Professional Elective B)*	SEE Duration	:	3 Hrs
Faculty Coordinator:			Dr Vidya Niranjan			

UNIT - I	**8 Hrs**
Introduction to Systems Biology: Scope, Applications of systems biology in medicine and cancer. Concepts, implementation and application. Databases for Systems Biology: BioFnet, Biomodels, Biosystems, ESCAPE, InnateDB, IPAD, Panther, SabioRK Mass Spectrometry and systems Biology: Mass analysers and working of spectrometry, Applications of Mass spectrometry in proteomics and metabolomics.	
UNIT - II	**8 Hrs**
Modeling Tools: SBML: Purpose and capabilities of SBML, Packages in SBML, Structure and modelling aspects, Integrated Imaging Informatics - ntegrin, centroid, cell culture.MathML: Basic elements of MathML, Ways of representation, MathML symbols. CellML: Structure and modelling aspects, Specifications of CellML, Petri Nets: Basic structure, Tokens and Arc, Firing of tokens, Disease modelling using petrinets. Reconstruction of metabolic network from Genome Information.	
UNIT - III	**9 Hrs**
Network Models and Applications: Natural Language Processing and Ontology enhanced Biomedical data mining, text mining. Standard platforms and applications - metabolic control analysis, glycolysis, metabolic network, Michaelis- Menten kinetics, and flux balance analysis. Signal Transduction - phosphorylation, Jak-Stat pathway, MAP kinase. Biological Processes - mitochondria, cyclin, Cdc2. Modeling of Gene Expression - lactose, lac operon, tRNA. Analysis of Gene Expression Data - support vector machines, cDNA microarray. Evolution and Self organization - hypercycle, quasispecies model, self-replication.	
UNIT - IV	**9 Hrs**
Integrated Regulatory and Metabolic Models - Phosphorylation, Gene expression, and Metabolites. Estimation Modeling and Simulation - Circadian rhythms, Petri net, mRNA. Deterministic - Circadian rhythms, mRNA, Circadian oscillations. Multi scale representations of Cells and Emerging Phenotypes - Gene Regulatory Networks, attractor, and Boolean functions.	
UNIT - V	**8 Hrs**
Multiscale representations of cells and Emerging phenotypes: Multistability and Multicellurarity, Spatio-Temporal systems biology, Cytomics – from cell state to predictive medicine. Optimization methods for De Novo Protein design. Global Gene expression assays: Microarrays and RNAseq. Mapping Genotype - Phenotype relationship in cellular networks.	

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

CO1	:	Explain conceptually systems biology using Biological data
CO2	:	Apply computational tools and techniques to solve problems in the field of Proteomics, Genomics, Cancer biology as well as Immunology
CO3	:	Analyze and evaluate High Throughput Data generated by sequencing/mapping/hybridization andother projects using Clustering and searching algorithms with case studies
CO4	:	Design and execute protocols to perform high throughput data analysis in the field of Proteomics,Genomics, Cancer biology as well as Immunology

Reference Books

1. Andres Kriete, Roland Eils, Computational Systems Biology, 2nd edition, Academic Press, 2013, ISBN:9780124059269

2. Andrzej K. Konopka, Systems Biology: Principles, Methods and Concepts, 1st edition, CRC Press, 2006, ISBN-13: 978-0824725204

3. Gustavo Caetano-Anollés, Evolutionary Genomics and Systems Biology, 1st edition, John Wiley & Sons, 2010. ISBN-13: 9781118210710

4. Huma M. Lodhi, Stephen H. Muggleton, Elements of Computational Systems Biology, 1st edition, John Wiley & Sons, 2010, ISBN-13: 9780470556740

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: I						
Course Code	:	MBT304B4	**INDUSTRIAL BIOTECHNOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*(Professional Elective B)*	SEE Duration	:	3 Hrs
Faculty Coordinator:			Dr Trilokchandran B			

UNIT - I	***m***
Introduction to industrial bio processes, Upstream and Downstream proceesing , Different types of culture media; Substrates for industrial microbial processes; Industrially important micro-organisms: Isolation, screening, Selection of mutants; Separation methods applicable to bioproducts.	
UNIT - II	**8 Hrs**
Process Technology for the production of various Products: Primary metabolite: ethanol, citric acid, vineger and amino acids; Production of alcoholic beverages: wine and beer; Secondary metabolites: Antibiotics; Process technology for the production of microbial biomass.	
UNIT - III	**8 Hrs**
Production of secondary metabolites with some case study. Production of bioplastics (PHB, PHA), bioinsecticides, bioherbicides, biopolymers and Biofertilizers	
UNIT - IV	**8 Hrs**
Process Technology for the production of various Products: Primary metabolite: ethanol, citric acid, vineger and amino acids; Production of alcoholic beverages: wine and beer; Secondary metabolites: Antibiotics; Process Technology for the production of microbial biomass.	
UNIT - V	**9 Hrs**
Technological processes for industrial manufacture of selected foods of commercial importance from plants and animal sources. Process involved in preparation of Yoghurt, acidophilus milk, cheese, bread, alcoholic beverage, vinegar and fermented food. Food packaging, Equipment involved in the commercially important food processing methods.	

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

CO1	:	Understand the importance of Industrail bioprocess
CO2	:	Apply the principles in manufacturing of industrail bioproducts
CO3	:	Interpret the large scale industrial applications of fermetation products
CO4	:	Develop and commercialization of food and food processing products.

Reference Books

1. Michael L. Shuler, Fikret Kargi ,Bioprocess Engineering: Basic Concepts, 2nd Edition,Pearson Education India, 2015, ISBN:978-9332549371

2. Wei-Shou Hu, Cell Culture Bioprocess Engineering, 2nd edition,CRC Press, 2020, ISBN:978-1498762854

3. Nurhan Turgut Dunford,Food and Industrial Bioproducts and Bioprocessing, 1st edition, 2012, John Wiley & Sons, Inc.,ISBN:9781119946083

4. Gopal Kumar Sharma, Anil Dutt Semwal, Janifer Raj Xavier, Advances in Fermented Foods and Beverages, 1st edition, NIPA ,2021,ISBN:9789390175697

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			RUBRIC for SEE		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MIM431T	**RESEARCH METHODOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Common Course to all M.Tech Programs*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. Rajeswara Rao K V S			

UNIT - I — 8 Hrs

Research Problem: Problem Solving – General Problem Solving, Logical Approach, Soft System Approach, Creative Approach, Group Problem Solving Techniques for Idea Generation. Formulation of Research Problems – Approaches to Research Problem, Exploration for Problem Identification, Hypothesis Generation and Formulation of the problem.

UNIT - II — 9 Hrs

Research Design: Experimental Design – Principles of Experiment, Laboratory Experiment, Experimental Design, Quasi Experimental Design, Action. Research, Validity and Reliability of Experiment and Quasi Experiments. Ex Post Facto Research – Exploratory Research, Historical Research, Descriptive Research, Field Studies, Survey Research, Qualitative Research Methods.

UNIT - III — 8 Hrs

Research Design for Data Acquisition: Measurement Design – Primary types of Measurement scales, Validity and Reliability Measurement, Sample Design – Non-Probability Sampling, Probability Sampling. Data Collection Procedures – Sources of secondary data, Primary data collection methods, Validity and Reliability of data collection procedures.

UNIT - IV — 9 Hrs

Data Analysis: Exploratory Data Analysis, Statistical Estimation, Hypothesis Testing, Parametric Tests, Non-Parametric Tests, Multiple Regression, Factor Analysis, Cluster Analysis

UNIT - V — 8 Hrs

Research Proposal: Purpose, Types, Development of Proposal, Evaluation of Research Proposal.
Report Writing: Pre-writing consideration, Format of Reporting, Briefing, Best practices for Journal writing.

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

CO1	:	Recognize the principles and concepts of research types, data types and analysis procedures.
CO2	:	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3	:	Express research output in a structured report as per the technical and ethical standards.
CO4	:	Develop a research design for the given engineering and management problem context.

Reference Books:

1. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Integration of Principles, Methods and Techniques, 17th Impression, Pearson India Education Services Pvt. Ltd, 2018. ISBN: 978-81-7758-563-6

2. William M. K. Trochim, James P. Donnelly, The Research Methods Knowledge Base, 3rd Edition, Atomic Dog Publishing, 2006, ISBN: 978-1592602919

3. Kothari C.R., Research Methodology Methods and Techniques, 4th Edition, New Age International Publishers, 2019, ISBN: 978-93-86649-22-5.

4. Levin, R.I. and Rubin, D.S., Statistics for Management, 8th Edition, Pearson Education: New Delhi, 2017, ISBN-13- 978-8184957495.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE

Sl.No	Content	Marks
1	Quizzes - Q1 & Q2	20
2	Tests - T1 & T2	40
3	Experiential Learning - EL1 & EL2	40
	Total Marks	100

RUBRIC for SEE

Q. No	Contents	Marks
Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
1 & 2	Unit-1: Question 1 or 2	20
3 & 4	Unit-2: Question 3 or 4	20
5 & 6	Unit-3: Question 5 or 6	20
7 & 8	Unit-4: Question 7 or 8	20
9 & 10	Unit-5: Question 9 or 10	20
	Total Marks	100

SEMESTER: II						
Course Code	:	MBT431I	**UPSTREAM PROCESS TECHNOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3-0-1		SEE Marks	:	100
Hours	:	42L + 28P	*Theory & Practice- (Professional Core - 3)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr H G Ashok kumar			

UNIT - I **9 Hrs**

Plant tissue culture techniques: Dedifferentiation and redifferentiation, Organogenesis and somatic embryogenesis, Gene regulation during somatic embryogenesis, Micropropgation of Ornamental (Anthurium and Orchids), horticultural (Banana), and medicinal (Rauwolfia serpentina) plants. Somatic hybridization and cybridization, and Somaclonal variation. Secondary metabolite Production in vitro cultures: from callus, cell suspension culture, and Hairy root culture, Biotic and abiotic elicitation.

UNIT - II **9 Hrs**

Production of products/traits in transgenic plants: Molecular farming/pharming- Amino acids (methionine), Lipids (omega-3 and omega-6 fatty acids), Vitamins (Vitamin E, β-Carotene), Iron, Starch (α-amylase and glucose isomerase in potato),Antibodies (IgG antibodies), Edible Vaccines (Cholera), bioplastics (PHB), Genetic manipulation of fruit ripening (Tomato), and Flower pigmentation (Petunia). Production of insect (Cotton), fungal, bacterial and viral resistant plants. Production of abiotic (Drought and saline) tolerant plants. RNAi and plant genome editing- (CRISPR)/CRISPR-associated protein 9 (Cas9), Zinc finger nucleases (ZFNs), meganucleases and transcription activator-like effector nucleases (TALENs) for crop improvement.

UNIT - III **8 Hrs**

Microbial production of natural/recombinant products: recombinant products: Restriction endonucleases, Cellulase, Amylase, Lipase, Alginate Lyase, Amino acids (L-Glutamic acid), Antibiotics (Undecylprodigiosin, 7-aminodeacetoxycephalospopranic acid), Biopolymers (recombinant Xanthan gum), Spider silk protein, Citric acid, and Insulin. Vaccines: Inactivated vaccine (SARS-CoV-2 Virus), Attenuated vaccine (Cholera), Viral vector vaccine (SARS-CoV-2 Virus), Peptide Vaccine (Malaria), Subunit Vaccines (Herpes Simplex Virus), DNA (Shigella flexneri) and mRNA Vaccine (SARS-CoV-2 Virus). Production of Beer, Wine, and Biofuel (Ethanol and Methane).

UNIT - IV **8 Hrs**

Animal cell culture techniques: Primary culture, adult and embryonic stem cells, hybridoma technology for monoclonal antibody production, Production of recombinant biopharmaceuticals in Milk [Cystic fibrosis transmembrane regulator (CFTR)], recombinant antibodies in Chicken Eggs, Increased muscle mass in Transgenic mice, High levels of omega-6-fatty acids, improving growth rate (Fish),Strategies to increase expression of recombinant proteins in mammalian cells by altering chromatin structure. Cloning Livestock by Nuclear Transfer (Dolly), Disease (Prion diseases)-Resistant Livestock, Gene therapy, Knockout mice model for human genetic disease research.

UNIT - V **8 Hrs**

Bioreactors and Fermentation: Production flow sheet, types of bioreactor, Fermentation type: Batch, continuous, and Fed batch, Optimisation of fermentation, Fermentation media, Measurement of temperature, pressure, pH, Dissolved Oxygen, foam, product activity, substrate concentration and critical components and agitation control. Measurement of flow rate of liquid and gases; online estimation of process parameters. Laboratory safety, Risk assessment, Standard operating systems, Biohazards, Bioethics and Validation, Issues and concerns, biosafety, societal and ethical aspects of genetically modified foods and crops.

LABORATORY **28 Hrs**

1. Initiation of cell suspension culture using explants of medicinal plants. 2. Elicitation of secondary metabolites in callus using various elicitors. 3. Extraction of secondary metabolites from callus culture and its estimation. 4. Production of antibiotics from bacterial and fungal species and study its inhibition activity. 5. Production Pectinase from microbial cultures and estimation of its activity. 6. Production of cellulase from microbial cultures and estimation of its activity. 7. Production of proteases from microbes and estimation of its activity. 8. Production of ethanol using agriculture/horticulture waste. 9. Isolation of primary cell lines and its maintenance. 10. Cell viability study by trypan blue dye.

Course Outcomes:

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

CO1	:	Elucidate culturing of microbial/plant/animal cells/tissues.
CO2	:	Use and illustrate modern techniques for production of compounds/ clones/genetically modified organisms, and interpret the results.
CO3	:	Differentiate, select, and evaluate the products/compounds produced by organisms.
CO4	:	Design protocols for production of compounds from biological systems, and interpret the data.

Reference Books

1. Glick BR and Patten CL, Molecular Biotechnology – Principles and applications of recombinant DNA, 6th Edition, ASM Press, 2022. ISBN-1683673662

2. Brown T.A. Gene Cloning and DNA Analysis – An Introduction, Wiley-Blackwell Science, 6th Edition, 2010, ISBN: 9781405181730

3. Clark DP, Biotechnology, Academic Cell, 2 edition, 2015, ISBN-13: 978-0123850157

4. Wagner R, Hauser H, Animal Cell Biotechnology, De Gruyter,1st edition, 2014, ISBN-13: 978- 3110278866

Scheme of Continuous Internal Evaluation (CIE): 10 + 30 + 30 + 30 = 100

QUIZZES: Quizzes will be conducted in online/offline mode. Two quizzes will be conducted & Each Quiz will be evaluated for 10 Marks. The average of two quizzes will be the Final Quiz marks.

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 30 Marks.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (10), Video based seminar /presentation /demonstration (20) adding upto 30 marks.

Laboratory: Conduction of laboratory exercises, Lab report & observation & analysis (30 Marks), Lab Test (10 Marks) & Innovative Experiment/Concept Design & Implementation (10 Marks) adding up to 50 Marks. The final marks will be reduced to 30 Marks.

Scheme of Semester End Examination (SEE) for 100 marks: Each unit consists of TWO Questions of 16 Marks each. Answer FIVE full questions selecting one from each unit (from 1 to 5). Question No. 11 is compulsory (Laboratory component) for 20 Marks.

Rubric for CIE & SEE for Integrated Theory courses with Laboratory

RUBRIC of CIE			***RUBRIC of SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	10	Each unit consists of TWO questions of 16 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5). Question No. 11 is compulsory (Laboratory component) for 20 Marks.		
2	Tests - T1 & T2	30			
3	Experiential Learning - EL1 & EL2	30	1 & 2	Unit-1: Question 1 or 2	16
4	Laboratory	30	3 & 4	Unit-2: Question 3 or 4	16
	Total Marks	100	5 & 6	Unit-3: Question 5 or 6	16
NO SEE for Laboratory			7 & 8	Unit-4: Question 7 or 8	16
			9 & 10	Unit-5: Question 9 or 10	16
			11	Laboratory Component (Compulsory)	20
				Total Marks	100

SEMESTER: II						
Course Code	:	MBT331T	**PHARMACEUTICAL TECHNOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*(Professional Core - 4)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Praveen kumar Gupta			

UNIT - I — 9 Hrs

Pharmaceutical product design and development: Configuration and conformation of drug molecules, rational drug design, various approaches in drug discovery, drug targets, chiral drugs and drug pharmacophores. ICH perspectives, strategies in product development, Design of Experiments, Preformulation studies, Formulation development and scale-up. Details on Pharmacopoeia

Regulatory requirements: Generic Drug Product development, Hatch-Waxman Act, Regulatory requirements for product approvals: Clinical research process, IND, NDA, ANDA, SUPAC, Post marketing surveillance. FDA Approval Process: Data procession for Global submission, Common Technical Document (CTD)/ electronic Common Technical Document (eCTD) Format, and CMC Regulatory Compliance, FDA Medical Device Regulation.

UNIT - II — **9 Hrs**

Facility design, unit operations and manufacturing: Structure Activity Relationship - QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs. Personnel & 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. 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 — **8 Hrs**

Drug Pharmacokinetics and Pharmacodynamics: Carriers for the active transport of drugs (With special emphasis on p-glycoprotein & design of pgp inhibitors. Drug Absorption Barriers: Extracellular barriers, Intracellular barriers, Study of cell penetrating peptides and fusogenic peptides. Drug Pharmacodynamics. Introduction to the different pathways of drug metabolism: Phase I and II reactions, sites of drug metabolism, subcellular localization of drug metabolizing enzymes, cofactors required for catalytic reactions. Introduction to ADME and basic pharmacokinetic parameters like Volume of distribution, Elimination half life, Elimination rate constant, Clearance, Area under curve, Bioavailability, calculation of parameters from plasma and urine data

UNIT - IV — **8 Hrs**

Introduction to Vaccinology: Classification, active immunization, means of passive immunization, antibodies in therapy, antibody engineering, monoclonal antibodies, immunoconjugates - specific drug targeting, immunotoxins. Immuno-Therapeutics: Development of immuno-drugs. Cytokines classification, pathways of activation, Therapeutic use of cytokines. Immunomodulators classification, thymic hormones and synthetic immunostimulators. Compliment pathways diagnostics, Basic immunotoxicology - Principles of testing of immunomodurating drugs and Xenobiotics Food as Remedies: Nutraceuticals bridging the gap between food and drug, Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers etc. Brief idea about some Nutraceutical rich supplements e.g. Bee pollen, Caffeine, Green tea, Lecithin, Mushroom extract, Chlorophyll, Kelp and Spirulina etc Probiotics and Prebiotics.

UNIT - V — **8 Hrs**

Drug Pharmacology: Chemical transmission and drug action in the CNS. Diuretics, Drugs altering the pH of urine, excretion of organic molecules.Molecular Cardiology: Congenital Heart Disease, Inherited Cardiomyopathies, Coronary Atherosclerosis, Derived Nitric Oxide and Control of Vascular Tone, Hypertension, Cardiac Arrhythmias, Cardiovascular Gene Therapy. Pulmonology: Asthma, Pulmonary Emphysema. Lung Cancer: The Role of Tumor Suppressor Genes – Strategies for controlling the diseases. Drugs acting on GIT: Antacids and anti-ulcer drugs, Laxatives and Anti-diarrheal drugs, Appetite stimulants and suppressants, Emetics and anti-emetics. Thyroid hormones and anti-thyroid drugs ACTH and corticosteroids, Androgens and anabolic steroids, oral contraceptives. Treatment of poisoning, Heavy metals and heavy metal antagonists, Acute, Sub acute and Chronic toxicity

Course Outcomes:

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

CO1	:	Understand the basic importance and of various pharmaceutical products and their development
CO2	:	Evaluate the manfacturing, quality control and associated regulatory requiremnts of pharmaceutical products

CO3	:	Apply knowledge and understanding towards drug release, interactions and releated mechanism with various human populations based on experimental design.
CO4	:	Describe approved biotech products, e.g., indications, advantages, disease impact, & product limits, & status of pipeline products, e.g., development issues

Reference Books

1. Douglas J Pisano and David S. Mantus. FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices, and Biologics, 2nd Edition. Informa Health Care, 2008, ISBN 9781420073546

2. Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Principles of Medicinal Chemistry, 7th Edition; Wolters Kluwer Health Adis (ESP), 2012, ISBN-13 : 978-1609133450

3. Leon Shargel and Andrew B.C.Yu.Applied biopharmaceutics and pharmacokinetics, 7th edition, McGraw Hll education, 2016, ISBN 978-0-07-183093-5

4. RandaHilal-Dandan, Laurence L. Brunton. Goodman and Gilman's Manual of Pharmacology and Therapeutics, 2nd Edition, McGraw Hill, 2014, ISBN: 9780071769174

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	MBT432C1	**3D BIOPRINTING**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective C (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Raju H			

UNIT - I	**9 Hrs**
Bioprinting: Bioprinting Essentials of Cell and Protein Viability; Software for Biofabrication; Design and Quality Control for Translating 3D-Printed Scaffolds; different types of bioprinting techniques and their advantages and disadvantages. 3D tissue designing and 3D tissue/organ printing; various process parameters and their role in bioprinting.	
UNIT - II	**9 Hrs**
Bioinks: Biomaterials used for bioink development with their merits and demerits. Inkjet Bioprinting; Polymers for Bioprinting; Hydrogels for 3D Bioprinting Applications; Bioprinting of Organoids; 3D Printing and Nanomanufacturing; Bioprinting Using Aqueous Two-Phase System; Critical parameters of bioink formulations for bioprinting, modulation of bioink properties to control different processing conditions.	
UNIT - III	**8 Hrs**
Bioprinted research 3D models and techniques: Biomaterials for In-vitro, In-vivo, and ex-vivo manipulation of cells, Bioprinter to engineer tissues for regenerative medicines/in vitro tissue/organ models. Indirect Rapid Prototyping for Tissue Engineering	
UNIT - IV	**8 Hrs**
In situ bioprinting and 4D bioprinting: Stereolithographic 3D Bioprinting for Biomedical Applications; Extrusion Bioprinting Biofabrication-based strategies from bench-to-bed to address specific clinical problems.	
UNIT - V	**8 Hrs**
Challenges and future direction of bioprinting: Ethical issues related to bioprinting. Bioprinting of Organs for Toxicology Testing; Bioprinting of Cardiac Tissues; Bioprinting of Skin; Bioprinting of Nerve; Bioprinting: An Industrial Perspective	

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

CO1	:	Understand the basic princples and of various types of 3D Bioprinting and their development
CO2	:	Evaluate the manfacturing, quality control and associated regulatory requiremnts of 3D bioprinting products
CO3	:	Apply knowledge and understanding towards growth, interactions and releated mechanism with various human populations based on experimental design.
CO4	:	Describe approved 3D Bioprinting products and development issues.

Reference Books

1.Anthony Atala and James J. Yoo, Essentials of 3D Biofabrication and Translation. 1st edition, Elsevier, 2015, ISBN-13: 978-0128009727.

2. Lijie Grace Zhang, John P. Fisher and Kam W. Leong, 3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine, 1st edition, Elsevier, 2015, ISBN13: 9780128005477.

3. Gabor Forgacs, Wei Sun, Biofabrication - Micro- and Nano-fabrication, Printing, Patterning and Assemblies, 1st Edition, Elsevier, 2013, ISBN-13 : 978-1455728527

4. Sabrie Soloman, 3D Bioprinting Revolution, 1st Edition, Khanna Book Publishng Co. Ltd, 2020, ISBN 978-938 9139082

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	MBT332C2	**FERMENTATION TECHNOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective C (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr G Vijaya kumar			

UNIT - I	**9 Hrs**
Major types of organisms used in fermentation. Microbial growth kinetics, Batch culture, Fed Batch and Continuous Culture Types, fermentation kinetics	
UNIT - II	**8 Hrs**
Isolation, preservation and improvement of industrially important microorganisms, media for industrial fermentations – media formulation, Development of inoculum for industrial fermentations.	
UNIT - III	**9 Hrs**
Fermentor design and types, basic functions of a Fermentor for microbial and animal cell culture, common measurements and control systems. Control of fermentation – requirements for control, sensors and controllers, control of incubation, aeration and agitation.anaerobic fermentation.	
UNIT - IV	**8 Hrs**
Computers in fermentation, modeling, software sensors, control and supervision of fermentation processes. Off-line / Online measurements – PID.	
UNIT - V	**8 Hrs**
Fermented products: Production of fermented Vitamins & Antibiotics (Vitamin B12, riboflavin, peptide antibiotics), Organic acids & Feed stocks (Citric acids & gluconic acids), Amino acids (Glutamic acid & Lysine)	

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

CO1	:	Understand the various micro organisms used for fermentation.
CO2	:	Apply various Isolation and preservation principles to develop inoculum for industrial fermrnters
CO3	:	Estimate various parameters measured during fermentation processes
CO4	:	Production of various industrially fermented products

Reference Books

1. Arium Kulia and Vinay Sharma, Principles and applications of Fermentation Technology, Wiley, 2018, ISBN: 9781119460268

2. Coulson, J.M. and J.F. Richardson, Chemical Engineering vol. 3, 3rd Edition, Elsevier, 2006, ISBN-13 : 978-8131204528

3. E. M. T. El-Mansi, Jens Nielsen, David Mousdale, Ross P. Carlson, Fermentation Microbiology & Biotechnology, CRC Press, 2020, ISBN 9780367656706

4. Stanbury, P.F., A. Whitaker & S.J. Hall. Principles of Fermentation Technology, 3rd edition, Butterworth-Heinemann, 2016, ISBN-13 : 978-0080999531

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	MBT333C3	**PARENTERAL FORMULATIONS**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective C (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Trilochandran B			

UNIT - I	**9 Hrs**
Introduction, scope, and history of sterile products,Characteristics of sterile dosage forms.Types of sterile dosage forms,.Sterile product packaging systems.Overview of product development.	
UNIT - II	**9 Hrs**
Overview of product Formulation components (solvents and solutes).Sterile products packaging chemistry,Formulation and stability of solutions,Dispersed systems. Formulation of freeze-dried powders, formulation problems and some case studies, sterile product manufacturing and Contamination control	
UNIT - III	**8 Hr**
Sterile manufacturing facilities, Water and air quality in sterile manufacturing facilities,Personnel requirements for sterile manufacturing, Sterilization methods in sterile product manufacturing, Sterile filtration.	
UNIT - IV	**8 Hr**
Sterile product filling, stoppering, and sealing, Freeze-dry (lyophilization) processing, Aseptic processing,Inspection, labelling and secondary packaging, Barrier and other advanced technologies in aseptic processing.	
UNIT - V	**8 Hr**
Stability, storage, and distribution of sterile drug products, Quality assurance and control, Microorganisms and sterility testing, Pyrogens and pyrogen/endotoxin testing, Particles and particulate matter testing, Sterile product-package integrity testing, Casestudy on IV Fluids manufacturing process.	

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

CO1	:	Understand the various requirements for sterile products
CO2	:	Apply various principles to develop isterile formulations
CO3	:	interpret various parameters streile manufacturing processes
CO4	:	apply the quality control procedures for the production of various parenteral formulation

Reference Books

1. Michael J. Akers, Sterile Drug Products, 1st edition, Informa Healthcare,2010, ISBN:9780849339936
2. Linda A. Felton,Remington Essentials of Pharmaceutics,Pharmaceutical Press, 1st edition, 2013, ISBN:978085711100
3. Leon Shargel, Andrew B.C. Yu,,Applied Biopharmaceutics & Pharmacokinetics 7th edition,McGrawHill, 2016, ISBN: 9780071829649
4. Sandeep Nema , John D. Ludwig, Pharmaceutical Dosage Forms - Parenteral Medications: Volume 1: Formulation and Packaging, 4th Edition, CRC Press, 2010, ISBN:978-1420086430

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			RUBRIC for SEE		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	MBT334C4	**AGRICULTURE BIOTECHNOLOGY AND CROP IMPROVEMENT**	CIE Marks	:	100
Credits L-T-P	:	3- 0 - 0		SEE Marks	:	100
Hours	:	42L	*Elective C (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Neeta Shivakumar			

UNIT - I	**8 Hrs**
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	**8 Hrs**
Concepts and scope of Agricultural Biotechnology: Tissue culture in crop improvement, Micropropagation. Meristem culture and production of virus-free plants. Haploids in plant breeding; Anther and microspore culture. Embryo and ovary culture. Somatic hybridization; Protoplast isolation and fusion, cybrids. Somaclonal variation. Synthetic seeds. Cryopreservation,Elicitation with various biotic and abiotic elicitors.	
UNIT - III	**9 Hrs**
Biotechnology for Sustainable Agriculture: an overview, Biotechnological tools to enhance sustainable production, Sustainable agriculture and food security, Green food production, Green house technology and protected cultivation: Types of Green house, Various component of green house, Design, criteria and calculation. Green house irrigation system, Pytotrons: Hydroponics and aeroponics. Organic Farming: Concept of Integrated nutrient management and Integrated pest management, molecular farming in animals and plants. Nanotechnology and its implication in Agricultural Biotechnology.	
UNIT - IV	**9 Hrs**
Introduction and basic concepts of classical plant breeding: The status of plant breeding in agriculture, the importance of breeding, history and development of plant breeding in the world and us. Conventional techniques, methods and practices of breeding: The techniques and selection methods. Breeding methods for self, for cross-pollinated, in vegetatively propagated. Peculiarities of the biennial and perennial species. Nature of heterosis, heterosis theory explaining, using heterózního effect in plant-breeding techniques for the breeding of F1 hybrids. Male sterility, genetic determination of male sterility, the use of male sterility in breeding F1 hybrids	
UNIT - V	**8 Hrs**
Alternative breeding techniques: Mutation breeding, induced mutagenesis, mutagens used, methods of working. Remote hybridization causes problems with pollination of species and the possibility of overcoming, the properties of distant hybrids. Properties of polyploids, the use of polyploidy in plant breeding, methods of obtaining polyploid breeding, use of aneuploidy. Haploids in plant breeding. Breeding for resistance to pests and diseases, genetic nature of resistance.	

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

CO1	:	Remember and explain various fundamentals of Agricultural Biotechnology with reference to breeding techniques and regulatory frameworks
CO2	:	Apply the knowledge of modern tools to analyze the improvement of agricultural practices
CO3	:	Analyze and apply various breeding techniques for crop improvement
CO4	:	The ability to propose an approach for the desired properties of the plants with the classical and biotechnological methods.

Reference Books

1. S S Purohit, Agricultural Biotechnology, 3rd ed., Agribios Publications, 2010, ISBN-13 : 978-8177543551
2. Stuart J. Smyth, Peter W.B. Phillips and David Castle, Handbook on Agriculture, Biotechnology and Development, 1st ed, Edward Elgar Publications, 2015, ISBN: 978178347 1355.
3. Bos I & Caligari P, Selection Methods in Plant Breeding, 2nd ed., Chapman & Hall, 2007, ISBN-13: 978-1402063695
4. Vijay Rani Rajpal, S. Rama Rao, S.N. Raina, Molecular Breeding for Sustainable Crop Improvement, Vol.2., 1st edition, Springer International Publishing, 2016, ISBN-13: 978-3319270883

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MBT331G	**BIOINSPIRED ENGINEERING**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hr
Faculty Coordinator:		Dr Nagashree Rao and Dr Ashwani Sharma				

UNIT - I **8 Hrs**

Introduction to Bio-inspired Engineering: Macromolecules, Stem cells; types and applications. Synthetic Biology; Bottom-up' and 'top-down' engineering approaches. Synthetic/ artificial life. Biological Clock, Genetic Algorithms.

UNIT - II **9 Hrs**

Principles of bioinspired materials: Biological and synthetic materials, Self-assembly, hierarchy and evolution. Biopolymers, Bio-steel, Bio-composites, multi-functional biological materials. Thermal Properties. Antireflection and photo-thermal biomaterials, Microfluidics in biology, Invasive and non-invasive thermal detection inspired by skin

UNIT - III **9 Hrs**

Lessons from Nature:Bioinspired Materials and mechanism: Firefly-Bioluminescence, Cockleburs –Velcro, Lotus leaf - Self-cleaning materials, Gecko - Gecko tape, Whale fins - Turbine blades, Box Fish / Bone - Bionic car, Shark skin - Friction reducing swim suits, Kingfisher beak - Bullet train, Coral - Calera cement, Forest floor / Ecosystem functioning - Flooring tiles, Morpho butterfly- Structural color, Namib beetle- Water collecting, Termite mound passive cooling, Birds/Insects-flights/ aerodynamics, Mosquito inspired micro needle.

UNIT - IV **8 Hrs**

Biomedical Inspiration-Concept and applications: Organ system- Circulatory- artificial blood, artificial heart, pacemaker. Respiratory- artificial lungs. Excretory- Artificial kidney and skin. Artificial Support and replacement of human organs: artificial liver and pancreas. Total joint replacements- artificial limbs. Visual prosthesis -artificial eye/ bionic eye.

UNIT - V **8 Hrs**

Biomimetics: Inventions in nature for Human Innovation: Photosynthesis and Photovoltaic cells, Bionic/Artificial leaf. Bio-ink and 3D-Bioprinting. Cellular automata. Biosensors: Artificial tongue and nose. Biomimetic echolation. Insect foot adaptations for adhesion. Thermal insulation and storage materials. Bees and Honeycomb Structure. Artificial Intelligence, Neural Networking and bio-robotics.

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

CO1	:	Elucidate the concepts and phenomenon of natural processes
CO2	:	Apply the basic principles for design and development of bioinspired structures
CO3	:	Analyse and append the concept of bio-mimetics for diverse applications
CO4	:	Designing technical solutions by utilization of bio-inspiration modules.

Reference Books:

1. D. Floreano and C. Mattiussi, Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, 1st edition, MIT Press, 2008, ISBN: 9780262062718

2. Guang Yang, Lin Xiao, and Lallepak Lamboni. Bioinspired Materials Science and Engineering. 1st edition, John Wiley, 2018, ISBN: 978-1-119-3903362

3. M.A. Meyers and P.Y. Chen. Biological Materials, Bioinspired Materials, and Biomaterials, 1st edition, Cambridge University Press, 2014, ISBN 978-1-107-01045.

4. Tao Deng. Bioinspired Engineering of Thermal Materials, 1st edtion, Wiley-VCH Press, 2018. ISBN: 978-3-527-33834-4.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes – Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests – T1 & T2	40			
3	Experiential Learning – EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MBT332G	**HEALTH INFORMATICS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr A H Manjunatha Reddy				

UNIT - I	**8 Hrs**
Introduction, Healthcare data, information and knowledge: Data types, data conversion, clinical data warehouse, data analytics, challenges, role of informatics in analytics, future trends	
UNIT - II	**8 Hrs**
Electronic health records: Introduction, scope for the e health records, challenges, examples, logical steps to selecting and implementing EHR	
UNIT - III	**8 Hrs**
Data standards and medical coding: Introduction, medical content standards, termonology standards, transport standards, medical coding and reimbursement, future trends,	
UNIT - IV	**9 Hrs**
Healthcare Enterprise: Overview of Health Informatics: Introduction, Key players in HI, organizations involved, barriers, programs, organizations and career, HI Resoruces	
UNIT - V	**9 Hrs**
Health Information privacy and security: Introduction, basic security principles, authentication and identity management, data security in the cloud and client/server management	

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

CO1	:	Understand the basic principles of Health informatics
CO2	:	Data capture to data transformation and to analysis
CO3	:	Creation of E health records, identify the challenges
CO4	:	Improvise the significant factors as per the spatio-temporal requirements

Reference Books:

1. Robert E. Hoyt Ann K. Yoshihashi, Health Informatics, Practical guide for Healthcare and Information Technology Professionals, 6th edition, Informatics Education, 2014, ISBN: 978-0-9887529-2-4

2. Kathryn J. Hannah Marion J. Ball, Health Informatics, Springer Series edition, Springer, 2005, ISBN: 1-85233-826-1

3. William R Hersh, Health Informatics, a Practical guide, 8th edition. 2022, ISBN 978-1-387-85475-2

4. Pentti Nieminen. Medical informatics and data analysis 1st edition, MDPI AG, 2021, ISBN-13 : 978-3036500980

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes – Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests – T1 & T2	40			
3	Experiential Learning – EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MCS331G	**BUSINESS ANALYTICS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Azra Nasreen and Dr. Badarinath K				

UNIT - I **9 Hrs**

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.

UNIT - II **9 Hrs**

Trendiness and Regression Analysis Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT - III **8 Hrs**

Organization Structures of Business analytics Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.

UNIT - IV **8 Hrs**

Forecasting Techniques Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

UNIT - V **8 Hrs**

Decision Analysis Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

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

CO1	:	Apply the concepts and methods of business analytics to solve business problems
CO2	:	Analyse, model and solve decision problems in different settings
CO3	:	Interpret results/solutions and identify appropriate courses of action for a given business scenario
CO4	:	Demonstrate skills like investigation, effective communication, working in team/Individual and following ethical practices by implementing solutions to decision making problems

Reference Books:

1. Business analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402

2. The Value of Business Analytics: Identifying the Path to Profitability, Evan Stubs , John Wiley & Sons, |DOI:10.1002/9781118983881,1st Edition 2014, ISBN:978111898388

3. Business Analytics, James Evans, Pearsons Education 2nd Edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824

4. Predictive Business Analytics Forward Looking Capabilities to Improve Business, Gary Cokins and Lawrence Maisel, Wiley; 1st Edition, 2013, ISBN: 978-1-118-17556-9 .

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
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.
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.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes – Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests – T1 & T2	40			
3	Experiential Learning – EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MCV331G	**INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr.V.AnanthaRam			

UNIT - I **08Hrs**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.

UNIT - II **09Hrs**

Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.

UNIT - III **09Hrs**

Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.

UNIT - IV **08 Hrs**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT - V **08 Hrs**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

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

CO1	:	Explain the Industrial and Occupational health and safety and its importance.
CO2	:	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	:	Characterize the different type materials, with respect to safety and health hazards of it.
CO4	:	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

Reference Books:

1.Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.

2. H. P. Garg, Maintenance Engineering Principles, Practices & Management, 2009,S. Chand and Company, New Delhi, ISBN:9788121926447

3.Fundamental Principles of Occupational Health and Safety, Benjamin O. ALLI, Second edition,2008 International Labour Office – Geneva: ILO, ISBN 978-92-2-120454-1

4.Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE

Sl.No	Content	Marks
1	Quizzes - Q1 & Q2	20
2	Tests - T1 & T2	40
3	Experiential Learning - EL1 & EL2	40
	Total Marks	100

RUBRIC for SEE

Q. No	Contents	Marks
Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
1 & 2	Unit-1: Question 1 or 2	20
3 & 4	Unit-2: Question 3 or 4	20
5 & 6	Unit-3: Question 5 or 6	20
7 & 8	Unit-4: Question 7 or 8	20
9 & 10	Unit-5: Question 9 or 10	20
	Total Marks	100

SEMESTER: II

Course Code	:	MCV332G	**INTELLIGENT TRANSPORTATION SYSTEMS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr.Sunil S			

UNIT - I **8 Hrs**

Introduction: –Historical Background, Definition, Future prospectus, ITS training and educational needs.
Fundamentals of Traffic Flow and Control- Traffic flow elements, Traffic flow models, Shock waves in Traffic streams, Traffic signalization and control principles, Ramp metering, Traffic simulation

UNIT - II **9 Hrs**

ITS User services-User services bundles, Travel and Traffic management, Public Transportation Operations, Electronic Payment, Commercial Vehicles Operations, Emergency Management, Advanced Vehicle Control and safety systems, Information Management, Maintenance and construction Management. ITS Architecture-Regional and Project ITS Architecture, Need of ITS architecture, concept of Operations, National ITS Architecture, Architecture development tool

UNIT - III **9 Hrs**

Technology Building Blocks for ITS-Introduction, Data acquisition, Communication Tools, Data Analysis, and Traveller Information. Various detection, identification and collection methods for ITS. ITS Applications and their benefits-Freeway and incident management systems, Advanced arterial traffic control systems, Advanced Public Transportation Systems, Multimodal Traveller Information systems

UNIT - IV **8 Hrs**

ITS Planning-Transportation planning and ITS, Planning and the National ITS Architecture, Planning for ITS, Integrating ITS into Transportation Planning, relevant case studies. ITS Standards-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing

UNIT - V **8 Hrs**

ITS Evaluation – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines, Challenges and Opportunities. ITS for Law Enforcement: Introduction, Enhance and support the enforcement traffic rules and regulations, ITS Funding options and ITS case studies

Course Outcomes:
After going through this course the student 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 implimentions

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

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
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.
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EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
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2	Tests – T1 & T2	40			
3	Experiential Learning – EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MEC331G	**ELECTRONIC SYSTEM DESIGN**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Prof. Ravishankar Holla				

UNIT - I **9 Hrs**

Design Process & its Fundamentals: Life Cycle of Electronic Products, Design and Development Process, Guidance for Product Planning, Design and Development, Technical Drawings, Circuit Diagrams, Computer-Aided Design (CAD)

UNIT - II **9 Hrs**

System Architecture and Protection Requirements: Introduction - Terminology, Functions and Structures, Systems Design Architecture, Electronic System Levels, System Protection
Experiential Learning: (4 quizzes on the below mentioned topics other than CIE) Reliability Analysis: Introduction, Calculation Principles, Exponential Distribution, Failure of Electronic, Components, Failure of Electronic Systems, Reliability Analysis of Electronic Systems, Recommendations for Improving Reliability of Electronic Systems

UNIT - III **8 Hrs**

Thermal Management and Cooling: Introduction - Terminology, Temperatures and Power Dissipation, Calculation Principles, Heat Transfer, Methods to Increase Heat Transfer, Application Examples in Electronic Systems, Recommendations for Thermal Management of Electronic Systems, Cooling systems, liquid, air and non cooling systems.

UNIT - IV **8 Hrs**

Electromagnetic Compatibility (EMC):
Introduction, Coupling Between System Components, Grounding Electronic Systems, Shielding from Fields, Electrostatic Discharge (ESD), Recommendations for EMC-compliant Systems Design

UNIT - V **8 Hrs**

Recycling Requirements and Design for Environmental Compliance: Introduction - Motivation and the Circular Economy, Manufacture, Use, and Disposal of Electronic Systems in the Circular Economy, Product Recycling in the Disposal Process, Material Recycling in the Disposal Process, Design and Development for Disassembly, Material Suitability in Design and Development, Recommendations for Environmentally Compliant Systems

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

CO1	:	Realize the fundamentals of Design, Architecture, thermal management, EMC and Recycling requirements of Electronic System Design
CO2	:	Analyze the various application wise design requirements in Electronic systems along with the related concepts of implementations, standards and Compliances.
CO3	:	Use modern open source tools to realize the various concepts of Electronic system design
CO4	:	Engage in self-study through assignments, simulations, case studies and projects

Reference Books:

1. Fundamentals of Electronic Systems Design, Jens Lienig, Hans Brümmer 2017, Springer International Publishing, ISBN 978-3-319-55839-4, DOI:10.1007/978-3-319-55840-0
2. “Embedded System Design”, Marwedel, Peter, Springer Nature, 10.1007/978-3-030-60910-8
3. “Electromagnetic Compatibility Engineering”, Henry W. Ott, WILEY Publication, ISBN: 978-0-470-18930-6
4. "Handbook of Electronic Systems Design" by Charles A. Harper, McGraw-Hill Inc.,US , 0070266832, 978-0070266834

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
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.
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EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes – Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests – T1 & T2	40			
3	Experiential Learning – EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MEC332G	**EVOLUTION OF WIRELESS TECHNOLOGIES**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Mahesh A				

UNIT - I **9 Hrs**

Introduction to cellular systems: Overview of Cellular Systems and evolution 2G/3G/4G/5G, Cellular Concepts – Frequency reuse, Co
channel and Adjacent channel Interference, C/I, Handoff, Blocking, Erlang Capacity, Bluetooth, WiFi, WWAN and PAN.

UNIT - II **9 Hrs**

Fundamentals of wireless communication: Wireless Channel, Wireless propagation, Link budget, Free-space path loss, Noise figure of receiver, Multipath fading, Shadowing, Fading margin, Shadowing margin, Wireless Channel Capacity, OFDM and LTE, Large Scale Propagation effects and Channel Models

UNIT - III **8 Hrs**

Fundamentals of 5G architecture: Difference between 4G and 5G, 5G Architecture, Planning of 5G Network, Quality of Service, Radio
Network, Requirements, Security, SIM in 5G Era, Specifications, Standardization, Terminal States

UNIT - IV **8 Hrs**

mmWave and Visible Light Communications: Back ground and concept of mmWave Communications, Frequency bands, propagation characteristics, channel models, applications and challenges in 5G

UNIT - V **8 Hrs**

Future Generations: Future Generations(where is the 6G?), Health Considerations, Identifiers, Interfaces, ,Key Derivation, Location Based Services, Massive Internet of Things, Measurements, Network Functions Virtualization,
Network Slicing, Open Source, , User Equipment, Vehicle-to-Vehicle communications (V2V),Virtual Reality (VR/AR/XR). Case study- Bharath Stack

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

CO1	:	Demonstrate their understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards
CO2	:	Compare different technologies used for wireless communication systems.
CO3	:	Demonstrate an ability explain recent techniques for Wireless Communication systems
CO4	:	Update the latest trends in wireless communications

Reference Books:

1. Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, Pearson, 2nd Edition.
2. Aditya K Jagannatham, “Principles of Modern Wireless Communications”, McGraw Hill, 2017
3. Robin Chataut, Robert Akl, “Massive MIMO Systems for 5G and beyond Networks—Overview, Recent Trends, Challenges, and Future Research Direction” Sensors, May 2020
4. A. N. Uwaechia and N. M. Mahyuddin, A Comprehensive Survey on Millimeter Wave, Communications for Fifth-Generation Wireless Networks: Feasibility and Challenges, in IEEE, Access, vol. 8, pp. 62367-62414, 2020

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
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.
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EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes – Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests – T1 & T2	40			
3	Experiential Learning – EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MET331G	**TRACKING AND NAVIGATION SYSTEMS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Prof. Shambulinga .M, Dr. B. Roja Reddy			

UNIT - I **9 Hrs**

An Introduction to Radar: Basic Radar, The simple form of the Radar Equation, Radar Block Diagram, Radar Frequencies, Application of radar, Types of Radars. Detection of signals in Noise, Receiver Noise and the Signal-to Noise Ratio, Probability of Detection and False alarm, Introduction to Doppler, MTI, UWB Radars

UNIT - II **8 Hrs**

Terrestrial Network based positioning and navigation: General Issues of wireless positions location, Fundamentals, positioning in cellular networks, positioning in WLANs, Positioning in Wireless sensor networks.

UNIT - III **8 Hrs**

Satellite-based navigation systems: Global Navigation satellite systems (GNSS), GNSS receivers.

UNIT - IV **9 Hrs**

LiDAR: Introduction to LiDAR, context and conceptual discussion of LiDAR, Types of LiDARS, LiDARS Detection modes, Flash LiDAR versus Scanning LiDAR, Monostatic versus Bistatic LiDAR, Major Devices in a LiDAR, LiDAR remote sensing, Basic components and physical principles of LiDAR, LiDAR accuracy and data formats.

UNIT - V **8 Hrs**

SONAR: Underwater acoustics, applications, comparison with radar, submarine detection and warfare, overcoming the effects of the ocean, sonar and information processing.Transmission of the acoustic signal: Introduction, detection contrast and detection index, transmission equation, equation of passive and active sonar.

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

CO1	:	Understand the concepts of Radar, LiDAR, Sonar, terrestrial and satellite based navigation system
CO2	:	Apply the concepts of radars, LiDAR, Sonar, cellular networks, WLAN, sensor networks and satellites in determining the user position and navigation.
CO3	:	Analyze the different parameters of satellite and terrestrial networks for navigation systems.
CO4	:	Evaluate the Radar, LiDAR, Sonar systems and satellite and terrestrial network based navigation and tracking systems

Reference Books:

1. M. L Skolnik,Introduction to RADAR Systems,3rd edition, 2017,TATA Mcgraw-Hill, ISBN: 978-0070445338
2. Mark A Richards, James A Scheer, William A Holam,Principles of Modern Radar Basic Principles, 2010, 1st edition,SciTech Publishing Inc, ISBN:978-1891121524 .
3. Davide dardari, Emanuela Falletti, Marco Luise, Satellite and Terrestrial Radio Positioning techniques- A signal processing perspective, 1st Edition, 2012, Elsevier Academic Press, ISBN: 978-0-12-382084-6.
4. Paul McManamon,LiDAR Technologies and Systems, SPIE press, 2019.
5. Pinliang Dong and Qi Chen,LiDAR Remote Sensing and Applications, CRC Press, 2018, ISBN: 978-1-4822-4301-7
6. Jean-Paul Marage, Yvon Mori, Sonar and Underwater Acoustics, Wiley, 2013, ISBN: 9781118600658

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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.
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EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes – Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests – T1 & T2	40			
3	Experiential Learning – EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MIM331G	**PROJECT MANAGEMENT**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Vikram N Bahadurdesai				

UNIT - I **8 Hrs**

Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.

UNIT - II **8 Hrs**

Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study – a schematic diagram, objectives of capital budgeting

UNIT - III **9 Hrs**

Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis

UNIT - IV **8 Hrs**

Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management

UNIT - V **9 Hrs**

Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, hemes / Epics / Stories, Implementing Agile.
Domain Specific Case Studies on Project Management: Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.

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

CO1	:	Explain project planning activities that accurately forecast project costs, timelines, and quality.
CO2	:	Evaluate the budget and cost analysis of project feasibility.
CO3	:	Analyze the concepts, tools and techniques for managing projects.
CO4	:	Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations).

Reference Books:

1. Prasanna Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 8th Edition, 2010, ISBN 0-07-007793-2.

2. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Edition, 2013, ISBN: 978-1-935589-67-9

3. Harold Kerzner, Project Management A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.

4. Rory Burke, Project Management – Planning and Controlling Techniques, John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
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EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
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2	Tests – T1 & T2	40			
3	Experiential Learning – EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MIS331G	**DATABASE AND INFORMATION SYSTEMS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Prof.Smitha G R				

UNIT - I **8 Hrs**

Advanced Database Models, Systems, and Applications : Enhanced Data Models: Introduction to Active, Temporal, Spatial, Multimedia, and Deductive Databases . Distributed Database Concepts : Distributed Database Concepts, Data Fragmentation, Replication, and Allocation Techniques for Distributed Database Design, Overview of Concurrency Control and Recovery in Distributed Databases

UNIT - II **8 Hrs**

Introduction to Information Retrieval and Web Search : Information Retrieval (IR) Concepts Retrieval Models, Types of Queries in IR Systems , Text Preprocessing , Inverted Indexing, Evaluation Measures of Search Relevance ,Web Search and Analysis, Trends in Information Retrieval .

UNIT - III **8 Hrs**

Information Systems, Organizations and Strategy: Organizations and information systems, How information systems impact organization and business firms, Using information systems to gain competitive advantage, management issues, Ethical and Social issues in Information Systems: Understanding ethical and Social issues related to Information Systems, Ethics in an information society, The moral dimensions of information society. A Case study on business planning.

UNIT - IV **9 Hrs**

Achieving Operational Excellence and Customer Intimacy: Enterprise systems, Supply chain management(SCM) systems, Customer relationship management(CRM) systems, Enterprise application. E-commerce: Digital Markets Digital Goods: E-commerce and the internet, E-commerce-business and technology, The mobile digital platform and mobile E-commerce, Building and E-commerce web site. A Case study on ERP.

UNIT - V **9 Hrs**

Managing Knowledge:
The knowledge management landscape, Enterprise-wide knowledge management system, Knowledge work systems, Intelligent techniques. Enhancing Decision Making: Decision making and information systems, Business intelligence in the enterprise. Business intelligence constituencies. Building Information Systems: Systems as planned organizational change, Overview of systems development.

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

CO1	:	Understand the different models for Infromation Retrieval.
CO2	:	Appricieate the technology of Information Retrieval and Web Search
CO3	:	To understand the basic principles and working of information technology.
CO4	:	Describe the role of information technology and information systems in business.

Reference Books:

1. Kenneth C. Laudon and Jane P. Laudon: Management Information System, Managing the Digital Firm, Pearson Education, 14th Global edition, 2016, ISBN:9781292094007.

2. Fundamentals of Database Systems, Ramez Elmasri, Shamkant B. Navathe, 7th Edition, 2016, Published by Pearson, Copyright © , ISBN-10: 0133970779

3. James A. O' Brien, George M. Marakas: Management Information Systems, Global McGraw Hill, 10th Edition, 2011, ISBN: 978-0072823110.

4. Database Management Systems, Raghu Ramakrishnan and Johannes Gehrke, 3rd Edition, 2003, McGraw-Hill, ISBN: 9780071231510

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
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.
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.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MIS332G	**MANAGEMENT INFORMATION SYSTEMS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Prof. Vanishree K				

UNIT - I **8 Hrs**

Overview: Introduction:
Professional Software Development, Software Engineering Ethics, Case studies. Software Processes: Models, Process activities, Coping with Change, Process improvement. The Rational Unified Process. Computer Aided Software Engineering. Agile Software Development: Introduction to agile methods, Agile development techniques, Agile project management and scaling agile methods. Information Systems in Global Business Today: The role of information systems in business today, Perspectives on information systems, Contemporary approaches to information systems

UNIT - II **9 Hrs**

Requirements Engineering and System Modeling:
Software Requirements: Functional and Non-functional requirements. Requirements Elicitation, Specification, Validation and Change. System Modeling: Context models, Interaction models, Structural models, Behavioural models, Model driven architecture. Information Systems, Organizations and Strategy: Organizations and information systems, How information systems impact organization and business firms, Using information systems to gain competitive advantage, management issues

UNIT - III **9 Hrs**

Development and Testing:
Design and implementation: Object oriented design using UML, Design patterns, Implementation issues, Open-source development. Software Testing: Development testing, Test-driven development, Release testing, User testing.
Securing Information Systems: System vulnerability and abuse, Business value of security and control, Establishing framework for security and control, Technology and tools for protecting information resources. A case study on cybercrime.

UNIT - IV **8 Hrs**

Advanced Software Engineering:
Dependable systems: Dependability properties, Sociotechnical systems, dependable processes, formal methods and dependability, A15 Availability and reliability, reliability requirements, Reliability measurements E-commerce: Digital Markets Digital Goods: E-commerce and the internet, E-commerce-business and technology, A Case study on ERP.

UNIT - V **8 Hrs**

Software Management:
Project Management: Risk Management, Managing People, Teamwork, Project Planning: Software Pricing, Plan driven development, Project Scheduling, Agile planning, Estimation Techniques, COCOMO cost modeling. Building Information Systems: Systems as planned organizational change, Overview of systems development.

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

CO1	:	Understand and apply the fundamental concepts of software engineering for information systems.
CO2	:	Develop the knowledge about software engineering for management of information systems.
CO3	:	Interpret and recommend the use information technology to solve business problems.
CO4	:	Apply a framework and process for aligning organization's IT objectives with business strategy.

Reference Books:

1. Kenneth C. Laudon and Jane P. Laudon: Management Information System, Managing the Digital Firm, Pearson Education, 14th Global edition, 2016, ISBN:9781292094007.
2. Ian Sommerville,– Software Engineering, 9th Edition, Pearson Education, 2013, ISBN: 9788131762165
3. W.S. Jawadekar: Management Information Systems, Tata McGraw Hill, 2006, ISBN: 9780070616349.
4. James A. O' Brien, George M. Marakas: Management Information Systems, Global McGraw Hill, 10th Edition, 2011, ISBN: 978-0072823110

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100
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.
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.
EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE		
Sl.No	**Content**	**Marks**
1	Quizzes - Q1 & Q2	20
2	Tests - T1 & T2	40
3	Experiential Learning - EL1 & EL2	40
	Total Marks	100

RUBRIC for SEE		
Q. No	**Contents**	**Marks**
Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
1 & 2	Unit-1: Question 1 or 2	20
3 & 4	Unit-2: Question 3 or 4	20
5 & 6	Unit-3: Question 5 or 6	20
7 & 8	Unit-4: Question 7 or 8	20
9 & 10	Unit-5: Question 9 or 10	20
	Total Marks	100

SEMESTER: II

Course Code	:	MMA331G	**STATISTICAL AND OPTIMIZATION METHODS**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr. PRAKASH R			

UNIT - I **9 Hrs**

Random Vectors:
Probability models of N random variables, Vector notation, Marginal probability functions, Independence of random variables and random vectors, Functions of random vectors, Expected value vector and Correlation matrix, Gaussian random vectors, Expected values of sums, Probability density function of the sum of two random variables, Moment Generating Functions (MGF), MGF of the sum of independent random variables, Characteristic function and Probability generating function.

UNIT - II **8 Hrs**

Estimation: Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Variance of a point estimator, Methods of point estimation - Method of moments and Method of maximum likelihood, Bayesian estimation of parameters.

UNIT - III **9 Hrs**

Inferential Statistics: Principles of Statistical Inference, Formulation of the problems with examples. Test of hypothesis - Null and alternative hypothesis, Procedure for statistical testing, Type I and Type II errors: level of significance, Rejection regions and power, Standard Normal null distribution (Z-test), Z-tests for means and proportions, Duality: two-sided tests and two-sided confidence intervals, P-value, Inference about variances, Special tests of significance for large and small samples (F, Chi – square, Z, t – test).

UNIT - IV **8 Hrs**

Fuzzy Optimization:
Basic concepts of fuzzy sets - Operations on fuzzy sets, Fuzzy relation equations, Fuzzy logic control, Fuzzification, Defuzzificatiuon, Knowledge base, Decision making logic, Membership functions, Rule base.
Artificial Neural Networks: Introduction - Neuron model, Multilayer perceptions - Back propagation algorithm and its variants, Loss functions in artificial neural networks, Stochastic gradient descent method.

UNIT - V **8 Hrs**

Machine Learning Algorithms:
Data mining, Hierarchy Clustering, k-Means Clustering, Distance Metric, Data mining for Big data, Characteristics of Big data, Statistical nature of Big data, Support Vector Machines, Statistical Learning Theory, Linear Support Vector Machine, Kernel functions and Nonlinear Support Vector Machines.

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

CO1	:	Illustrate the fundamental concepts of statistics, random variables, estimation, inferential statistics, fuzzy optimization and machine learning algorithms.
CO2	:	Derive the solution by applying the acquired knowledge of random variables, estimation, inferential statistics, fuzzy optimization and machine learning algorithms to the problems of engineering applications.
CO3	:	Evaluate the solution of the problems using appropriate statistical and probability techniques to the real world problems arising in many practical situations.
CO4	:	Compile the overall knowledge of statistics, probability distributions and estimation, tests of hypothesis and optimization gained to engage in life – long learning.

Reference Books:

1. Roy D. Yates, David J. Goodman, “Probability and Stochastic Processes”, 3rd Edition, An Indian Adaptation, Wiley, 2021, ISBN: 9789354243455.

2. Douglas C. Montgomery and George C. Runger, “Applied Statistics and Probability for Engineers”, 7th Edition, John Wiley & Sons, 2019, ISBN: 9781119570615.

3. Trevor Hastie Robert Tibshirani Jerome Friedman, “The Elements of Statistical Learning - Data Mining, Inference, and Prediction”, 2nd Edition, Springer, 2009 (Reprint 2017), ISBN-10: 0387848576, ISBN-13: 9780387848570.

4. Michael Baron, “Probability and Statistics for Computer Scientists”, 2nd Edition, CRC Press, 2014, ISBN- 13: 978-1-4822-1410-9.

5. Shai Shalev-Shwartz and Shai Ben-David “Understanding Machine Learning: From Theory to Algorithms”, 1st Edition, Cambridge University Press, 2014, ISBN: 978-1-107-05713-5.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II

Course Code	:	MME331G	**INDUSTRY 4.0**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	42L	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:		Dr. Gopalakrishna H D				

UNIT - I **8 Hrs**

Fundamentals of Industry 4.0
Introduction, Industry 4.0, RAMI 4.0 (Reference Architecture Model Industry 4.0), Servitization, Product Service-System (PSS) Industry 4.0 across the Sectors Introduction, Transportation 4.0: Multimodal Transportation Systems, Rail 4.0, Digital Transformation of Railways, Logistics 4.0 (Implications), Fundamentals of Industry 4.0, Introduction, Industry 4.0, RAMI 4.0 (Reference Architecture Model Industry 4.0), Servitization, Product Service-System (PSS)
Industry 4.0 across the Sectors
Introduction, Transportation 4.0: Multimodal Transportation Systems, Rail 4.0, Digital Transformation of Railways, Logistics 4.0 (Implications)

UNIT - II **8 Hrs**

The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.

UNIT - III **8 Hrs**

Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing.
Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns.
Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.

UNIT - IV **9 Hrs**

Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing.
Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software.

UNIT - V **9 Hrs**

Augmented Reality: Definitions and application of AR, VR, MR, Limitations of AR, VR, Hardware devices and Software systems, Technical issues and challenges in AR, Industrial applications, IoT and the Need for Data Rationalization
Internet of Things (IoT), Internet of Things Vision, Internet of Things (IoT) Frameworks, Architecture of Internet of Things (IoT), Visualizing the Internet of Things (IoT), Essential Technologies of the Internet of Things (IoT), Key Technologies Involved in Internet of Things, Enablers of IoT, Collaborative Operations , Training.
Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward.
A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.

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

CO1	:	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals
CO2	:	Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services
CO3	:	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4	:	Evaluate the effectiveness of Cloud Computing in a networked economy

Reference Books:

1. Alasdair Gilchrist, Industry 4.0 The Industrial Internet Of Things, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2. Alp Ustundag, Emre Cevikcan, Industry 4.0: Managing The Digital Transformation, Springer, 2018 ISBN 978-3-319-57869-9.
3.Ovidiu Vermesan and Peer Friess, Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Rivers Publishers, 2016 ISBN 978-87-93379-81-7
4.Christoph Jan Bartodziej, The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: II						
Course Code	:	MBT433P	**BIOPYTHON LABORATORY**	CIE Marks	:	50
Credits L-T-P	:	1-0-1		SEE Marks	:	50
Hours	:	14L+28P	*(Coding / Skill Laboratory)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Shivandappa			

Content **28 Hrs**

1. Accessing, retrival and parsing sequence information 2. Sequence alignment - pairwise and multple sequence alignment 3. de novo genome assembly 4. Network analysis using transcriptomic data 5. Metagenomic analysis 6. ChipSeq analysis 8. Genome and Proteome annotation 9. Differential Gene Expression Assay 10. High throughput virtual screening of ligand library

Course Outcomes:

After going through this course the student 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	:	1. Accessing, retrival and parsing sequence information 2. Sequence alignment - pairwise and multple sequence alignment 3. de novo genome assembly 4. Network analysis using transcriptomic data 5. Metagenomic analysis 6. ChipSeq analysis 8. Genome and Proteome annotation 9. Differential Gene Expression Assay 10. High throughput virtual screening of ligand library. 11. Metaproteomic analysis of microbiota sample. 12. Proteomics analysis of SARS-CoV-2 infected cell proteome. 13. Proteomics analysis of naso-pharyngeal swabs samples from COVID-19 infected samples 14. Proteomic analysis of the respiratory tract samples from CoviD-19 infected cell proteome.
CO3	:	Analyze and evaluate programming applications of Python with case studies related to basic sequence anysis, genome and proteome analysis as well as annotation.
CO4	:	Design and implement basic workflows to perform high throughput data analysis in the field Next Genration Sequencing data analysis and structure analysis.

Scheme of Continuous Internal Evaluation (CIE- Laboratory) : Only LAB Course 30 + 10 + 10 = 50. The Laboratory session is held every week as per the timetable and the performance of the student is evaluated in every session. The average of marks over number of experiments conducted over the weeks is considered for 30 Marks i.e (Lab Report, Observation & Analysis). The students are encouraged to implement additional innovative experiments in the lab (10 marks). At the end of the semester a test is conducted for 10 Marks (Lab Test). This adds to 50 Marks.

Scheme of Semester End Examination (SEE- Laboratory) : Only LAB Course 40 + 10 =50. Students will be evaluated for Write-up, Experimental Setup, Experiment Conduction with Results, Analysis & Discussions for 40 Marks and Viva will be conducted for 10 Marks adding to 50 Marks.

Only LAB Courses with 50 Marks

RUBRIC FOR CIE			RUBRIC FOR SEE	
Sl.No	Content	Marks	Content	Marks
1	Write Up, Setup, Conduction Results, Analysis & Discussions	30	1. Write Up, Setup, Conduction 2. Results, Analysis & Discussions	40
2	Innovative Experiment/Concept Design & Implementation	10		
3	Laboratory Internal	10	Viva Voce	10
	Total Marks	50	Total Marks	50

Phase *	Activity
I	Test 1 is conducted after completion 9 of hours of training program (3 Class) for 50 marks Part A- Quiz for 15 Marks and Part B for 50 Marks (Descriptive answers). Part B – 50 Marks is consolidated to 35 and total marks on 50 is 15 + 35 = 50 Marks.
II	Test 2 is conducted after completion 18 hours of training program (6 Class) for 50 marks Part A- Quiz for 15 Marks and Part B for 50 Marks (Descriptive answers). Part B – 50 Marks is consolidated to 35 and total marks on 50 is 15 + 35 = 50 Marks.
Average of 2 tests is considered as final CIE marks.	
Semester End Examination: SEE is conducted for 50 Marks for a duration of 2 hours.	

SEMESTER: II						
Course Code	:	MHS131T	**PROFESSIONAL SKILL DEVELOPMENT- I**	CIE Marks	:	50
Credits L-T-P	:	2-0-0		SEE Marks	:	50
Hours	:	28L	*Common Course to all M.Tech Programs*	SEE Durations	:	2 Hrs
Faculty Coordinator:			Dr. C.Bindu Ashwini			

UNIT - I	4 Hrs
Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis. Resume Writing: Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.	
UNIT - II	8 Hrs
Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution method, Inequalities. Reasoning – a. Verbal - Blood Relation, Sense of Direction, Arithmetic & Alphabet. b. Non- Verbal reasoning - Visual Sequence, Visual analogy and classification. Analytical Reasoning - Single & Multiple comparisons, Linear Sequencing. Logical Aptitude, - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. Verbal Analogies/Aptitude – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving,	
UNIT - III	6 Hrs
Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews	
UNIT - IV	5 Hrs
Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion(Assertiveness) and presentation skills;	
UNIT - V	5 Hrs
Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited). Leadership Skills: Ethics and Integrity, Goal Setting, leadership ability.	

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

CO1	:	Develop professional skill to suit the industry requirement.
CO2	:	Analyze problems using quantitative and reasoning skills
CO3	:	Develop leadership and inter personal working skills.
CO4	:	Demonstrate verbal communication skills with appropriate body language.

Reference Books:

1. The 7 Habits of Highly Effective People, Stephen R Covey Free Press, 2004 Edition, ISBN: 0743272455

2. How to win friends and influence people, Dale Carnegie General Press, 1st Edition, 2016, ISBN: 9789380914787

3. Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204

4. Ethnus, Aptimithra: Best Aptitude Book ,2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Phase *	Activity
I	Test 1 is conducted after the completion of 9 hours of training programme (3 Classes). Question paper will have two parts. Part A will be Quiz for 10 Marks and Part B for 50 Marks Descriptive answers.
II	Test 2 is conducted after the completion of 18 hours of training programme (6 Classes). Question paper will have two parts. Part A will be Quiz for 10 Marks and Part B for 50 Marks Descriptive answers. Total test marks will be reduced to 30 Marks and Total Quiz marks will be 20 Marks. Final CIE would be 50 Marks.
CIE marks 20 Quiz + 30 Test = 50 Marks	
Semester End Examination: SEE is conducted for 50 Marks for a duration of 2 hours.	

SEMESTER: III						
Course Code	:	MBT461T	**DOWNSTREAM PROCESS TECHNOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3- 1 - 0		SEE Marks	:	100
Hours	:	42L + 28T	*Professional Core - 5*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr A V Narayan			

UNIT - I	**8 Hrs**
Introduction to downstream processing, Recovery of intracellular and extracellular products, cell disruption techniques, differential and ultracentrifugation, scale up and selection of centrifuge. Numericals on centrifugation	
UNIT - II	**9 Hrs**
Filtration and Purification: Filtration, Pre-filtration, depth filtration, mechanism of depth filtration, modules of depth filtration. Flow rates and pressure variations in depth filtration. Membrane filtration, microfiltration, ultrafiltration, Diafiltration, cross-flow filtration, transmembrane pressure and Flux calculations with numerical. Virus removal methods: Viral removal and deactivation methods, Viral filtration, uv-radiation, membrane filtration for virus removal. Methods of operation and scale up activities for viral clearance.	
UNIT - III	**9 Hrs**
Chromatography: Introduction to chromatography, Types of chromatography: -Affinity chromatography, mechanism. - Membrane chromatography, types of membranes used in bioprocess, compatibility of membranes, biofouling of membranes, concentration polarization and methods of control. Membrane chromatography modules and mechanism and scale-up techniques for purification of biomolecules, Electrochromatography, Simulated moving bed chromatography.	
UNIT - IV	**8 Hrs**
Drying: Drying curve, Batch and continuous dryers, Freeze drying, spray drying. Crystallization: Principles of crystallization. Extraction: process details, selection of solvent, percentage extraction, distribution coefficient. Adsorption: Types of adsorption, different adsorbents, isotherms.	
UNIT - V	**8 Hrs**
Current Scenario in the bioprocess industries Process design criteria for low volume high value products and high volume low value products. Process economics: cost cutting strategies, costing for purification of a by-product. Case-Studies Purification Case studies on monoloclonal antibodies (mAbs), recombinant proteins, bacterial vaccines, viral vaccines. Downstream processing of albumin and clotting factors, interferons, tissue pasminogen activator	

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

CO1	:	Summarize the current process involved in industrial purification of biological products
CO2	:	Acquire the knowledge on different filtration and purification techniques
CO3	:	Understand the different types of chromatography and viral reduction, removal and its importance
CO4	:	Overview on case studies pertaining to bioproducts currently in market

Reference Books

1. Uwe Gottschalk, Process Scale Purification of Antibodies, 2nd edition, John Wiley & Sons,2017,ISBN: 978-1-119-12691-1

2. Harrison R.G. Todd P. Rudge S.R. and D.P. Petrides, Bioseparations Science and Engineering, 2nd edition, Oxford University Press, 2015, ISBN: 9780195391817

3. Mukesh Doble, Principles of Downstream Processing in Biological and Chemical Processes, 1st edition. CRC Press, Taylor & Francis group, 2015, ISBN 9781771881401

4. Nooralabettu Krishna Prasad, Downstream Process Technology: A New Horizon in Biotechnology, 1st edition, PHI Learning Publications, 2010, ISBN: 978-81-203-4040-4

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: III						
Course Code	:	MBT361D1	**IMMUNOTECHNOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3- 1 - 0		SEE Marks	:	100
Hours	:	42L + 28T	*Elective E (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Ashwani Sharma			

UNIT - I	**9 Hrs**
Introduction to Immune System, organs, cells and molecules involved in innate and adaptive immunity.Hematopoiesis and its regulation, role of cytokines, chemokines and leukotrienes, phagocytosis and microbicidal mechanisms. Immediate hypersensitivity: role of eosinophils, and mast cells. Genetic basis of immune response – Heterogenecity; Immune modulators.	
UNIT - II	**9 Hrs**
Receptors of innate immunity: Toll-like receptors, opsonization, Immunochemistry of Antigens - Immunogenicity, Antigenicity, haptens, super antigens , Toxins-Toxiods, Hapten carrier system. B and T cell epitopes, T cell receptors, Activation of T cells, APC-T cell interaction, Differentiation and activation of B cells, BCR and its editing, Major Histocompatibility Complex: genetic organization of H2 and HLA complexes. Class I and class II MHC molecules, MHC restriction. Antigen processing and presentation pathways.	
UNIT - III	**8 Hrs**
Antibody structure and function: Classification of immunoglobulins, immunoglobulin domains, concept of variability, isotypes, allotypes and idiotypic markers. Antigen-antibody interactions, Immunoglobulin genes, VJ/VDJ rearrangements and genetic mechanisms responsible for antibody diversity,Class switching, The complement system: classical and alternative pathways.	
UNIT - IV	**8 Hrs**
Hybridoma, monoclonal antibodies, and antibody engineering, Immunological Techniques antibody generation, detection of molecules using ELISA, RIA, Western blot, immunoprecipitation, flowcytometry, immunofluorescence microscopy, Insitu localization techniques such as FISH,GISH, Monoclonal antibodies and their application.	
UNIT - V	**8 Hrs**
Application of immunological principles- Transplantation immunology- immunological basis of graft rejection and its clinical manifestations, immunosuppressive therapy, Immunostimulants, Vaccines: types, recombinant vaccines and clinical applications, Tumor immunology and autoimmunity.	

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

CO1	:	Apprehend the concepts of immunity and immune reactions.
CO2	:	Analyze the various types of immune responses
CO3	:	Apply the knowledge of immunology to identify various immunological reactions and interactions
CO4	:	Evaluate the significance and applications of various immunological techniques.

Reference Books

1. Ashim K. Chakravarthy. Immunology and Immunotechnology, 1st edition, Oxford University Press. 2006. 9780195676884
2. T. Kindt, R. Goldsby, B. A. Osborne, Kuby Immunology, 6th edition, W. H. Freeman Publishers, 2006. ISBN-13 : 978-0716767640
3. Ken Murphy, Paul Travers, Mark Walport, Immunobiology, 7th edition, Garland Science Publishers. 2008, ISBN-13 : 978-0815341239
4. Eli Benjamini, Richard Coico, Geoffrey Sunshine, Immunology: A short course, 5th edition Wiley Liss, NY, 2003. ISBN-13 : 978-0471348900

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: III						
Course Code	:	MBT261D2	**NEXT GENERATION SEQUENCING**	CIE Marks	:	100
Credits L-T-P	:	3- 1 - 0		SEE Marks	:	100
Hours	:	42L + 28T	*Elective E (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Vidya Niranjan			

UNIT - I	**9 Hrs**
Introduction to Sequencing technology: Sequencing platforms, Chemistry of difference sequencing platforms, Advantages and disadvantages of the platforms, Need of Hybrid platforms. Base calling algorithms, Base quality, Phred values, Reads quality checks, Interpretations from quality checks. Adapter and primer contamination, Adapter trimming and trimming of low-quality reads. Processing reads using clipping of reads-Advantages and disadvantages of processing of reads	
UNIT - II	**9 Hrs**
Approaches and Basic tools in high throughput data analysis: NGS data –Retrieval, Format Conversion, Alignment and Assembly, Visualization, Variant Calling, Annotation, Gene–Level Statistical Analyses, Gene Expression analysis. FastQC Toolkit, Burrows-Wheeler Aligner (BWA) and Bowtie Alignment programs, burrows wheeler algorithm. Reference indexing and Alignment. Building from source, The bowtie aligner, -n alignment mode, -v alignment mode, Reporting Modes, Paired-end Alignment, Colorspace Alignment, Colorspace reads, Building a colorspace index, Decoding colorspace alignments, Paired-end colorspace alignment, File formats in NGS, Artifacts in alignment programs.	
UNIT - III	**8 Hrs**
Big Data Analytics: Introduction to Cloud computing, Hadoop architecture. MIKE2.0, Multiple layer architecture, Distributed Parallel architecture, NGS data analysis using Hadoop. HPC overview and programming: Introduction to Linux operating system, Secure shell script: basic tools and commands, Basic Linux Commands, Basic commands used in HPC cluster, Major components and its functions in HPC Cluster- head node, login node, interactive node, compute node, I/O node, HPC Data Storage, Serial and parallel batch jobs and scripting to run processes in parallel.	
UNIT - IV	**8 Hrs**
Workflows for NGS Data analytics: Whole Genome Sequencing: Tools, Pipeline and command line scripts for execution of pipeline. Human Exome sequencing, Transcriptome sequencing, CHIP Sequencing, small RNA sequencing, Methylome sequencing, RAD Sequencing and RRL sequencing, Metagenome sequencing: 16s amplicon sequencing whole metagenome sequencing, Targeted Sequencing, New era for NGS analysis, New tools and techniques and implemetation.	
UNIT - V	**8 Hrs**
Specific Applications of NGS informatics: States of the genetic research for complex disease, NGS and genetics of complex disease, Personal genome sequencing, Disease gene identification, Next generation sequencing in cancer research, Clinical sequencing, Diagnostic NGS, Applications of NGS in Agriculture for crop improvement, NGS in Pharmaceutical development	

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

CO1	:	Understand the basic knowledge of Next Generation Sequencing
CO2	:	Analyze and apply the appropriate tools and techniques to perform high throughput data analysis
CO3	:	Design pipeline for various applications of NGS analysis
CO4	:	Develop high throughput data analysis tools for various biological applications

Reference Books

1. Stuart M. Brown, Next-generation DNA sequencing informatics, 2nd edition, Cold Spring Harbor Laboratory Press, 2015, ISBN-13 : 978-1621821236

2. Naiara Rodríguez-Ezpeleta, Michael Hackenberg, Ana M. Aransay, Bioinformatics for High Throughput Sequencing, 1st edition, Springer, 2011, ISBN: 978-1-4614-0781-2

3. Kulski, J. Next Generation Sequencing - Advances, Applications and Challenges,1st editon, Intech, 2017, ISBN13: 978-953-51-2240-1

4. Urszula Demkow and RafalPloski, Clinical Applications for Next-Generation Sequencing, 1st edition, Academic Press, 2015, ISBN-13 : 978-0128017395

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: III						
Course Code	:	MBT362D3	**DESIGN AND DRAWING OF BIOREACTORS**	CIE Marks	:	100
Credits L-T-P	:	3- 1 - 0		SEE Marks	:	100
Hours	:	42L + 28T	*Elective E (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr G Vijaya kumar			

UNIT - I	**9 Hrs**
Design of Batch reactor: Process design of Batch Reactor with agitator, number of blades, baffles and shaft. Drawing of the designed batch (Sectional front view and top view) using CAED.	
UNIT - II	**9 Hrs**
Design of fedbatch reactor: Process design of FedBatch Reactor with agitator, number of blades, baffles and shaft. Drawing of the designed batch (Sectional front view and top view) using CAED.	
UNIT - III	**8 Hrs**
Design of Continuous Bioreactors: Process design of Continuous Batch Reactor with agitator, number of blades, baffles and shaft. Drawing of the designed batch (Sectional front view and top view) using CAED.	
UNIT - IV	**8 Hrs**
Mass Transfer and Rheology: Mass transfer in bioreactors, Rheology of fermentation broths, Heterogeneous reactions in bioprocesses.	
UNIT - V	**8 Hrs**
Scaleup of Bioreactors: Heat Transfer in Bioreactors, Scale up of Bioreactors: Criteria for scaleup, Non Ideal reactors: Design and Analysis	

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

CO1	:	Understand design procedure for various bioreactors.
CO2	:	Apply Biochemical engineering principles to design various bioreactors.
CO3	:	Estimate physical dimensions of various parts of bioreactors and accessories
CO4	:	Analyze various design options at all design stages to scaleup bioreactors

Reference Books

1. Michael Shuler and Fikret Khargi, Bioprocess Engineering, Basic Concepts, 2nd Edition, Prentice Hall, 2015, ISBN:978-9332549371

2. Robert H Perry and Don W Green, Perrys Chemical Engineering Handbook, 7th Edition, McGraw Hill, 1998, ISBN:115982-7

3. Tapobrata Panda, Bioreactors Analysis and Design, 1st Edition, Tata McGraw-Hill, 2011, ISBN:9781259005725

4. V V Mahajani and S B Umarji, Joshi's Process Equipment Design, 5th Edition, Trinity Press, 2016, ISBN: 978935138019

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE			***RUBRIC for SEE***		
Sl.No	**Content**	**Marks**	**Q. No**	**Contents**	**Marks**
1	Quizzes - Q1 & Q2	20	Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
2	Tests - T1 & T2	40			
3	Experiential Learning - EL1 & EL2	40	1 & 2	Unit-1: Question 1 or 2	20
	Total Marks	100	3 & 4	Unit-2: Question 3 or 4	20
			5 & 6	Unit-3: Question 5 or 6	20
			7 & 8	Unit-4: Question 7 or 8	20
			9 & 10	Unit-5: Question 9 or 10	20
				Total Marks	100

SEMESTER: III						
Course Code	:	MBT363D4	**TOXICOLOGY IN LIFE SCIENCES**	CIE Marks	:	100
Credits L-T-P	:	3- 1 - 0		SEE Marks	:	100
Hours	:	42L + 28T	*Elective E (Professional Elective)*	SEE Durations	:	3 Hrs
Faculty Coordinator:			Dr Raju H			

UNIT - I	**9 Hrs**
Toxicology and Toxicological Chemistry: Inorganic, Organic and Radioactive toxic Elements; Fate of Toxins; Toxic Effect of Natural and Synthetic Products; Ecotoxicology; Toxicology of Organs and Organ Systems; Biomarkers in toxicology; Quantitative Assessments of Biochemical Analyses; Tissues and Primary Cultures for Toxicity Studies.	
UNIT - II	**9 Hrs**
Movement and Distribution of Toxins: Enteral and Parenteral sites of toxicants absorption, Active and Passive transport mechanism in cell membranes, Volume of Distribution, Storage of Toxicants in Tissues, Blood–Brain Barrier, Passage of Toxicants Across the Placenta, Redistribution of Toxicants, Excretion of Toxicants	
UNIT - III	**8 Hrs**
Evaluation of Toxicity and Risk Assessment: Principles of Pharmacology and Toxicology, Factors Affecting Toxicity of Nanomaterials: Impact of Physiochemical Properties and Surface Chemistry of Nanomaterials on Toxicity. Predicting and Assessment of Toxicity Risk. Xenobiotic agents and microbial susceptibility, Toxicity of Metals, Organic Solvents and Related Chemicals, Food Additives, Drug Residues, and Food Contaminants, Pesticides, Mycotoxins and Toxins from Unicellular Organisms	
UNIT - IV	**8 Hrs**
Mechanisms of Minimizing Toxic Effects: Organic Compounds and Metal Detoxification, Regulation, and Sequestration, Stress Proteins and Proteotoxicity, Oxidative Stress, Enzyme Dysfunction, Heme Biosynthesis Inhibition, Oxidative Phosphorylation Inhibition, Ionic and Osmotic Regulation, Acid–Base Regulation.	
UNIT - V	**8 Hrs**
Preventive mesures of toxicity: Principles and Housing regulations, Housing Structure, Control of disease Vectors and Pests, Indoor Air Pollutants and Toxic Materials, Water Supplies and Water-Quality Issues, Medication Errors and Prevention, Chemical additives in food and cosmetics, Safety testing of new drugs. Detection of poisons, toxins, antidotes and antivenoms	

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

CO1	:	Summarize the current toxicity involved in biological products
CO2	:	Analyze the various types of toxicicological materials and responses
CO3	:	Apply the knowledge of Movement and Distribution of Toxins to identify various reactions and interactions
CO4	:	Overview on case studies pertaining to mechanisms of minimizing and priventive toxic effects

Reference Books

1. A. Hayes, Tao Wang, Darlene Dixon, Ted Loomis, Essentials of Toxicology, 5th Edition, Academic Press, 2019, ISBN 9780128159224

2. Gulzar Ahmad Nayik, Jasmeet Kour, Handbook of Plant and Animal Toxins in Food, 1st Edition, CRC Press Publisher, 2022, ISBN 9781032013954

3. Richard B. Philp, Ecosystems and Human Health: Toxicology and Environmental Hazards, 3rd edition, CRC Press, 2017, ISBN 9781138073951

4. Michael C. Newman, William H. Clements, Ecotoxicology, A Comprehensive Treatment, 1st Edition, CRC Press, 2018, ISBNISBN 9781138582804

Scheme of Continuous Internal Evaluation (CIE): 20 + 40 + 40 = 100

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.

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.

EXPERIENTIAL LEARNING: Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning and Program specific requirements (15), Video based seminar/presentation/demonstration (25) adding upto 40 marks.

Scheme of Semester End Examination (SEE) for 100 marks: The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Rubric for CIE & SEE Theory courses

RUBRIC for CIE

Sl.No	Content	Marks
1	Quizzes - Q1 & Q2	20
2	Tests - T1 & T2	40
3	Experiential Learning - EL1 & EL2	40
	Total Marks	100

RUBRIC for SEE

Q. No	Contents	Marks
Each unit consists of TWO questions of 20 Marks each. Answer FIVE full questions selecting ONE from each unit (1 to 5).		
1 & 2	Unit-1: Question 1 or 2	20
3 & 4	Unit-2: Question 3 or 4	20
5 & 6	Unit-3: Question 5 or 6	20
7 & 8	Unit-4: Question 7 or 8	20
9 & 10	Unit-5: Question 9 or 10	20
	Total Marks	100

SEMESTER III

Course Code	:	MBT461N	**INTERNSHIP**	CIE Marks	:	50
Credits L-T-P	:	0 - 0 - 6		SEE Marks	:	50
Hours/Week	:	12		SEE Durations	:	3 Hrs

Guidelines:

1. The duration of the internship shall be for a period of 6 weeks on full time basis after II semester final exams and before the commencement of III semester.
2. The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3. Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.
4. Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5. Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. 6. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be softbound in Ivory color for PG circuit
Programs and Light Blue for Non-Circuit Programs.

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

CO1: Apply Engineering and Management principles to solve the problems CO2: Analyze real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and lifelong learning

Scheme of Continuous Internal Evaluation (CIE):

The evaluation committee shall consist of Guide, Professor, Associate Professor/Assistant Professor. The committee shall assess the presentation and the progress reports.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
I	Application of Engineering knowledge in industries, ability to comprehend the functioning of the Organization/ Departments.	40%
II	Importance of Resource Management, Environment and Sustainability. Demonstration and Presentation of Internship work with Report Submission	60%

Scheme for Semester End Evaluation (SEE):

The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

SEMESTER III

Course Code	:	MBT461P	**MINOR PROJECT**	CIE Marks	:	50
Credits L-T-P	:	0 - 0 - 6		SEE Marks	:	50
Hours/Week	:	12		SEE Durations	:	3 Hrs

Guidelines:

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The minor project would be performed in-house.
5. The implementation of the project must be preferably carried out using the resources available in the department/college.

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

CO1: Conceptualize, design and implement solutions for specific problems. CO2: Communicate the solutions through presentations and technical reports. CO3: Apply resource managements skills for projects.
CO4: Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination

Evaluation shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor and Associate Professor/Assistant Professor.

Phase *	Activity	Weightage
I	Approval of the selected topic, formulation of Problem Statement and Objectives with Synopsis submission	20 %
II	Mid-term seminar to review the progress of the work with documentation	40 %
III	Oral presentation, demonstration and submission of project report	40 %

* Phase wise rubrics to be prepared by the respective departments

CIE Evaluation shall be done with weightage / distribution as follows:

• Selection of the topic & formulation of Problem Statement and Objectives	10 %
• Design and simulation/ Algorithm development/ Experimental setup	25 %
• Conducting experiments/ Implementation / Testing	25 %
• Demonstration & Presentation	25 %
• Report writing	15 %

Scheme of Semester End Examination (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

- Brief write up about the project 05%
- Methodology and Experimental Results & Discussion 20%
- Presentation / Demonstration of the Project 25%
- Report 20%
- Viva Voce 30%

SEMESTER IV

Course Code	:	MBT491P	**MAJOR PROJECT**	CIE Marks	:	100
Credits L-T-P	:	0 - 0 - 18		SEE Marks	:	100
Hours/Week	:	36		SEE Durations	:	3 Hrs

Guidelines:

1. Major Project is to be carried out for a duration of 18 weeks
2. Students must adhere to the Project Presentation Schedule, report to their guide on a weekly basis and get their Project diary signed by their guide 4. Students must execute the Major Project individually and not in teams.
5. It is mandatory for the students to present/publish their project work in National/International Conferences or Journals
6. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be soft bound and in Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs

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

CO1: Conceptualize, Design and Implement solutions for specific problems. CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics and societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination

Evaluation shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor, Associate Professor/Assistant Professor.

Phase *	Activity	Weightage
I	Selection of Project Title, Formulation of Problem Statement and Objectives	20 %
II	Design, Implementation and Testing	40 %
II	Experimental Result & Analysis, Conclusions and Future Scope of Work, Report Writing and Paper Publication	40 %

* Phase wise rubrics to be prepared by the respective departments

Scheme for Semester End Evaluation (SEE):

Major Project SEE evaluation shall be conducted in two stages. This is initiated after fulfilment of submission of Project Report and CIE marks.

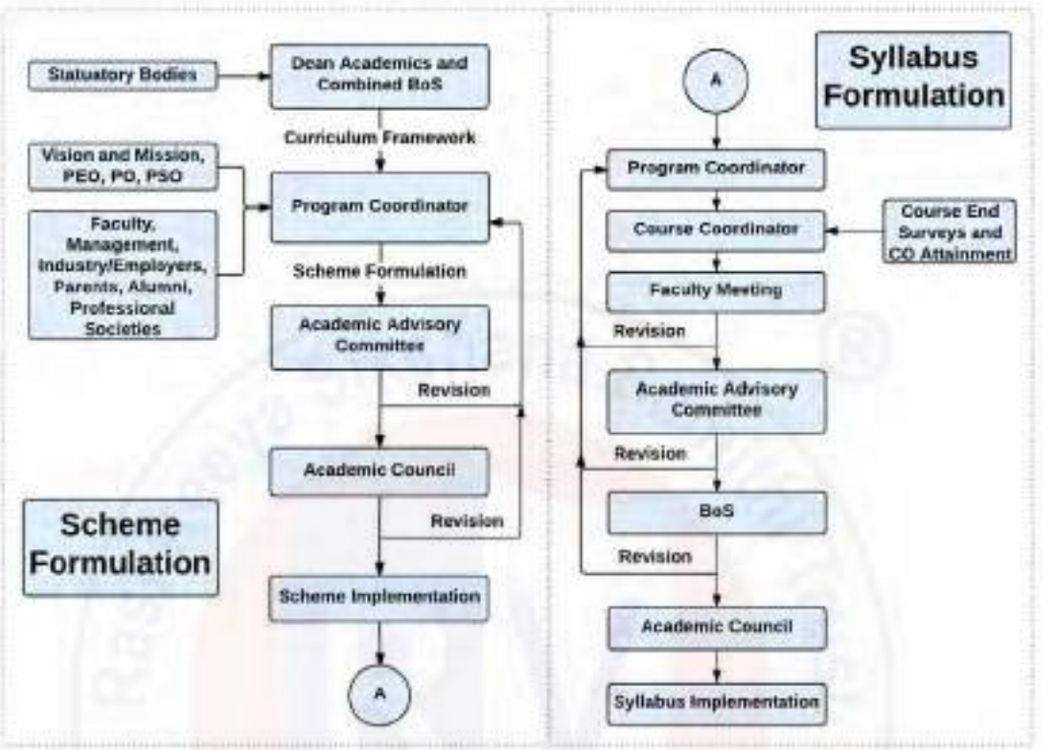
Stage-1 Report Evaluation: Evaluation of Project Report shall be done by the Guide and an External examiner.

Stage-2 Project Viva-voce: Major Project Viva-voce examination is conducted after receipt of evaluation reports from Guide and External examiner.

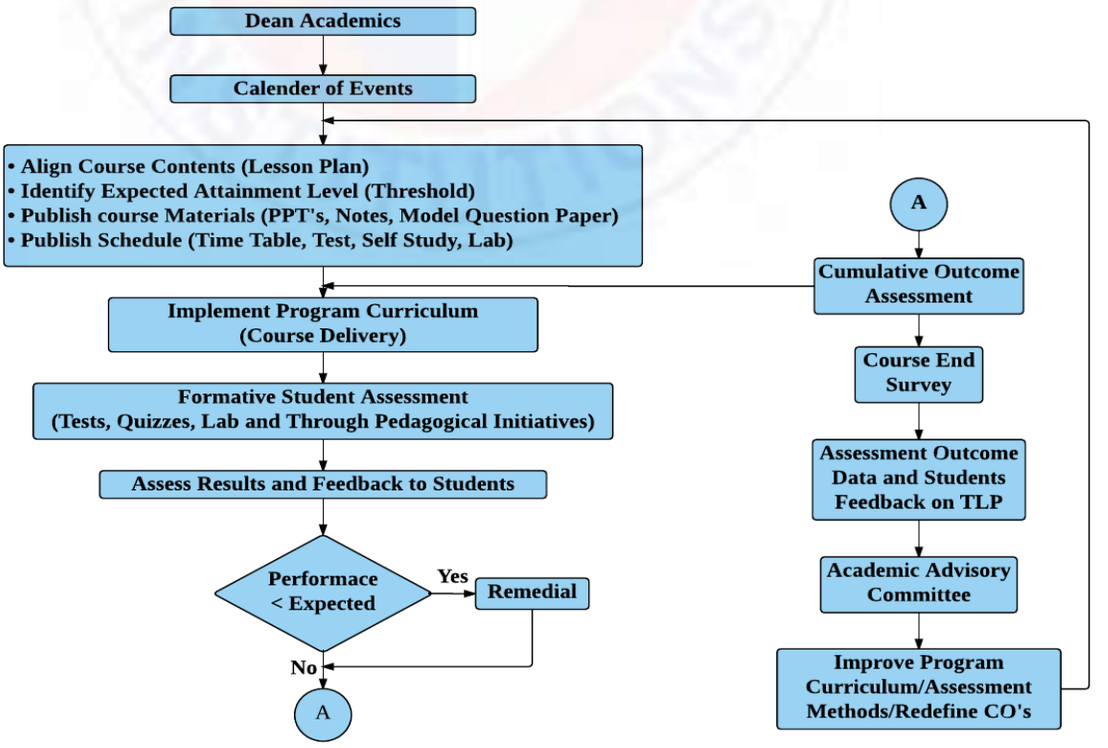
SEE procedure is as follows:

Report Evaluation	Internal Examiner: 100 Marks	**= 200**	
	External Examiner: 100 Marks	200 / 2 = **100**	**A**
Viva-Voce	Jointly evaluated by Internal Guide & External Evaluator	**= 100**	**B**
	Total Marks = (A + B) / 2 =	**100**	

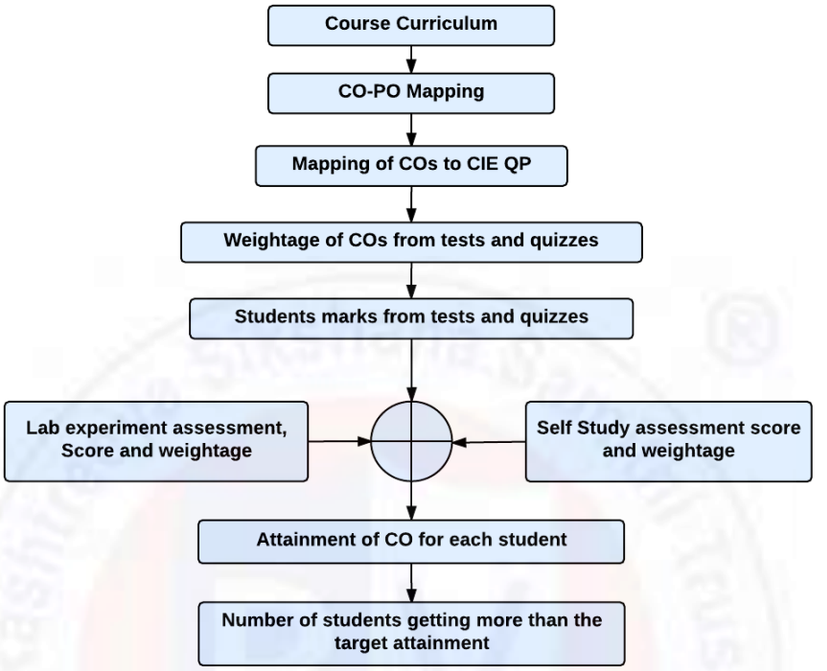
Curriculum Design Process



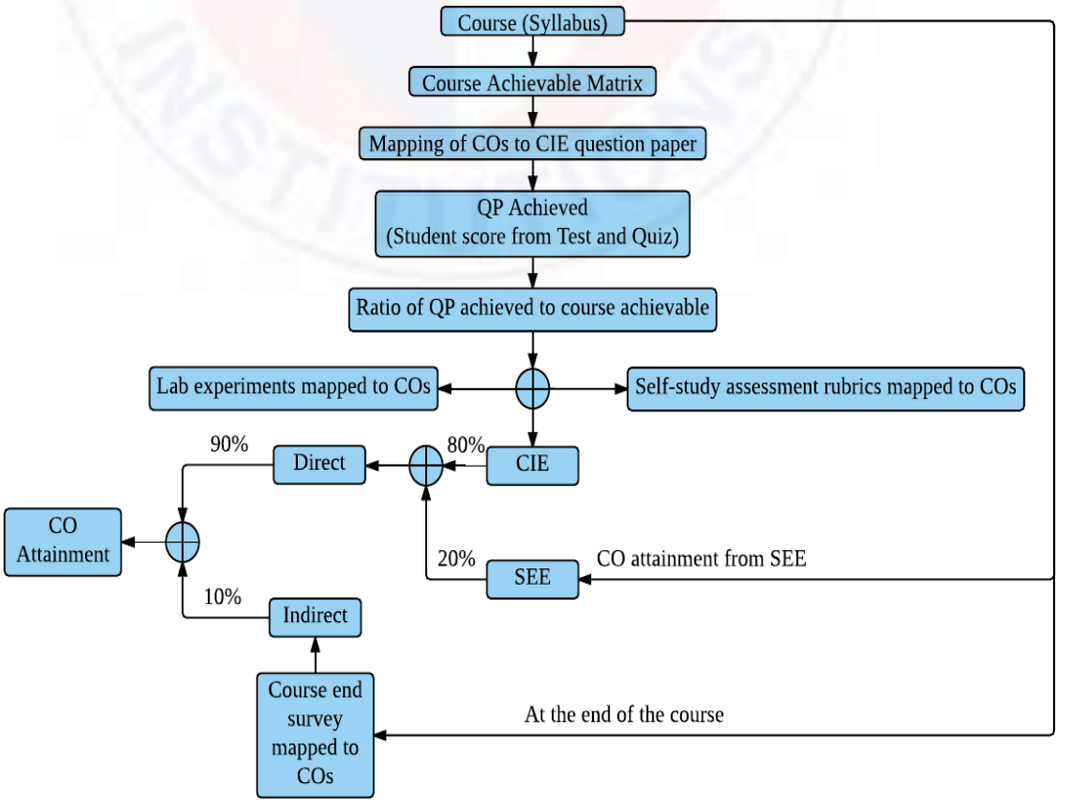
Academic Planning And Implementation



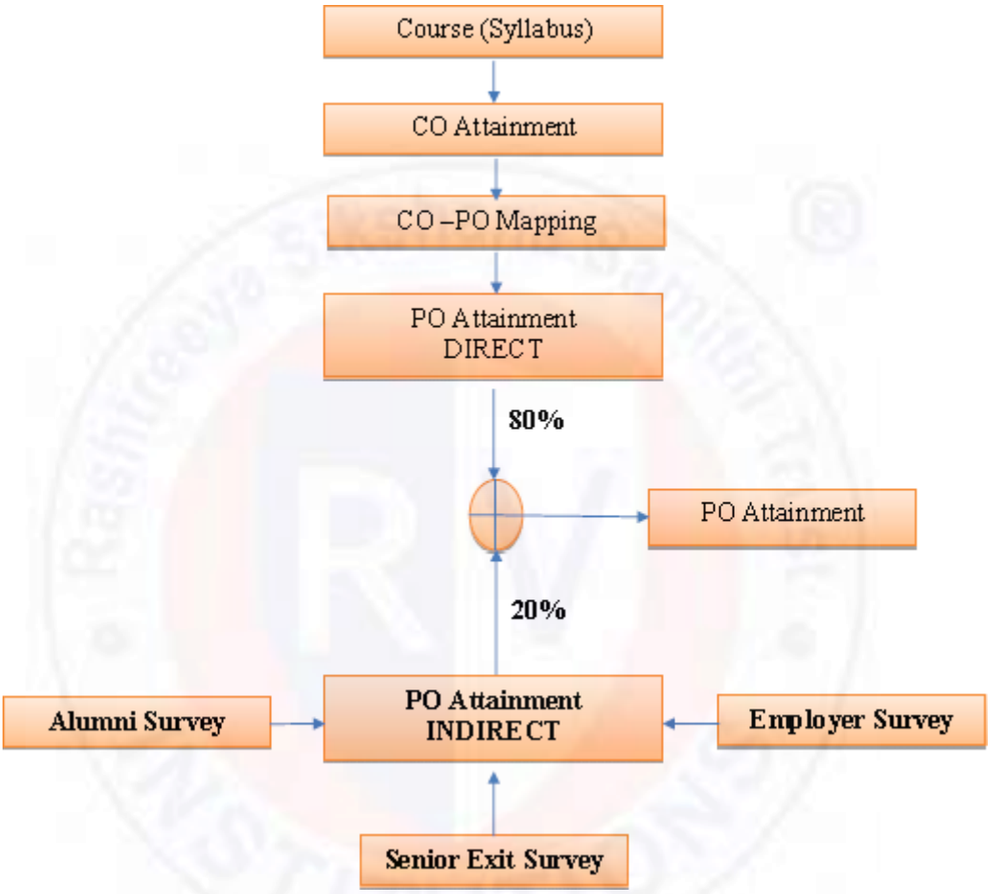
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



INNOVATIVE TEAMS OF RVCE

1. Ashwa Racing : Ashwa Mobility Foundation (AMF) is a student R&D platform that designs and fabricates Formula-themed race cars and future mobility solutions to tackle urban transportation problems.
2. Astra Robotics Team : Involved in the design, fabrication, and building of application-specific robots.
3. Coding Club : To facilitate students in acquiring the skills, confidence, and opportunities to change their world using coding. The club aims to help students become successful in GSoC, ACM-ICPC, and other recognized coding competitions.
4. Entrepreneurship Development Cell : E-Cell is a student-run body that aims to promote entrepreneurship by conducting workshops, speaker sessions, and discussions on business andits aspects. The organization possesses a mentor board to help startups grow.
5. Frequency Club Team : This team contributes to both software and hardware domains, mainly focusing on Artificial Intelligence, Machine Learning, and its advances.
6. Team Garuda : Design and development of a supermileage urban concept electric car. Indigenous development of E-mobility products.
7. Team Jatayu : Aims to build a low-cost Unmanned Aerial Vehicle capable of autonomous navigation, obstacle avoidance, object detection, localization, classification, and air drop of a package of optimum weight.
8. Solar Car : Aims to build a roadworthy solar electric vehicle to contribute to a green and sustainable environment.
9. Team Antariksh : A Space Technology Student Club whose goal is to understand, disseminate, and apply engineering skills for innovation in the field of Space technology, including the development of operational rockets of various altitude platforms.
10. Team Chimera : Building a Formula Electric Car through research and development inE-Mobility.Electrifying Formula Racing.
11. Helios Racing Team : Involved in the design, manufacturing, and testing of All-Terrain Vehicles and other supportive tasks for the functioning of the team. Participating in BAJA competitions organized by SAE in India and the USA.
12. Team Hydra : Developing autonomous underwater vehicles for various real-world applications such as water purification, solid waste detection and disposal, etc.
13. Team Krushi : Aims to develop low-cost equipment to help farmers in cultivating and harvesting. Uses new technology applications to reduce labor time and cost for farmers. Aims at developing implements for tractors.
14. Team Vyoma : Design, fabrication, and testing of radio-controlled aircraft and research on various types of unmanned aerial vehicles.
15. Team Dhruva : Organizing activities like quizzes based on astronomy, stargazing, and telescope handling sessions. Construction of a standard observatory and working on small projects with organizations like ICTS, IIA, ARIES, etc.
16. Ham Club : To popularize Amateur Radio as a hobby among students, alongside exploring technical innovations in the communications domain. Intended to provide human capital for service to the nation during times of natural calamities.

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 InclusiveTechnology

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 againstthe global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

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