



VIT[®]
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF BIO SCIENCES AND TECHNOLOGY

B.Tech Biotechnology

(B.Tech BBT)

Curriculum

(2021-2022 admitted students)



VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF BIO SCIENCES AND TECHNOLOGY

To nurture high-quality bioengineers and science graduates with the potential to innovate, invent and disseminate knowledge for the benefit of society and environment.

MISSION STATEMENT OF THE SCHOOL OF BIO SCIENCES AND TECHNOLOGY

- To create opportunities for multi-disciplinary education, training and research in biotechnology and bio-sciences.
- To instill a spirit of innovation and creativity in young minds from across the globe with sound research aptitude.
- To foster ethically strong biologists who effectively contribute towards the growth of the nation.



B.TECH BIOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs).

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems
2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry
3. Graduates will function in their profession with social awareness and responsibility
4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country
5. Graduates will be successful in pursuing higher studies in engineering or management
6. Graduates will pursue career paths in teaching or research



B.TECH BIOTECHNOLOGY

PROGRAMME OUTCOMES (POs).

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_02: Having a clear understanding of the subject related concepts and of contemporary issues and apply them to identify, formulate and analyse complex engineering problems.

PO_03: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_04: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_05: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_06: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_07: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_08: Having a clear understanding of professional and ethical responsibility

PO_09: Having cross cultural competency exhibited by working as a member or in teams

PO_10: Having a good working knowledge of communicating in English – communication with engineering community and society

PO_11: Having a good cognitive load management skills related to project management and finance

PO_12: Having interest and recognise the need for independent and lifelong learning

B.TECH BIOTECHNOLOGY

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of B. Tech. (Biotechnology) programme, graduates will be able to

- PSO1: Apply knowledge to find innovative solutions for biotechnological problems
- PSO2: Explore problems related to biotechnology and provide valid conclusions through industry-academia interface
- PSO3: Infer the potentials and impact of biotechnological innovations for finding sustainable ethical solutions to issues pertaining to health, environment and agriculture



CREDIT INFO		
S.no	Category	Credits
1	Foundation Core	54
2	Discipline-linked Engineering Sciences	11
3	Discipline Core	47
4	Discipline Elective	15
5	Projects and Internship	9
6	Open Elective	15
7	Bridge Course	0
8	Non-graded Core Requirement	11
Total Credits		162

Foundation Core									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	BBIT100L	Biology	Theory Only	1.0	3	0	0	0	3.0
2	BCHY101L	Engineering Chemistry	Theory Only	1.0	3	0	0	0	3.0
3	BCHY101P	Engineering Chemistry Lab	Lab Only	1.0	0	0	2	0	1.0
4	BCSE101E	Computer Programming: Python	Embedded Theory and Lab	1.0	1	0	4	0	3.0
5	BCSE103E	Computer Programming: Java	Embedded Theory and Lab	1.0	1	0	4	0	3.0
6	BECE101L	Basic Electronics	Theory Only	1.0	2	0	0	0	2.0
7	BECE101P	Basic Electronics Lab	Lab Only	1.0	0	0	2	0	1.0
8	BEEE101L	Basic Electrical Engineering	Theory Only	1.0	2	0	0	0	2.0
9	BEEE101P	Basic Electrical Engineering Lab	Lab Only	1.0	0	0	2	0	1.0
10	BENG101L	Technical English Communication	Theory Only	1.0	2	0	0	0	2.0
11	BENG101P	Technical English Communication Lab	Lab Only	1.0	0	0	2	0	1.0
12	BENG102P	Technical Report Writing	Lab Only	1.0	0	0	2	0	1.0
13	BFLE200L	B.Tech. Foreign Language - 2021 onwards	Basket	1.0	0	0	0	0	2.0
14	BHSM200L	B.Tech. HSM Elective - 2021 onwards	Basket	1.0	0	0	0	0	3.0
15	BMAT100L	Mathematics	Theory Only	1.0	3	1	0	0	4.0
16	BMAT101L	Calculus	Theory Only	1.0	3	0	0	0	3.0
17	BMAT101P	Calculus Lab	Lab Only	1.0	0	0	2	0	1.0
18	BMAT202L	Probability and Statistics	Theory Only	1.0	3	0	0	0	3.0
19	BMAT202P	Probability and Statistics Lab	Lab Only	1.0	0	0	2	0	1.0
20	BMAT203L	Linear Algebra and Differential Equations	Theory Only	1.0	3	1	0	0	4.0
21	BPHY101L	Engineering Physics	Theory Only	1.0	3	0	0	0	3.0
22	BPHY101P	Engineering Physics Lab	Lab Only	1.0	0	0	2	0	1.0
23	BSTS101P	Quantitative Skills Practice I	Soft Skill	1.0	0	0	3	0	1.5
24	BSTS102P	Quantitative Skills Practice II	Soft Skill	1.0	0	0	3	0	1.5
25	BSTS201P	Qualitative Skills Practice I	Soft Skill	1.0	0	0	3	0	1.5
26	BSTS202P	Qualitative Skills Practice II	Soft Skill	1.0	0	0	3	0	1.5



Discipline-linked Engineering Sciences

sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	BBIT201L	Principles of Chemical Engineering	Theory Only	1.0	3	0	0	0	3.0
2	BBIT201P	Chemical Engineering Lab	Lab Only	1.0	0	0	2	0	1.0
3	BBIT205L	Bioinformatics	Theory Only	1.0	2	0	0	0	2.0
4	BBIT205P	Bioinformatics Lab	Lab Only	1.0	0	0	2	0	1.0
5	BBIT301L	Principles of Bioprocess Engineering	Theory Only	1.0	3	0	0	0	3.0
6	BBIT301P	Bioprocess Engineering Lab	Lab Only	1.0	0	0	2	0	1.0

Discipline Core

sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	BBIT202L	Biochemistry	Theory Only	1.0	3	0	0	0	3.0
2	BBIT202P	Biochemistry Lab	Lab Only	1.0	0	0	2	0	1.0
3	BBIT203L	Microbiology	Theory Only	1.0	3	0	0	0	3.0
4	BBIT203P	Microbiology Lab	Lab Only	1.0	0	0	2	0	1.0
5	BBIT204L	Cell Biology and Genetics	Theory Only	1.0	3	0	0	0	3.0
6	BBIT204P	Cell Biology and Genetics Lab	Lab Only	1.0	0	0	2	0	1.0
7	BBIT206L	Analytical Techniques in Biotechnology	Theory Only	1.0	3	0	0	0	3.0
8	BBIT206P	Analytical Techniques in Biotechnology Lab	Lab Only	1.0	0	0	2	0	1.0
9	BBIT207L	Molecular Biology	Theory Only	1.0	3	0	0	0	3.0
10	BBIT207P	Molecular Biology Lab	Lab Only	1.0	0	0	2	0	1.0
11	BBIT302L	Genetic Engineering	Theory Only	1.0	3	0	0	0	3.0
12	BBIT302P	Genetic Engineering Lab	Lab Only	1.0	0	0	2	0	1.0
13	BBIT303L	Genomics and Proteomics	Theory Only	1.0	3	0	0	0	3.0
14	BBIT304L	Biochemical Engineering	Theory Only	1.0	2	1	0	0	3.0
15	BBIT305L	Immunology	Theory Only	1.0	3	0	0	0	3.0
16	BBIT305P	Immunology Lab	Lab Only	1.0	0	0	2	0	1.0
17	BBIT306L	Animal Biotechnology	Theory Only	1.0	3	0	0	0	3.0
18	BBIT307L	Plant Biotechnology	Theory Only	1.0	3	0	0	0	3.0
19	BBIT308L	Industrial Biotechnology	Theory Only	1.0	3	0	0	0	3.0
20	BBIT309L	Downstream Processing	Theory Only	1.0	3	0	0	0	3.0
21	BBIT309P	Downstream Processing Lab	Lab Only	1.0	0	0	2	0	1.0

Discipline Elective

sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	BBIT310L	AI in Biology	Theory Only	1.0	3	0	0	0	3.0
2	BBIT311L	Biobusiness	Theory Only	1.0	3	0	0	0	3.0
3	BBIT312L	Pharmaceutical Biotechnology	Theory Only	1.0	3	0	0	0	3.0



Discipline Elective									
4	BBIT313L	Regenerative Medicine	Theory Only	1.0	3	0	0	0	3.0
5	BBIT314L	Stem Cell Technology	Theory Only	1.0	3	0	0	0	3.0
6	BBIT315L	Environmental Biotechnology	Theory Only	1.0	3	0	0	0	3.0
7	BBIT316L	Nanobiotechnology	Theory Only	1.0	3	0	0	0	3.0
8	BBIT317L	Tissue Engineering	Theory Only	1.0	3	0	0	0	3.0
9	BBIT318L	Forensic Science and Technology	Theory Only	1.0	3	0	0	0	3.0
10	BBIT319L	Food Process Engineering	Theory Only	1.0	3	0	0	0	3.0
11	BBIT320L	Medical Diagnostics	Theory Only	1.0	3	0	0	0	3.0
12	BBIT321L	Food Biotechnology	Theory Only	1.0	3	0	0	0	3.0
13	BBIT322L	Cancer Biology and Informatics	Theory Only	1.0	3	0	0	0	3.0
14	BBIT323L	Protein Engineering and Design	Theory Only	1.0	3	0	0	0	3.0
15	BBIT391J	Technical Answers to Real Problems Project	Project	1.0	0	0	0	0	3.0
16	BBIT392J	Design Project	Project	1.0	0	0	0	0	3.0
17	BBIT393J	Laboratory Project	Project	1.0	0	0	0	0	3.0
18	BBIT394J	Product Development Project	Project	1.0	0	0	0	0	3.0
19	BBIT396J	Reading Course	Project	1.0	0	0	0	0	3.0
20	BBIT397J	Special Project	Project	1.0	0	0	0	0	3.0
21	BBIT398J	Simulation Project	Project	1.0	0	0	0	0	3.0
22	BBIT401L	Molecular Modelling and Drug Design	Theory Only	1.0	3	0	0	0	3.0
23	BBIT402L	Neurobiology and Cognitive Science	Theory Only	1.0	3	0	0	0	3.0
24	BBIT403L	Industrial Enzymology	Theory Only	1.0	3	0	0	0	3.0
25	BBIT404L	Emerging and Re-emerging Infectious Diseases	Theory Only	1.0	3	0	0	0	3.0
26	BBIT405L	Biological Data Analysis and Simulation	Theory Only	1.0	3	0	0	0	3.0
27	BBIT406L	Computational Biology	Theory Only	1.0	3	0	0	0	3.0
28	BBIT407L	Biomaterials	Theory Only	1.0	3	0	0	0	3.0
29	BBIT408L	Anatomy and Physiology	Theory Only	1.0	3	0	0	0	3.0
30	BBIT409L	Clinical Data Management	Theory Only	1.0	3	0	0	0	3.0
31	BBIT410L	Pharmacoinformatics	Theory Only	1.0	3	0	0	0	3.0
32	BBIT411L	Preclinical Drug Discovery and Development	Theory Only	1.0	3	0	0	0	3.0
33	BBIT412L	Heat and Mass Transfer	Theory Only	1.0	3	0	0	0	3.0
34	BBIT413P	Applied Biology Lab	Lab Only	1.0	0	0	2	0	1.0
35	BBIT414L	Bioinspired Design	Theory Only	1.0	3	0	0	0	3.0
36	BBIT415L	Food, Nutrition and Health	Theory Only	1.0	3	0	0	0	3.0
37	BBIT416L	Systems Biology	Theory Only	1.0	3	0	0	0	3.0

Projects and Internship									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	BBIT399J	Summer Industrial Internship	Project	1.0	0	0	0	0	1.0
2	BBIT497J	Project - I	Project	1.0	0	0	0	0	3.0
3	BBIT498J	Project - II / Internship	Project	1.0	0	0	0	0	5.0
4	BBIT499J	One Semester Internship	Project	1.0	0	0	0	0	14.0



Open Elective									
sl.no	Course Code	Course Title	Course Type	Ver sio n	L	T	P	J	Credits
1	BECE320E	Embedded C Programming	Embedded Theory and Lab	1.0	2	0	2	0	3.0
2	BHUM201L	Mass Communication	Theory Only	1.0	3	0	0	0	3.0
3	BHUM202L	Rural Development	Theory Only	1.0	3	0	0	0	3.0
4	BHUM203L	Introduction to Psychology	Theory Only	1.0	3	0	0	0	3.0
5	BHUM204L	Industrial Psychology	Theory Only	1.0	3	0	0	0	3.0
6	BHUM205L	Development Economics	Theory Only	1.0	3	0	0	0	3.0
7	BHUM206L	International Economics	Theory Only	1.0	3	0	0	0	3.0
8	BHUM207L	Engineering Economics	Theory Only	1.0	3	0	0	0	3.0
9	BHUM208L	Economics of Strategy	Theory Only	1.0	3	0	0	0	3.0
10	BHUM209L	Game Theory	Theory Only	1.0	3	0	0	0	3.0
11	BHUM210E	Econometrics	Embedded Theory and Lab	1.0	2	0	2	0	3.0
12	BHUM211L	Behavioral Economics	Theory Only	1.0	3	0	0	0	3.0
13	BHUM212L	Mathematics for Economic Analysis	Theory Only	1.0	3	0	0	0	3.0
14	BHUM213L	Corporate Social Responsibility	Theory Only	1.0	3	0	0	0	3.0
15	BHUM214L	Political Science	Theory Only	1.0	3	0	0	0	3.0
16	BHUM215L	International Relations	Theory Only	1.0	3	0	0	0	3.0
17	BHUM216L	Indian Culture and Heritage	Theory Only	1.0	3	0	0	0	3.0
18	BHUM217L	Contemporary India	Theory Only	1.0	3	0	0	0	3.0
19	BHUM218L	Financial Management	Theory Only	1.0	3	0	0	0	3.0
20	BHUM219L	Principles of Accounting	Theory Only	1.0	3	0	0	0	3.0
21	BHUM220L	Financial Markets and Institutions	Theory Only	1.0	3	0	0	0	3.0
22	BHUM221L	Economics of Money, Banking and Financial Markets	Theory Only	1.0	3	0	0	0	3.0
23	BHUM222L	Security Analysis and Portfolio Management	Theory Only	1.0	3	0	0	0	3.0
24	BHUM223L	Options , Futures and other Derivatives	Theory Only	1.0	3	0	0	0	3.0
25	BHUM224L	Fixed Income Securities	Theory Only	1.0	3	0	0	0	3.0
26	BHUM225L	Personal Finance	Theory Only	1.0	3	0	0	0	3.0
27	BHUM226L	Corporate Finance	Theory Only	1.0	3	0	0	0	3.0
28	BHUM227L	Financial Statement Analysis	Theory Only	1.0	3	0	0	0	3.0
29	BHUM228L	Cost and Management Accounting	Theory Only	1.0	3	0	0	0	3.0
30	BHUM229L	Mind, Embodiment and Technology	Theory Only	1.0	3	0	0	0	3.0
31	BHUM230L	Health Humanities in Biotechnological Era	Theory Only	1.0	3	0	0	0	3.0
32	BMAT102L	Differential Equations and Transforms	Theory Only	1.0	3	1	0	0	4.0
33	BMEE102P	Engineering Design Visualisation Lab	Lab Only	1.0	0	0	4	0	2.0
34	BMEE201L	Engineering Mechanics	Theory Only	1.0	2	1	0	0	3.0
35	BSTS301P	Advanced Competitive Coding - I	Soft Skill	1.0	0	0	3	0	1.5
36	BSTS302P	Advanced Competitive Coding - II	Soft Skill	1.0	0	0	3	0	1.5
37	CFOC101M	Advanced Green Manufacturing Systems	Online Course	1.0	0	0	0	0	3.0
38	CFOC102M	Introduction to Cognitive Psychology	Online Course	1.0	0	0	0	0	3.0



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39	CFOCI05M	Emotional Intelligence	Online Course	1.0	0	0	0	0	2.0
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Open Elective									
40	CFOC109M	Design Thinking - A Primer	Online Course	1.0	0	0	0	0	1.0
41	CFOC115M	Design and Analysis of Algorithms	Online Course	1.0	0	0	0	0	2.0
42	CFOC119M	Training of Trainers	Online Course	1.0	0	0	0	0	3.0
43	CFOC120M	Knowledge Management	Online Course	1.0	0	0	0	0	2.0
44	CFOC122M	Educational Leadership	Online Course	1.0	0	0	0	0	2.0
45	CFOC126M	Data Analysis and Decision Making - III	Online Course	1.0	0	0	0	0	3.0
46	CFOC130M	Human Resource Development	Online Course	1.0	0	0	0	0	3.0
47	CFOC133M	E-Business	Online Course	1.0	0	0	0	0	3.0
48	CFOC134M	Innovation, Business Models and Entrepreneurship	Online Course	1.0	0	0	0	0	2.0
49	CFOC139M	Role of Craft and Technology in Interior - Architecture	Online Course	1.0	0	0	0	0	2.0
50	CFOC161M	Data Science for Engineers	Online Course	1.0	0	0	0	0	2.0
51	CFOC171M	Introduction to Haskell Programming	Online Course	2.0	0	0	0	0	3.0
52	CFOC175M	Nanotechnology in Agriculture	Online Course	1.0	0	0	0	0	2.0
53	CFOC177M	Drug Delivery: Principles and Engineering	Online Course	1.0	0	0	0	0	3.0
54	CFOC178M	Functional Genomics	Online Course	1.0	0	0	0	0	1.0
55	CFOC179M	Introduction to Proteogenomics	Online Course	1.0	0	0	0	0	3.0
56	CFOC182M	Organic Chemistry in Biology and Drug Development	Online Course	1.0	0	0	0	0	3.0
57	CFOC186M	Deep Learning	Online Course	1.0	0	0	0	0	3.0
58	CFOC188M	Ethical Hacking	Online Course	1.0	0	0	0	0	3.0
59	CFOC191M	Forests and their Management	Online Course	1.0	0	0	0	0	3.0
60	CFOC193M	Bioengineering: An Interface with Biology and Medicine	Online Course	1.0	0	0	0	0	2.0
61	CFOC194M	Human Molecular Genetics	Online Course	1.0	0	0	0	0	1.0
62	CFOC202M	Cell Culture Technologies	Online Course	1.0	0	0	0	0	2.0
63	CFOC203M	Natural Hazards	Online Course	1.0	0	0	0	0	2.0
64	CFOC231M	Google Cloud Computing Foundation Course	Online Course	1.0	0	0	0	0	2.0
65	CFOC237M	Sustainable Architecture	Online Course	1.0	0	0	0	0	3.0
66	CFOC253M	Plastic Waste Management	Online Course	1.0	0	0	0	0	2.0
67	CFOC293M	Data Base Management System	Online Course	1.0	0	0	0	0	2.0
68	CFOC294M	Introduction to Algorithms and Analysis	Online Course	1.0	0	0	0	0	3.0
69	CFOC304M	Programming, Data Structures And Algorithms Using Python	Online Course	1.0	0	0	0	0	2.0
70	CFOC309M	Discrete Mathematics	Online Course	1.0	0	0	0	0	3.0
71	CFOC310M	An Introduction to Artificial Intelligence	Online Course	1.0	0	0	0	0	3.0
72	CFOC380M	Ethics in Engineering Practice	Online Course	1.0	0	0	0	0	2.0
73	CFOC381M	Introduction to Research	Online Course	1.0	0	0	0	0	2.0
74	CFOC383M	Roadmap for Patent Creation	Online Course	1.0	0	0	0	0	2.0
75	CFOC384M	Entrepreneurship Essentials	Online Course	1.0	0	0	0	0	3.0
76	CFOC395M	Speaking Effectively	Online Course	1.0	0	0	0	0	2.0
77	CFOC397M	Intellectual Property	Online Course	1.0	0	0	0	0	3.0
78	CFOC406M	Human Behaviour	Online Course	1.0	0	0	0	0	2.0
79	CFOC409M	Literature, Culture and Media	Online Course	1.0	0	0	0	0	3.0
80	CFOC415M	German - I	Online Course	1.0	0	0	0	0	3.0
81	CFOC486M	Managerial Skills for Interpersonal Dynamics	Online Course	1.0	0	0	0	0	3.0

Open Elective									
82	CFOC498M	Business Statistics	Online Course	1.0	0	0	0	0	3.0
83	CFOC499M	Global Marketing Management	Online Course	1.0	0	0	0	0	2.0
84	CFOC508M	Entrepreneurship	Online Course	1.0	0	0	0	0	3.0
85	CFOC561M	Biomedical Nanotechnology	Online Course	1.0	0	0	0	0	1.0
86	CFOC570M	Public Speaking	Online Course	1.0	0	0	0	0	3.0
87	CFOC572M	Dairy And Food Process And Products Technology	Online Course	1.0	0	0	0	0	3.0
88	CFOC575M	Wildlife Ecology	Online Course	1.0	0	0	0	0	3.0
89	CFOC591M	Principles Of Management	Online Course	1.0	0	0	0	0	3.0
90	CFOC600M	Data Analysis for Biologists	Online Course	1.0	0	0	0	0	2.0

Bridge Course									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	BENG101N	Effective English Communication	Lab Only	1.0	0	0	4	0	2.0

Non-graded Core Requirement									
Course Code	Course Title	Course Type	Version	L	T	P	J	Credits	
BBIT101N	Introduction to Engineering	Project	1.0	0	0	0	0	1.0	
BCHY102N	Environmental Sciences	Online Course	1.0	0	0	0	0	2.0	
BEXC100N	Extracurricular Activities / Co-Curricular Activities -B.Tech. Programmes	Basket	1.0	0	0	0	0	2.0	
BHUM101N	Ethics and Values	Online Course	1.0	0	0	0	0	2.0	
BSSC101N	Essence of Traditional Knowledge	Online Course	1.0	0	0	0	0	2.0	
BSSC102N	Indian Constitution	Online Course	1.0	0	0	0	0	2.0	

BBIT100L	Biology		L	T	P	C
			3	0	0	3
Pre-requisite	Nil	Syllabus version				
		1.0				
Course Objectives						
<ol style="list-style-type: none"> 1. To build a basic understanding of origin and evolution of biological beings 2. To inculcate fundamental concepts of organization and principles of living systems 3. To demonstrate applications of biology in engineering disciplines 						
Course Outcomes						
<ol style="list-style-type: none"> 1. Conceive the basic concepts of biology including diversity, evolution, and ecology 2. Outline the design principles of cell, its biochemistry, and biophysics 3. Interpret and analyze biological flow of information at molecular and hereditary level 4. Describe the organismal complexities in animals and plants 5. Identify the importance of biology in different engineering disciplines 						
Module:1		Introduction to biology and evolution	7 hours			
Bioscience fundamentals; diversification of life including viruses; Chemical basis of life, early origin of life experiments; Concept of evolution and natural selection; Levels of ecological study; Biotic and abiotic factors in ecosystem						
Module:2		Cell structure and functions	5 hours			
Cell as fundamental unit of life; prokaryotic cell structures; Eukaryotic cell structures; Nuclear transport; Endomembrane system; Dynamic cytoskeleton						
Module:3		Chemistry and complexity of life	6 hours			
Structure and functions of bio macromolecules – carbohydrates, proteins, lipids, and nucleic acids						
Module:4		Metabolism and energy transformation	5 hours			
Driving force for metabolic reactions, ATP energy-coupling; Electrochemical processes-ATP-synthesis and electron transport chain						
Module:5		Molecular information	6 hours			
DNA and gene; DNA synthesis; Cell division- mitosis and meiosis; Central dogma of molecular biology; Transcription, RNA processing, and translation; Post-translational modifications						
Module:6		Overview of animal and plant systems	6 hours			
Plant forms and functions; Plant cells and tissue systems; Animal tissues, organs, and systems; Animal forms and functions; Animal homeostasis						
Module:7		Genetics and genomics	5 hours			
Mendel's experiment-mono hybrid cross and di hybrid cross; Linkage and crossing-over; Mendel's rules and human diseases; Gene sequencing and genomics						
Module:8		Engineering in biology	5 hours			
Biology and engineering needs; Bio-inspired design and bio-robotics; Biology and wellness e.g. retinal prosthetics and biosensor, bio-chips, bio-pesticides, nanoparticles.						
		Total Lecture hours:	45 hours			
<i>Proceedings of the 63rd Academic Council [23.09.2021]</i>						

Text Book(s)			
1.	Biological Science. By Scott Freeman, Kim Quillin, Lizabeth Allison, Michael Black, Emily Taylor, 6 th edition 2017, Prentice Hall, NJ, USA.		
2.	Biology for Engineers, by G. K. Suraishkumar, 1 st Edition, 2019, Oxford University Press, India.		
Reference Books			
1.	Campbell Biology. By Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Rebecca Orr. 12th edition, 2021. Pearson publisher, USA		
2.	Concepts in Biology. By Eldon D. Enger, Frederick C. Ross, David B. Bailey, Edition 14 th , 2017 (Indian Edition). Tata McGraw-Hill publication, India		
Mode of Evaluation: CAT, Application oriented assignment, Quiz, and FAT			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BCHY101L	Engineering Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. To enable students to have fundamental understanding of the basic concepts of different disciplines of chemistry. 2. To provide avenues for learning advanced concepts from school to university 3. To empower students with emerging concepts in applied chemistry to be useful in addressing societal needs 4. To integrate analytical and computational ability with experimental skills to create individuals competent in basic science and its by-product of its application. 5. To offer opportunities to create pathways for self-reliant in terms of knowledge and higher learning 					
Course Outcomes :					
<ol style="list-style-type: none"> 1. Understand the fundamental concepts in organic, inorganic, physical, and analytical chemistry. 2. Analyze the principles of applied chemistry in solving the societal issues. 3. Apply chemical concepts for the advancement of materials. 4. Appreciate the fundamental principles of spectroscopy and the related applications. 5. Design new materials, energy conversion devices and new protective coating techniques. 					
Module:1	Chemical thermodynamics and kinetics	6 hours			
Laws of thermodynamics - entropy change (selected processes) – spontaneity of a chemical reaction and Gibbs free energy - heat transfer; Kinetics - Concept of activation energy and energy barrier - Arrhenius equation- effect of catalysts (homo and heterogeneous) – Enzyme catalysis (Michaelis-Menten Mechanism).					
Module:2	Metal complexes and organometallics	6 hours			
Inorganic complexes - structure, bonding and application; Organometallics – introduction, stability, structure and applications of metal carbonyls, ferrocene and Grignard reagent; Metals in biology (haemoglobin, chlorophyll- structure and property).					
Module:3	Organic intermediates and reaction transformations	6 hours			
Organic intermediates - stability and structure of carbocations, carbanions and radicals; Aromatics (aromaticity) and heterocycles (3, 4, 5, 6 membered and fused systems); Organic transformations for making useful drugs for specific disease targets (two examples) and dyes (addition, elimination, substitution and cross coupling reactions).					
Module:4	Energy devices	6 hours			
Electrochemical and electrolytic cells – electrode materials with examples (semi-conductors), electrode-electrolyte interface- chemistry of Li ion secondary batteries, supercapacitors; Fuel cells: H ₂ -O ₂ and solid oxide fuel cell (SOFC); Solar cells - photovoltaic cell (silicon based), photoelectrochemical cells and dye-sensitized cells.					
Module:5	Functional materials	7 hours			
Oxides of AB, AB ₂ , ABO ₃ type (specific examples); Composites - types and properties; Polymers - thermosetting and thermoplastic polymers – synthesis and application (TEFLON, BAKELITE); Conducting polymers- polyacetylene and effect of doping – chemistry of display devices specific to OLEDs; Nano materials – introduction, bulk vs nano (quantum dots), top-down and bottom-up approaches for synthesis, and properties of nano Au.					
Module:6	Spectroscopic, diffraction and microscopic techniques	5 hours			
Fundamental concepts in spectroscopic and instrumental techniques; Principle and applications of UV-Visible and XRD techniques (numericals); Overview of various techniques such as AAS, IR, NMR, SEM and TEM.					
Module:7	Industrial applications	7 hours			

Water purification methods - zeolites, ion-exchange resins and reverse osmosis; Fuels and combustion -LCV, HCV, Bomb calorimeter (numericals), anti-knocking agents); Protective coatings for corrosion control: cathodic and anodic protection - PVD technique; Chemical sensors for environmental monitoring - gas sensors; Overview of computational methodologies: energy minimization and conformational analysis.			
Module:8	Contemporary topics	2 hours	
Guest lectures from Industry and, Research and Development Organizations			
Total Lecture hours:			45 hours
Textbook			
1.	Theodore E. Brown, H Eugene, LeMay Bruce E. Bursten, Catherine Murphy, Patrick Woodward, Matthew E. Stoltzfus, Chemistry: The Central Science, 2017, 14th edition, Pearson Publishers, 2017. UK		
Reference Books			
1.	Peter Vollhardt, Neil Schore, Organic Chemistry: Structure and Function, 2018, 8th ed. WH Freeman, London		
2.	Atkins' Physical Chemistry: International, 2018, Eleventh edition, Oxford University Press; UK		
3.	Colin Banwell, Elaine McCash, Fundamentals for Molecular Spectroscopy, 4th Edition, McGraw Hill, US		
4.	Solid State Chemistry and its Applications, Anthony R. West. 2014, 2nd edition, Wiley, UK.		
5.	Angèle Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Photovoltaic solar energy: From fundamentals to Applications, 2017, Wiley publishers, UK.		
6.	Lawrence S. Brown and Thomas Holme, Chemistry for engineering students, 2018, 4 th edition – <i>Open access version</i>		
Mode of Evaluation: CAT, Written assignment, Quiz and FAT			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BCHY101P	Engineering Chemistry Lab			L	T	P	C
				0	0	2	1
Pre-requisite	NIL			Syllabus version			
				1.0			
Course Objective							
To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.							
Course Outcome :							
At the end of the course the student will be able to							
<ol style="list-style-type: none"> 1. Understand the importance and hands-on experience on analysis of metal ions by means of experiments. 2. Get practical experience on synthesis and characterization of the organic molecules and nanomaterials in the laboratory. 3. Apply their knowledge in thermodynamic functions, kinetics and molecular geometries through the experiments. 							
Indicative Experiments							
1.	Thermodynamics functions from EMF measurements : Zinc – Copper system						
2.	Determination of reaction rate, order and molecularity of ethylacetate hydrolysis						
3.	Colorimetric estimation of Ni ²⁺ using conventional and smart phone digital-imaging methods						
4.	Laboratory scale preparation of important drug intermediate - para aminophenol for the synthesis for acetaminophen						
5.	Magnesium-sea water activated cell – Effect of salt concentration on voltage generation						
6.	Analysis of iron in an alloy sample by potentiometry						
7.	Preparation of tin oxide by sol- gel method and its characterization						
8.	Size dependent colour variation of Cu ₂ O nanoparticles by spectrophotometer						
9.	Determination of hardness of water sample by complexometric titration before and after ion-exchange process						
10.	Computational Optimization of molecular geometry using Avogadro software						
Total Laboratory Hours						30 hours	
Mode of assessment: Mode of assessment: Continuous assessment / FAT / Oral examination and others							
Recommended by Board of Studies				28.06.2021			
Approved by Academic Council				No. 63	Date	23.09.2021	

BCSE101E	Computer Programming: Python			L	T	P	C
				1	0	4	3
Pre-requisite	NIL			Syllabus version			
				1.0			
Course Objectives							
1. To provide exposure to basic problem-solving techniques using computers. 2. To inculcate the art of logical thinking abilities and propose novel solutions for real world problems through programming language constructs.							
Course Outcome							
1. Classify various algorithmic approaches, categorize the appropriate data representation, and demonstrate various control constructs. 2. Choose appropriate programming paradigms, interpret and handle data using files to propose solution through reusable modules; idealize the importance of modules and packages.							
Module:1	Introduction to Problem Solving			1 hour			
Problem Solving: Definition and Steps, Problem Analysis Chart, Developing an Algorithm, Flowchart and Pseudocode.							
Module:2	Python Programming Fundamentals			2 hours			
Introduction to python – Interactive and Script Mode – Indentation – Comments – Variables – Reserved Words – Data Types – Operators and their precedence – Expressions – Built-in Functions – Importing from Packages.							
Module:3	Control Structures			2 hours			
Decision Making and Branching: if, if-else, nested if, multi-way if-elif statements – Looping: while loop, for loop – else clauses in loops, nested loops – break, continue and pass statements.							
Module:4	Collections			3 hours			
Lists: Create, Access, Slicing, Negative indices, List methods, List comprehensions – Tuples: Create, Indexing and slicing, Operations on tuples – Dictionary: Create, add, and replace values, Operations on dictionaries – Sets: Creation and operations.							
Module:5	Strings and Regular Expressions			2 hours			
Strings: Comparison, Formatting, Slicing, Splitting, Stripping – Regular Expressions: Matching, Search and replace, Patterns.							
Module:6	Functions and Files			3 hours			
Functions – Parameters and Arguments: Positional arguments, Keyword arguments, Parameters with default values – Local and Global scope of variables – Functions with Arbitrary arguments – Recursive Functions – Lambda Function, Files: Create, Open, Read, Write, Append and Close – tell and seek methods.							
Module:7	Modules and Packages			2 hours			
Built-in modules – User-Defined modules – Overview of Numpy and Pandas packages.							
				Total Lecture hours:		15 hours	
Text Book(s)							
1.	Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 2nd Edition, No starch Press, 2019						
Reference Books							
1.	Martic C Brown, Python: The Complete Reference, 4th Edition, McGraw Hill Publishers, 2018.						
2.	John V. Guttag, Introduction to computation and programming using python: with applications to understanding data. 2nd Edition, MIT Press, 2016.						

Mode of Evaluation: No separate evaluation for theory component.			
Indicative Experiments			
1.	Problem Analysis Chart, Flowchart and Pseudocode Practices.		
2.	Sequential Constructs using Python Operators, Expressions.		
3.	Branching (if, if-else, nested if, multi-way if-elif statements) and Looping (for, while, nested looping, break, continue, else in loops).		
4.	List, Tuples, Dictionaries & Sets.		
5.	Strings, Regular Expressions.		
6.	Functions, Lambda, Recursive Functions and Files.		
7.	Modules and Packages (NumPy and Pandas)		
Total Laboratory Hours			60 hours
Text Book(s)			
1.	Mariano Anaya, Clean Code in Python: Develop maintainable and efficient code, 2 nd Edition, Packt Publishing Limited, 2021.		
Reference Books			
1.	Harsh Bhasin, Python for beginners, 1 st Edition, New Age International (P) Ltd., 2019,		
	Mode of assessment: Continuous assessments and FAT		
Recommended by Board of Studies		03.07.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BCSE103E	Computer Programming : Java	L	T	P	C
		1	0	4	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> To introduce the core language features of Java and understand the fundamentals of Object -Oriented programming in Java. To develop the ability of using Java to solve real world problems. 					
Course Outcome:					
At the end of this course, students should be able to:					
<ol style="list-style-type: none"> Understand basic programming constructs; realize the fundamentals of Object Orientated Programming in Java; apply inheritance and interface concepts for enhancing code reusability. Realize the exception handling mechanism; process data within files and use the data structures in the collection framework for solving real world problems. 					
Module:1	Java Basics	2 hours			
OOP Paradigm - Features of Java Language - JVM - Bytecode - Java program structure – Basic programming constructs - data types - variables – Java naming conventions – operators.					
Module:2	Looping Constructs and Arrays	2 hours			
Control and looping constructs - Arrays – one dimensional and multi-dimensional – enhanced for loop – Strings - Wrapper classes.					
Module:3	Classes and Objects	2 hours			
Class Fundamentals – Access and non-access specifiers - Declaring objects and assigning object reference variables – array of objects – constructors and destructors – usage of “this” and “static” keywords.					
Module:4	Inheritance and Polymorphism	3 hours			
Inheritance – types — use of “super” – final keyword - Polymorphism – Overloading and Overriding - abstract class – Interfaces.					
Module:5	Packages and Exception Handling	2 hours			
Packages: Creating and Accessing - Sub packages. Exception Handling - Types of Exception - Control Flow in Exceptions - Use of try, catch, finally, throw, throws in Exception Handling - User defined exceptions.					
Module:6	IO Streams and Files	2 hours			
Java I/O streams – FileInputStream & FileOutputStream – FileReader & FileWriter- DataInputStream & DataOutputStream – BufferedInputStream & BufferedOutputStream – PrintOutputStream - Serialization and Deserialization.					
Module:7	Collection Framework	2 hours			
Generic classes and methods - Collection framework: List and Map.					
Total Lecture hours:					15 hours
Text Book(s)					
1.	Y. Daniel Liang, “Introduction to Java programming” - comprehensive version-11 th Edition, Pearson publisher, 2017.				
Reference Books					
1.	Herbert Schildt , The Complete Reference -Java, Tata McGraw-Hill publisher, 10 th Edition, 2017.				
2	Cay Horstmann, “Big Java”, 4th edition, John Wiley & Sons publisher, 5 th edition, 2015				
3	E.Balagurusamy, “Programming with Java”, Tata McGraw-Hill publishers, 6 th edition, 2019				

BECE101L	Basic Electronics	L	T	P	C
		2	0	0	2
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives					
1. To introduce the students to the basic concepts of electronic components, sources, measurements. and instrumentation.					
2. To apply the inculcated knowledge for developing simple circuits using various electronic components and devices					
3. To familiarize the students with the basic concepts of number systems and digital logic.					
4. To analyse the concepts associated with multiple sensors and their sensing mechanisms.					
Course Outcome					
Students will be able to					
1. Understand the basic electronic components, sources, and measuring equipment					
2. Comprehend the characteristics of diodes, transistors and their applications					
3. Design and analyse the amplifiers and oscillators					
4. Design and implement simple digital circuits					
5. Analyse the performance metrics of the measurement systems.					
6. Comprehend the basic concept of various sensors and their sensing mechanisms.					
Module:1	Electronic Components, Sources, and Measuring Equipment	3 hours			
Evolution of Electronics – Impact of Electronics in Industry and Society – Familiarization of Resistors, Capacitors, Inductors – Colour Coding – types and specifications, – Electro-mechanical components – Relay and Contactors – Regulated Power supply, Function Generator – Multimeter – CRO					
Module:2	Junction Diodes	4 hours			
Intrinsic and extrinsic semiconductors – doping - PN Junctions, Formation of Junction, Physical operation of diode, Barrier Potential, I - V Characteristics, Rectifiers, Zener diode – I-V Characteristics, Zener diode as Voltage regulator.					
Module:3	Transistors	5 hours			
Bipolar Junction Transistor (BJT) - Device structure and physical operation, Concept of CB, CE and CC Configuration, Transistor as a Switch, - Metal-Oxide Field Effect Transistor (MOSFET) - Device Structure, mode of operation and Characteristics, MOSFET configurations (CS, CD, CG).					
Module:4	Amplifiers and Oscillators	4 hours			
BJT as an amplifier (CE configuration), MOSFET as an amplifier (CS configuration), Feedback concept, Oscillators - Barkhausen's criteria for sustained oscillation, RC Phase Shift Oscillator, LC Oscillator.					
Module:5	Digital Logics	4 hours			
Number systems, conversion of bases, Boolean algebra, Logic Gates, Concept of universal gate, Simplification and implementation of Boolean functions.					
Module:6	Principles of Measurement and Analysis	3 hours			
Units and standards, Errors, Functional Elements of a Measurement System and Instruments, Applications and Classification of Instruments, Types of measured Quantities, Measures of Dispersion, Sample deviation and sample mean, Calibration and standard.					
Module:7	Sensors and Transducers	5 hours			
Sensor fundamentals and characteristics - General concepts and terminology of measurement systems, Sensors and transducers - Classification of sensors, Static and dynamic characteristics. Principle of Resistive Sensors, Capacitive Sensors, Inductive Sensors, Magnetic sensors, Optical sensor, Self-generating Sensors					
Module:8	Contemporary issues	2 hours			
Guest lectures from Industry and, Research and Development Organisations					
Total Lecture hours:					30 hours

Text Book(s)			
1.	A. P. Malvino, D. J. Bates, Electronic Principles, 2017, 7/e, Tata McGraw-Hill.		
2	Albert D. Helfrick and William D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 2016, First Edition, Pearson Education, Noida, India.		
Reference Books			
1.	David A Bell, Electronic Devices and Circuits, Oxford Press, 5 th Edition, 2008		
2	Robert L. Bolysted and Louis Nashelsky, Electronic Devices and Circuit Theory, Prentice Hall of India, 11th Edition, 2017		
3	D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003		
4	A.K. Sawhney, Puneet Sawhney, A Course In Electrical and Electronic Measurements, and Instrumentation, Dhanpat Rai & Co., 2015		
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT			
Recommended by Board of Studies		08.07.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

Mode of Evaluation: No separate evaluation for theory component.			
Indicative Experiments			
1.	Programs using sequential and branching structures.		
2.	Experiment the use of looping, arrays and strings.		
3.	Demonstrate basic Object-Oriented programming elements.		
4.	Experiment the use of inheritance, polymorphism and abstract classes.		
5.	Designing packages and demonstrate exception handling.		
6.	Demonstrate the use of IO streams, file handling and serialization.		
7.	Program to discover application of collections.		
Total Laboratory Hours			60 hours
Text Book(s)			
1.	Marc Loy, Patrick Niemeyer and Daniel Leuck, Learning Java, O'Reilly Media, Inc., 5 th Edition, 2020.		
Reference Books			
1.	Dhruti Shah, 100+ Solutions in Java: A Hands-On Introduction to Programming in Java, BPB Publications, 1 st Edition, 2020.		
Mode of assessment: Continuous assessments and FAT			
Recommended by Board of Studies		03.07.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BECE101P		Basic Electronics Lab		L	T	P	C
				0	0	2	1
Pre-requisite	Nil			Syllabus version			
				1.0			
Course Objectives							
1. To learn the various characteristics of diodes and transistors 2. To understand the concept of digital logic functions and verify the truth tables 3. To learn the performance metrics of measurement systems and characteristics of various sensors							
Course Outcome							
Students will be able to 1. Analyse the various characteristics and applications of diodes and transistors 2. Design logic circuits using logic gates and verify their truth tables 3. Measure the physical parameters using different transducers							
Indicative Experiments							
1	Identify, mark the terminal and find the value of a particular component from the given group of electronic components, Study of electronic measurement devices (Multimeter, DSO, function generator)						
	Half Wave and Full Wave Rectifier circuits						
	Zener Diode as a voltage regulator						
	Characteristics of BJT in Common Emitter Configuration						
	Characteristics of MOSFET in Common Source Configuration						
	Frequency response of BJT single stage amplifier						
	Study of the signal generation using RC Phase Shift Oscillator						
	Study of logic gates and implementation of Boolean Functions						
	Strain gauge sensors for measurement of normal						
	Displacement measurement using LVDT and LDR.						
	Temperature measurement using RTD, Thermocouple.						
Total Laboratory Hours						30 hours	
Text Book(s)							
1.	A. P. Malvino, D. J. Bates, Electronic Principles, 2017, 7/e, Tata McGraw-Hill.						
2	Albert D. Helfrick and William D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 2016, First Edition, Pearson Education, Noida, India.						
Reference Books							
1.	Robert L. Bolysted and Louis Nashelsky, Electronic Devices and Circuit Theory, Prentice Hall of India, 11th Edition, 2017						
2	D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003						
Mode of assessment: Continuous assessment / FAT / Oral examination and others							
Recommended by Board of Studies				08.07.2021			
Approved by Academic Council				No. 63	Date	23.09.2021	

BEEE101L		Basic Electrical Engineering		L	T	P	C
				2	0	0	2
Pre-requisite	NIL	Syllabus version					
		1.0					
Course Objectives							
<ol style="list-style-type: none"> 1. Provide insights into relevant concepts and principles in electrical engineering 2. Facilitate understand and comprehend laws, rules and theorems to compute parameters of electric circuits 3. Enable comprehend and analyze the concepts of electrical machines and measuring instruments 							
Course Outcome							
On completion of this course, the students will be able to							
<ol style="list-style-type: none"> 1. Evaluate DC and AC circuit parameters using various laws and theorems 2. Analyze the parameters of magnetically coupled circuits and compare various types of electrical machines 3. Comprehend the measurement techniques of electrical parameters 4. Understand the concept of electric supply system and comprehend essential electrical safety requirements 							
Module:1	DC Circuits	6 hours					
Basic circuit elements and sources; Ohms law, Kirchhoff's laws; Series and parallel connection of circuit elements; Source transformation; Node voltage analysis; Mesh current analysis; Maximum power transfer theorem							
Module:2	AC Circuits	6 hours					
Alternating voltages and currents, RMS, average, form factor, peak factor; Single phase RL, RC, RLC series and parallel circuits; Power and power factor; Balanced three phase systems							
Module:3	Magnetic Circuits	4 hours					
Electromagnetic Induction: Self and mutual; Magnetically coupled circuits; Series and parallel magnetic circuits; Dot convention							
Module:4	Electrical Machines	5 hours					
Principle of operation, construction and applications of DC machines, transformers, induction motors, synchronous generators, stepper motor, Brushless DC (BLDC) motor							
Module:5	Electrical Measurements	4 hours					
Principle, Construction and operation of moving coil and moving iron instruments; Power and energy measurement in single phase and three phase systems							
Module: 6	Electrical Supply Systems & Safety	3 hours					
Concepts of electrical power generation, transmission and distribution systems; Wiring; Electrical safety; Earthing; Protective devices							
Module: 7	Contemporary Issues	2 hours					
Guest lectures from Industry and, Research and Development Organizations							
		Total Lecture hours:				30 hours	
Text Book(s)							
1.	Allan R. Hambley, Electrical Engineering: Principles & Applications, 2019, 7 th edition, Pearson Education						
Reference Books							
1.	DP Kothari & I J Nagrath, Basic Electric Engineering, 2019, 4 th edition, McGraw Hill Education						
2.	John Bird, Electrical Circuit Theory and Technology, 2013, 5 th edition, Routledge Publications						
3.	S. Salivahnan, R Rengaraj, G R Venkatakrishnan, Basic Electrical, Electronics and Measurement Engineering, 2018, McGraw Hill Education						
4.	E.W Golding, F.C Widdis, Electrical Measurements and Measuring Instruments,						

	2011, Reem Publications		
5.	V K Mehta and Rohit Mehta, Principles of Power System, 2005, S. Chand		
Mode of Evaluation: CAT, Written Assignment, Quiz, FAT			
Recommended by Board of Studies		03.07.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BEEE101P	Basic Electrical Engineering Lab			L	T	P	C
				0	0	2	1
Pre-requisite	NIL			Syllabus version			
				1.0			
Course Objectives							
1. Understanding the concepts of electrical engineering for development and implementation of electrical systems Impart knowledge and skill in wiring and its standards 3. Facilitate comprehend and identify appropriate measuring devices for an electric circuit							
Course Outcome							
On completion of this course, the students will be able to 1. Understand, analyze and validate the electric circuit parameters 2. Design and develop electrical systems for domestic and commercial applications 3. Acquire skills for interpretation of measurement during experimentation 4. Attain skills to use modern engineering tools for electrical system layout planning							
Indicative Experiments							
1	Verification of Kirchhoff's voltage law						
2	Verification of Kirchhoff's current law						
3	Verification of maximum power transfer theorem						
4	Sinusoidal steady state response of RLC circuits						
5	Wiring circuit for a single lamp and a fan with regulator						
6	Wiring circuit for Godown with two-way switch						
7	Load test on single phase transformer/DC motor						
8	Measurement of power in a single phase AC Load						
9	Measurement of power and energy consumed by a given three phase AC load						
10	Study of earthing and measurement of earth pit resistance						
11	Cost estimation of residential electrical wiring						
12	Electrical layout for a residential/commercial/industrial application using CAD software						
						Total Laboratory Hours	30 hours
Text Book(s)							
1	Allan R. Hambley, Electrical Engineering: Principles & Applications, 2019, 7 th edition, Pearson Education						
Mode of assessment: CAT, FAT, Oral examination							
Recommended by Board of Studies		03.07.2021					
Approved by Academic Council		No. 63	Date	23.09.2021			

BENG101L	Technical English Communication		L	T	P	C
			2	0	0	2
Pre-requisite	NIL	Syllabus version				
		1.0				
Course Objectives:						
<ol style="list-style-type: none"> 1. To develop LSRW skills for effective communication in professional situations 2. To enhance knowledge of grammar and vocabulary for meaningful communication 3. To understand information from diverse texts for effective technical communication 						
Course Outcomes:						
<ol style="list-style-type: none"> 1. Use grammar and vocabulary appropriately while writing and speaking 2. Apply the concepts of communication skills in formal and informal situations 3. Demonstrate effective reading and listening skills to synthesize and draw intelligent inferences 4. Write clearly and significantly in academic and general contexts 						
Module:1	Introduction to Communication					4 hours
Nature and Process - Types of communication: Intra-personal, Interpersonal, Group-verbal and non-verbal communication / Cross-cultural Communication - Communication Barriers and Essentials of good communication - Principles of Effective Communications						
Module:2	Grammatical Aspects					4 hours
Sentence Pattern - Modal Verbs - Concord (SVA) - Conditionals - Error detection						
Module:3	Written Correspondence					4 hours
Job Application Letters - Resume Writing - Statement of Purpose						
Module:4	Business Correspondence					4 hours
Business Letters: Calling for Quotation, Complaint & Sales Letter – Memo - Minutes of Meeting - Describing products and processes						
Module:5	Professional Writing					4 hours
Paraphrasing & Summarizing - Executive Summary - Structure and Types of Proposal – Recommendations						
Module:6	Team Building & Leadership Skills					4 hours
Principles of Leadership - Team Leadership Model - Negotiation Skills - Conflict Management						
Module:7	Research Writing					4 hours
Interpreting and Analysing a research article - Approaches to Review Paper Writing - Structure of a research article - Referencing						
Module:8	Guest Lecture from Industry and R&D organizations					2 hours
Contemporary Issues						
					Total Lecture hours:	30 hours
Text Book(s)						
1.	Raman, Meenakshi & Sangeeta Sharma. (2015). <i>Technical Communication: Principles and Practice</i> , (3 rd Edition). India: Oxford University Press.					
Reference Books						
1.	Taylor, Shirley & Chandra .V. (2010). <i>Communication for Business A Practical Approach</i> 4 th Edition. India: Pearson Longman.					
2.	Kumar, Sanjay & Pushpalatha. (2018). <i>English Language and Communication Skills for Engineers</i> . India: Oxford University Press.					
3.	Koneru Aruna. (2020). <i>English Language Skills for Engineers</i> . India: McGraw Hill Education.					
4.	Rizvi, M. Ashraf. (2018). <i>Effective Technical Communication</i> 2 nd Edition. Chennai: McGraw Hill Education.					
5.	Mishra, Sunitha & Muralikrishna,C. (2014). <i>Communication Skills for Engineers</i> . India: Pearson Education.					

6.	Watkins, P. (2018). <i>Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers</i> . India: Cambridge University Press.		
Mode of Evaluation : CAT / Assignment / Quiz / FAT / Group Discussion			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BENGI01P	Technical English Communication Lab		L	T	P	C
			0	0	2	1
Pre-requisite	NIL		Syllabus version			
			1.0			
Course Objectives:						
1. To use appropriate grammatical structures in professional communication 2. To improve English communication skills for better employability 3. To enhance meaningful communication skills in writing and public speaking						
Course Outcomes:						
1. Demonstrate professional rhetoric and articulate ideas effectively 2. Interpret material on technology and deliver eloquent presentations 3. Apply receptive and productive skills in real life situations and develop workplace communication						
Indicative Experiments						
1.	Grammar & Vocabulary Error Detection Activity: -Worksheets					
2.	Listening to Narratives Interviews of eminent personalities & Ted Talks Activity: Listening Comprehension / Summarising					
3.	Video Resume SWOT Analysis & digital resume techniques Activity: Preparing a digital résumé for mock interview					
4.	Product & Process Description Describing and Sequencing Activity: Demonstration of product and process					
5.	Mock Meetings Types of meetings and meeting etiquette Activity: Conduct of meetings and drafting minutes of the meeting					
6.	Reading research article Scientific and Technical articles Activity: Writing Literature review					
7.	Analytical Reading Case Studies on Communication, Team Building and Leadership Activity: Group Discussion					
8.	Presentations Preparing Conference/Seminar paper Activity: Individual/ Group presentations					
9.	Intensive Listening Scientific documentaries Activity: Note taking and Summarising					
10.	Interview Skills Interview questions and techniques Activity: Mock Interviews					
Total Laboratory Hours					30 hours	
Mode of Assessment: Continuous Assessment / FAT / Written Assignments / Quiz/ Oral Presentation and Group Activity.						
Recommended by Board of Studies			28.06.2021			
Approved by Academic Council			No. 63	Date	23.09.2021	

Course Code	Course Title	L	T	P	C
BENG102P	Technical Report Writing	0	0	2	1
Pre-requisite	Technical English Communication	Syllabus version			
		1.0			
Course Objectives					
1.To augment specific writing skills for preparing technical reports 2.To think critically, evaluate, analyse general and complex technical information 3.To acquire proficiency in writing and presenting reports					
Course Outcome					
1. Write error free sentences using appropriate grammar, vocabulary and style 2. Synthesize information and concepts in preparing reports 3. Demonstrate the ability to write and present reports on diverse topics					
Indicative Experiments					
1	Advanced Grammar, Vocabulary and Editing Usage of Tenses - Adjectives and Adverbs - Jargon vs Technical Vocabulary - Abbreviations - Mechanics of Editing: Punctuation and Proof Reading Activity: Worksheets				
2	Research and Analyses Synchronise Technical Details from Newspapers - Magazines - Articles and e-content Activity: Writing introduction and literature review				
3	Systematisation of Information Techniques to Converge Objective-Oriented data in Diverse Technical Reports Activity: Preparing Questionnaire				
4	Data Visualisation Interpreting Data - Graphs - Tables- Charts - Imagery - Infographics Activity: Transcoding				
5	Introduction to Reports Meaning - Definition - Purpose - Characteristics and Types of Reports Activity: Worksheets on Types of reports				
6	Structure of Reports Title- Preface- Acknowledgement - Abstract-Summary- Introduction - Materials and Methods- Results- Discussion - Conclusion - Suggestions/Recommendations Activity: Identifying the structure of report				
7	Report Writing Data Collection - Draft an Outline and Organize Information Activity: Drafting reports				
8	Supplementary Texts Appendix- Index- Glossary- References- Bibliography - Notes				

	Activity: Organizing supplementary texts		
9	Review of Final Reports Structure- Content- Style - Layout and Referencing Activity: Examining clarity and coherence in final reports		
10	Presentation Presenting Technical Reports Activity: Planning, creating and digital presentation of reports		
Total Laboratory Hours		30 hours	
Mode of Continuous assessment: Continuous Assessment/FAT/Assignments/Quiz/Presentations/Oral examination			
Recommended by Board of Studies		28-06-2021	
Approved by Academic Council		No. 63	Date 23-09-2021

BMAT100L	Mathematics			L	T	P	C
				3	1	0	4
Pre-requisite	NIL			Syllabus Version			
				1.0			
Course Objectives							
The course is aimed at providing							
1. Necessary and relevant background to understand the other important engineering mathematics courses.							
2. Basic knowledge for the non-mathematics students to learn further topics and apply it in solving real-world engineering problems.							
Course Outcomes							
At the end of the course the student should be able to							
1. Solve a system of linear equations by matrix method.							
2. Apply the techniques of differentiation to find maxima and minima, and techniques of integration to evaluate areas and volumes of revolution.							
3. Understand the concept of ordinary differential equations, and first and second order linear differential equations.							
4. Have a clear understanding of analytic geometry and vector algebra.							
5. Apply concepts of mathematical logic and elementary probability to real life problems.							
Module:1	Matrices			5 hours +3 hours			
Matrices - types of matrices - operations on matrices - determinants - adjoint matrix – inverse of a matrix - solution of a system of linear equations by inversion method – elementary transformations – rank of a matrix - consistency and inconsistency of system of equations.							
Module:2	Differential Calculus			6 hours + 2 hours			
Differentiation of functions of single variable – differentiation techniques physical interpretations - differentiation of implicit functions – higher order derivatives – Taylor's, Maclaurin's series - maxima and minima of functions of a single variable.							
Module:3	Integral Calculus			6 hours + 2 hours			
Techniques of integration - integration by parts- Partial fractions - definite integrals – properties- evaluation of area and volume by integration.							
Module:4	Linear Ordinary Differential Equations			6 hours + 2 hours			
Differential equations-definition and examples- formation of differential equation- solving differential equations of first order - solving second order homogenous differential equations with constant coefficients.							
Module:5	Analytic geometry			5 hours + 2 hours			
Analytic geometry of three dimensions - direction cosines and direction ratios - plane, straight line and sphere, distance between points, distance to a plane.							

Module:6	Vector Algebra	7 hours + 2 hours
Vectors—operations on vectors-angle between two vectors-projection of one vector on another vector –equations of plane, straight line and sphere in vector forms-shortest distance between two skew lines - equation of a tangent plane to a sphere		
Module:7	Logic and Probability	8 hours + 2 hours
Mathematical logic – propositions – truth table – connectives– tautology – contradiction. Permutations and combinations – probability – classical approach – addition law - conditional probability - multiplicative law - Bayes' theorem and applications		
Module:8	Contemporary Issues	2 hours
Industry Expert Lecture and R& D lecture		
	Total Lecture hours:	45 hours
	Total Tutorial hours :	15 hours
Text Book(s)		
1. Engineering Mathematics, K. A. Stroud and Dexter J. Booth, 7 th Edition, Palgrave Macmillan (2013).		
Reference Books		
1. B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers		
2. S. Lipschutz and M. Lipson, Discrete Mathematics, 6 th Edition, Tata McGraw -Hill (2017).		
3. S. Lipschutz and J. Schiller Introduction to Probability and Statistics, , 3 rd Indian Edition, Tata McGraw -Hill (2017).		
Mode of Evaluation		
Digital Assignments (Solutions by using soft skill), Quiz, Continuous Assessments, Final Assessment Test		
Recommended by Board of Studies	24.06.2021	
Approved by Academic Council	No.:63	Date 23.09.2021

BMAT101L	Calculus			L	T	P	C
				3	0	0	3
Pre-requisite	Nil			Syllabus version			
				1.0			
Course Objectives							
<p>1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.</p> <p>2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.</p> <p>3. Enhance to use technology to model the physical situations into mathematical problems, experiment, interpret results, and verify conclusions.</p>							
Course Outcomes							
At the end of the course the student should be able to:							
<p>1. Apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions</p> <p>2. Evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints</p> <p>3. Evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.</p> <p>4. Use special functions to evaluate various types of integrals.</p> <p>5. Understand gradient, directional derivatives, divergence, curl, Green's, Stokes and Gauss Divergence theorems.</p>							
Module:1 Single Variable Calculus			8 hours				
Differentiation- Extrema on an Interval Rolle's Theorem and the Mean value theorem-Increasing and decreasing functions.-First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution.							
Module:2 Multivariable Calculus			5 hours				
Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and its properties.							
Module:3 Application of Multivariable Calculus			5 hours				
Taylor's expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange's multiplier method.							
Module:4 Multiple integrals			8 hours				
Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates.							
Module:5 Special Functions			6 hours				
Beta and Gamma functions–interrelation between beta and gamma functions-evaluation of multiple integrals using gamma and beta functions. Dirichlet's integral -Error functions complementary error functions.							
Module:6 Vector Differentiation			5 hours				
Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials. Statement of vector identities-simple problems.							
Module:7 Vector Integration			6 hours				
Line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems -verification and evaluation of vector integrals using them.							
Module:8 Contemporary Topics			2 hours				
Guest lectures from Industry and, Research and Development Organizations							
			Total Lecture hours:			45 hours	
Text Book							
1.	George B.Thomas, D.Weir and J. Hass, Thomas Calculus, 2014, 13th edition, Pearson						

Reference Books				
1	Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, Wiley India			
2	B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers			
3	John Bird, Higher Engineering Mathematics, 2017, 6th Edition, Elsevier Limited			
4	James Stewart, Calculus: Early Transcendental, 2017, 8th edition, Cengage Learning			
5	K.A.Stroud and Dexter J Booth, Engineering Mathematics, 2013, 7th Edition, Palgrave Macmillan.			
Mode of Evaluation: CAT, Assignment, Quiz and FA I				
Recommended by Board of Studies		24 06 2021		
Approved by Academic Council		No. 63	Date	23.09.2021

BMAT13P		Calculus Lab			L	T	P	Cr
					0	0	2	1
Pre-requisite	NIL	Syllabus version						
		1.0						
Course Objectives								
1. To familiarize with the basic syntax, semantics and library functions of MATLAB which serves as a tool not only in calculus but also many courses in engineering and sciences								
2. To visualize mathematical functions and its related properties.								
3. To evaluate single and multiple integrals and understand it graphically.								
Course Outcomes								
At the end of the course the student should be able to:								
1. Demonstrate MATLAB code for challenging problems in engineering								
2. Using plots/displays, interpret and illustrate elementary mathematical functions and procedures.								
Indicative Experiments								
1.	Introduction to MATLAB through matrices and general Syntax							
2.	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB							
3.	Evaluating Extremum of a single variable function							
4.	Understanding integration as Area under the curve							
5.	Evaluation of Volume by Integrals (Solids of Revolution)							
6.	Evaluating maxima and minima of functions of two variables							
7.	Applying Lagrange multiplier optimization method							
8.	Evaluating Volume under surfaces							
9.	Evaluating triple integrals							
10.	Evaluating gradient, curl and divergence							
11.	Evaluating line integrals in vectors							
12.	Applying Green's theorem to real world problems							
							Total Laboratory Hours	30 hours
Text Book								
1.	Brian H. Hahn, Daniel T. Valentine, Essential MATLAB for Engineers and Scientists, Academic Press, 7th edition, 2019.							
Reference Books								
1.	Amos Gilat, MATLAB: An Introduction with Applications, Wiley, 6/e, 2016.							
2.	Maritn Brokate, Pammy Manchanda, Abul Hasan Siddiqi, Calculus for Scientists and Engineers, Springer, 2019							
Mode of assessment: DA and FAT								
Recommended by Board of Studies					24.06.2021			
Approved by Academic Council					No. 63	Date	23.09.2021	

BMAT202L	Probability and Statistics	L	T	P	C
		3	0	0	3
Pre-requisite	BMAT101L, BMAT101P	Syllabus version			
		1.0			
Course Objectives :					
<ol style="list-style-type: none"> 1. To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations. 2. To analyze distributions and relationship of real-time data. 3. To apply estimation and testing methods to make inference and modelling techniques for decision making. 					
Course Outcome :					
At the end of the course the student should be able to:					
<ol style="list-style-type: none"> 1. Compute and interpret descriptive statistics using numerical and graphical techniques. 2. Understand the basic concepts of random variables and find an appropriate distribution for analyzing data specific to an experiment. 3. Apply statistical methods like correlation, regression analysis in analyzing, interpreting experimental data. 4. Make appropriate decisions using statistical inference that is the central to experimental research. 5. Use statistical methodology and tools in reliability engineering problems. 					
Module:1	Introduction to Statistics	6 hours			
Statistics and data analysis; Measures of central tendency; Measure of Dispersion, Moments-Skewness-Kurtosis (Concepts only).					
Module:2	Random variables	8 hours			
Random variables- Probability mass function, distribution and density functions-Joint probability distribution and Joint density functions; Marginal, Conditional distribution and Density functions- Mathematical expectation and its properties- Covariance, Moment generating function.					
Module:3	Correlation and Regression	4 hours			
Correlation and Regression – Rank Correlation; Partial and Multiple correlation; Multiple regression.					
Module:4	Probability Distributions	7 hours			
Binomial distribution; Poisson distributions; Normal distribution; Gamma distribution; Exponential distribution; Weibull distribution.					
Module:5	Hypothesis Testing-I	4 hours			
Testing of hypothesis –Types of errors - Critical region, Procedure for testing of hypothesis- Large sample tests- Z test for Single Proportion- Difference of Proportion- Mean and difference of means.					
Module:6	Hypothesis Testing-II	9 hours			
Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – One way-Two way-Three way classifications - CRD-RBD- LSD.					
Module:7	Reliability	5 hours			
Basic concepts- Hazard function-Reliabilities of series and parallel systems- System					

Reliability - Maintainability-Preventive and repair maintenance- Availability.			
Module:8	Contemporary Issues	2 hours	
Total lecture hours:			45 hours
Text Book:			
1. R. E. Walpole, R. H. Myers, S. L. Mayers, K. Ye, Probability and Statistics for engineers and scientists, 2012, 9 th Edition, Pearson Education.			
Reference Books			
1. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, 2016, 6 th Edition, John Wiley & Sons.			
2. E. Balagurusamy, Reliability Engineering, 2017, Tata McGraw Hill, Tenth reprint.			
3. J. L. Devore, Probability and Statistics, 2012, 8 th Edition, Brooks/Cole, Cengage Learning.			
4. R. A. Johnson, Miller Freund's, Probability and Statistics for Engineers, 2011, 8th edition, Prentice Hall India.			
5. Bilal M. Ayyub, Richard H. McCuen, Probability, Statistics and Reliability for Engineers and Scientists, 2011, 3 rd edition, CRC press.			
Mode of Evaluation: Digital Assignments, Continuous Assessment Tests, Quiz, Final Assessment Test.			
Recommended by Board of Studies	24-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BMAT202P	Probability and Statistics Lab		L	T	P	C
			0	0	2	1
Pre-requisite	BMAT101L, BMAT101P		Syllabus version			
			1.0			
Course Objectives:						
<ol style="list-style-type: none"> To enable the students for having experimental knowledge of basic concepts of statistics using R programming. To study the relationship of real-time data and decision making through testing methods using R. To make students capable to do experimental research using statistics in various engineering problems. 						
Course Outcomes:						
At the end of the course the student should be able to:						
<ol style="list-style-type: none"> Demonstrate R programming for statistical data. Carry out appropriate analysis of statistical methods through experimental techniques using R. 						
Indicative Experiments						
1.	Introduction: Understanding Data types; importing/exporting data		Total Laboratory hours: 30			
2.	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations					
3.	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination					
4.	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficients of determination					
5.	Fitting the probability distributions: Binomial distribution					
6.	Normal distribution, Poisson distribution					
7.	Testing of hypothesis for one sample mean and proportion from real time problems					
8.	Testing of hypothesis for two sample means and proportion from real time problems					
9.	Applying the t-test for independent and dependent samples					
10.	Applying Chi-square test for goodness of fit test and Contingency test to real dataset					
11.	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design, Latin square Design					
Text Book						
1. Statistical analysis with R by Joseph Schmuller, John Wiley and sons Inc., New Jersey 2017.						
Reference Books:						
<ol style="list-style-type: none"> The Book of R: A First course in Programming and Statistics, by Tilman M Davies, William Pollock, 2016. R for Data Science, by Hadley Wickham and Garrett Golemund, O' Reilly Media Inc., 2017. 						
Mode of assessment: Continuous assessment, FAT / Oral examination and others						
Recommended by Board of Studies			24-06-2021			
Approved by Academic Council			No. 64	Date	16-12-2021	

BMAT203L	Linear Algebra and Differential Equations	L	T	P	C
		3	1	0	4
Pre-requisite	BMAT101L, BMAT101P	Syllabus Version			
		1.0			
Course Objectives					
The course is aimed at providing					
<ol style="list-style-type: none"> 1. Necessary and relevant background to understand the other important engineering Mathematics courses. 2. Impart basic knowledge for formulating and solving practical engineering problems. 					
Course Outcomes					
At the end of the course the student should be able to					
<ol style="list-style-type: none"> 1. Solve a system of equations by matrix method. 2. Apply concepts of sequences and series to model real life problems. 3. Understand the concept of ordinary differential equations of first and second order linear differential equations. 4. Formulate practical problems using various mathematical techniques. 5. Apply the techniques of differential equations to model dynamic problems. 					
Module:1	Matrices	6 hours			
Lines in two-dimensional space, Planes in three-dimensional space, Matrices and elementary row operations, Reduced row-echelon matrices and solution sets, Matrix arithmetic, The multiplicative identity and solution sets, Determinants, Eigenvalues and eigenvectors, Gaussian elimination.					
Module:2	Sequences and series	6 hours			
Sequences, series, alternating series, convergence, absolute convergence, comparison tests, Ratio and Root tests, Strategy for Testing Series.					
Module:3	Power Series	5 hours			
power series, representation of functions as power series, Taylor and McClaurin series, Applications of Taylor Polynomials					
Module:4	First Order Differential Equations	6 hours			
Modeling via differential equation, solving differential equations of first order, Analytical techniques: separation of variables, Qualitative techniques: slope and direction fields, numerical technique: Euler's method, Existence and uniqueness of solutions, Equilibria and the phase line, bifurcations, Linear differential equations, Integrating factor methods.					
Module:5	Modelling using First order systems	5 hours			
Modeling differential equations of first order systems, geometrical interpretation, analytical methods for special systems, Euler's method, Lorenz equations					
Module:6	Linear Systems	7 hours			
Properties of linear systems, linearity principle, straight-line solutions, phase planes for linear systems with real eigenvalues, complex eigenvalues, and special cases: repeated and zero eigenvalues, second-order linear differential equations, the trace-determinant plane, linear systems in three dimensions.					
Module:7	Force and Resonance	8 hours			
Forced Harmonic oscillators, sinusoidal forcing, undamped forcing and resonance, amplitude and phase of the steady state, the Tacoma Narrow bridge.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
		Total Tutorial hours :		15 hours	

Text Book(s)			
<ol style="list-style-type: none"> 1. Calculus, James Stewart, 8th edition, Cengage Learning, 2015. 2. Differential Equations, Paul Blanchard, Robert L. Devaney, Glen R. Hall, 4th Edition, Brooks/Cole; 2012. 			
Reference Books			
<ol style="list-style-type: none"> 1. Introductory Linear Algebra, Bernard Kolman, David R. Hill, Pearson Education, 2011. 2. Introduction to Linear Algebra, Gilbert Strang, 5th edition, Cengage Learning, 2015. 3. Elementary Linear Algebra, Enton Howard, Wiley India, 2016. 4. Differential Equations, Shepley Ross, Wiley India, 2007. 			
Mode of Evaluation			
Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test			
Recommended by Board of Studies		24-06-2021	
Approved by Academic Council	64	Date	16-12-2021

Course Code	Course Title	L	T	P	C
BPHY101L	Engineering Physics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> To explain the dual nature of radiation and matter. To apply Schrödinger's equation to solve finite and infinite potential problems and apply quantum ideas at the nanoscale. To understand the Maxwell's equations for electromagnetic waves and apply the concepts to semiconductors for engineering applications. 					
Course Outcome					
At the end of the course the student will be able to					
<ol style="list-style-type: none"> Comprehend the phenomenon of waves and electromagnetic waves. Understand the principles of quantum mechanics. Apply quantum mechanical ideas to subatomic domain. Appreciate the fundamental principles of a laser and its types. Design a typical optical fiber communication system using optoelectronic devices. 					
Module:1	Introduction to waves	7 hours			
Waves on a string - Wave equation on a string (derivation) - Harmonic waves- reflection and transmission of waves at a boundary (Qualitative) - Standing waves and their eigenfrequencies.					
Module:2	Electromagnetic waves	7 hours			
Physics of divergence - gradient and curl - Qualitative understanding of surface and volume integral - Maxwell Equations (Qualitative) - Displacement current - Electromagnetic wave equation in free space - Plane electromagnetic waves in free space - Hertz's experiment.					
Module:3	Elements of quantum mechanics	6 hours			
Need for Quantum Mechanics: Idea of Quantization (Planck and Einstein) - Compton effect (Qualitative) – de Broglie hypothesis - - Davisson-Germer experiment - Wave function and probability interpretation - Heisenberg uncertainty principle - Schrödinger wave equation (time dependent and time independent).					
Module:4	Applications of quantum mechanics	5 hours			
Eigenvalues and eigenfunction of particle confined in one dimensional box - Basics of nanophysics - Quantum confinement and nanostructures - Tunnel effect (qualitative) and scanning tunneling microscope.					
Module:5	Lasers	6 hours			
Laser characteristics - spatial and temporal coherence - Einstein coefficients and their significance - Population inversion - two, three and four level systems - Pumping schemes - threshold gain coefficient - Components of a laser - He-Ne, Nd:YAG and CO ₂ lasers and their engineering applications.					
Module:6	Propagation of EM waves in optical fibers	6 hours			
Introduction to optical fiber communication system - light propagation through fibers - Acceptance angle - Numerical aperture - V-parameter - Types of fibers – Attenuation - Dispersion-intermodal and intramodal. Application of fiber in medicine - Endoscopy.					
Module:7	Optoelectronic devices	6 hours			
Introduction to semiconductors - direct and indirect bandgap – Sources: LED and laser diode, Photodetectors: PN and PIN.					
Module:8	Contemporary issues	2 hours			
Total Lecture hours:					45 hours

Textbook(s)			
1.	H. D. Young and R. A. Freedman, University Physics with Modern Physics, 2020, 15 th Edition, Pearson, USA.		
2.	D. K. Mynbaev and Lowell L. Scheiner, Fiber Optic Communication Technology, 2011, 1 st Edition, Pearson, USA		
Reference Books			
1.	H. J. Pain, The Physics of vibrations and waves, 2013, 6 th Edition, Wiley Publications, India.		
2.	R. A. Serway, J. W. Jewett, Jr, Physics for Scientists and Engineers with Modern Physics, 2019, 10 th Edition, Cengage Learning, USA.		
3.	K. Krane, Modern Physics, 2020, 4 th Edition, Wiley Edition, India.		
4.	M.N.O. Sadiku, Principles of Electromagnetics, 2015, 6 th Edition, Oxford University Press, India.		
5.	W. Silfvast, Laser Fundamentals, 2012, 2 nd Edition, Cambridge University Press, India.		
Mode of Evaluation: Written assignment, Quiz, CAT and FAT			
Recommended by Board of Studies		26-06-2021	
Approved by Academic Council		No. 63	Date 23-09-2021

BPHY101P	Engineering Physics Lab			L	T	P	C
				0	0	2	1
Pre-requisite	12th or equivalent			Syllabus version			
				1.0			
Course Objectives							
To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.							
Course Outcome							
At the end of the course the student will be able to							
1. Comprehend the dual nature of radiation and matter by means of experiments.							
2. Get hands-on experience on the topics of quantum mechanical ideas in the laboratory.							
3. Apply low power lasers in optics and optical fiber related experiments.							
Indicative Experiments							
1.	To determine the dependence of fundamental frequency with the length and tension of a stretched string using sonometer.						
2.	To determine the characteristics of EM waves using Hertz experiment						
3.	To determine the wavelength of laser source (He-Ne laser and diode lasers of different wavelengths) using diffraction grating						
4.	To demonstrate the wave nature of electron by diffraction through graphite sheet						
5.	To determine the Planck's constant using electroluminescence process						
6.	To numerically demonstrate the discrete energy levels and the wavefunctions using Schrödinger equation (e.g., particle in a box problem can be given as an assignment)						
7.	To determine the refractive index of a prism using spectrometer (angle of prism will be given)						
8.	To determine the efficiency of a solar cell						
9.	To determine the acceptance angle and numerical aperture of an optical fiber						
10.	To demonstrate the phase velocity and group velocity (simulation)						
						Total Laboratory Hours	30 hours
Mode of assessment: Continuous assessment / FAT / Oral examination							
Recommended by Board of Studies				26.06.2021			
Approved by Academic Council				No. 63	Date	23.09.2021	

BSTS101P	Quantitative Skills Practice I	L	T	N	C
		0	0	3	1.5
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> To enhance the logical reasoning skills of the students and help them improve problem-solving abilities To acquire skills required to solve quantitative aptitude problems To boost the verbal ability of the students for academic and professional purposes 					
Course Outcomes:					
<ol style="list-style-type: none"> Exhibit sound knowledge to solve problems of Quantitative Aptitude Demonstrate ability to solve problems of Logical Reasoning Display the ability to tackle questions of Verbal Ability 					
Module:1	Logical Reasoning	5 hours			
Word group categorization questions					
Puzzle type class involving students grouping words into right group orders of logical sense					
Cryptarithmic					
Module:2	Data arrangements and Blood relations	6 hours			
Linear Arrangement - Circular Arrangement - Multi-dimensional Arrangement - Blood Relations					
Module:3	Ratio and Proportion	6 hours			
Ratio - Proportion - Variation - Simple equations - Problems on Ages - Mixtures and alligations					
Module:4	Percentages, Simple and Compound Interest	6 hours			
Percentages as Fractions and Decimals - Percentage Increase / Decrease - Simple Interest - Compound Interest - Relation Between Simple and Compound Interest					
Module:5	Number System	6 hours			
Number system- Power cycle - Remainder cycle - Factors, Multiples - HCF and LCM					
Module:6	Essential grammar for Placement	7 hours			
<ul style="list-style-type: none"> Prepositions Adjectives and Adverbs Tense Speech and Voice Idioms and Phrasal Verbs Collocations, Gerunds and Infinitives Definite and Indefinite Articles Omission of Articles Prepositions Compound Prepositions and Prepositional Phrases Interrogatives 					
Module:7	Reading Comprehension for Placement	3 hours			
Types of questions - Comprehension strategies - Practice exercises					
Module:8	Vocabulary for Placement	6 hours			
Exposure to questions related to Synonyms – Antonyms – Analogy - Confusing words - Spelling correctness					
		Total Lecture hours:			45 hours
Text Book(s)					
1.	SMART. (2018). <i>Place Mentor 1st</i> (Ed.). Chennai: Oxford University Press.				
2.	Aggarwal R.S. (2017). <i>Quantitative Aptitude for Competitive Examinations 3rd</i> (Ed.). New Delhi: S. Chand Publishing.				

3.	FACE. (2016). <i>Aptipedia Aptitude Encyclopedia</i> 1 st (Ed.). New Delhi: Wiley Publications.		
4.	ETHNUS. (2016). <i>Aptimithra</i> , 1 st (Ed.) Bangalore: McGraw-Hill Education Pvt. Ltd.		
Reference Books			
1.	Sharma Arun. (2016). <i>Quantitative Aptitude</i> , 7 th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.		
Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BSTS102P	Quantitative Skills Practice II	L	T	P	C
		0	0	3	1.5
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> 1. Help to trigger the students' logical thinking skills and apply it in real-life scenarios 2. Learn to deploy the strategies of solving quantitative ability problems 3. To expand the verbal ability of students 4. Assist to run the gamut of employability skills 					
Course Outcomes:					
<ol style="list-style-type: none"> 1. Become proficient in interacting and using decision making models effectively 2. Help to understand the given concepts expressly to deliver an impactful presentation 3. Acquire knowledge of solving quantitative aptitude and verbal ability questions effortlessly 					
Module:1	Logical Reasoning puzzles - Advanced	2 hours			
Advanced puzzles: <ul style="list-style-type: none"> • Sudoku • Mind-bender style word statement puzzles • Anagrams • Rebus puzzles 					
Module:2	Logical connectives, Syllogism and Venn diagrams	2 hours			
Logical Connectives - Advanced Syllogisms - 4, 5, 6 and other multiple statement problems - Challenging Venn Diagram questions: Set theory					
Module:3	Permutation, Combination and Probability - Advanced	4 hours			
Fundamental Counting Principle- Permutation and Combination - Computation of Permutation - Advanced problems - Circular Permutations - Computation of Combination - Advanced problems -Advanced probability					
Module:4	Quantitative Aptitude	6 hours			
Logarithms, Progressions, Geometry and Quadratic equations - Advanced <ul style="list-style-type: none"> • Logarithm • Arithmetic Progression • Geometric Progression • Geometry • Mensuration • Coded inequalities • Quadratic Equations Concepts followed by advanced questions of CAT level					
Module:5	Image interpretation	2 hours			
Image interpretation: Methods - Exposure to image interpretation questions through brainstorming and practice					
Module:6	Critical Reasoning - Advanced	3 hours			
Concepts of Critical Reasoning - Exposure to advanced questions of GMAT level					
Module:7	Recruitment Essentials	8 hours			
Mock interviews					
Cracking other kinds of interviews					

Skype/ Telephonic interviews Panel interviews Stress interviews			
Guesstimation			
1. Best methods to approach Guesstimation questions			
2. Practice with impromptu interview on Guesstimation questions			
Case studies/ situational interview			
1. Scientific strategies to answer case study and situational interview questions			
2. Best ways to present cases			
3. Practice on presenting cases and answering situational interviews asked in recruitment rounds			
Module:8	Problem solving and Algorithmic skills		18 hours
Logical methods to solve problem statements in Programming - Basic algorithms introduced			
Total Lecture hours:			45 hours
Text Book(s)			
1.	SMART. (2018). <i>Place Mentor</i> 1 st (Ed.). Chennai: Oxford University Press.		
2.	Aggarwal R.S. (2017). <i>Quantitative Aptitude for Competitive Examinations</i> 3 rd (Ed.). New Delhi: S. Chand Publishing.		
3.	FACE. (2016). <i>Aptipedia Aptitude Encyclopedia</i> 1 st (Ed.). New Delhi: Wiley Publications.		
4.	ETHNUS. (2016). <i>Aptimithra</i> , 1 st (Ed.) Bangalore: McGraw-Hill Education Pvt.Ltd.		
Reference Books			
1.	Sharma Arun. (2016). <i>Quantitative Aptitude</i> , 7 th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.		
Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council		No. 63	Date 23.09.2021

BENG1PN		Effective English Communication		L	T	P	C
				0	0	4	2
Pre-requisite	Nil	Syllabus Version					
		1.0					
Course Objectives:							
1. To hone LSRW skills for effective communication							
2. To enhance communication skills for future career aspirations							
3. To gain critical communication skills in writing and public speaking							
—							
1. Write effective sentences using appropriate grammar and vocabulary							
2. Express clearly in everyday conversations with lucid pronunciation							
3. Analyse the given listening inputs for effective comprehension							
4. Apply different reading strategies to various texts and use them appropriately							
Indicative Experiments							
1.	Fundamentals of Grammar: Parts of Speech, Articles, Tenses, Sentence Structure, Types of Sentences, Subject-Verb Agreement Activity: Exercises and worksheets						
2.	Speaking for Self-Expression: Formal Self-Introduction, Expressing Oneself Activity: Self-Introduction, Just a Minute (JAM)						
3.	Basic Listening: Listening to Simple Conversations, Short Speeches/Stories Activity: Gap fill exercises						
4.	Reading Skills: Reading Strategies, Skimming and Scanning Activity: Cloze reading, Reading comprehension, Reading newspaper articles						
5.	Drafting Paragraphs: Keywords Development, Writing Paragraphs using Connectives Activity: Picture and poster interpretation						
6.	Vocabulary Enrichment: Synonyms and Antonyms, Prefixes and Suffixes, Word Formation, One Word Substitution, Frequently used Idioms and Phrases, Homophones and Homonyms Activity: Crossword puzzles and worksheets						
7.	Listening for Pronunciation: Introduction to Phonemes, Listening to Native Speakers, Listening to Various Accents Activity: Listening and imitating, Spell Bee						
8.	Interactive Speaking: Everyday Conversations, Team Interactions, Simulations Activity: Situational role plays						
9.	Email and Letter Writing: Types and Format of Emails and Letters Activity: Official e-mails and letters, personal letters						
10.	Reading for Comprehension: Short Stories by Indian Writers Activity: Summarising, loud reading						
Total Laboratory Hours						60 hours	
Mode of Evaluation: Continuous assessment / FAT / Written assignments / Quiz/ Oral examination / Group activity							
Recommended by Board of Studies				28.06.2021			
Approved by Academic Council				No. 63	Date	23.09.2021	

BBIT201L	Principles of Chemical Engineering	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Formulate material and energy balance to solve various compositions and flow rates of process streams. 2. Perform calculations pertaining to various processes, unit operations and fluid flow. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Explain the basics of engineering calculations pertaining to dimensions and system of units. 2. Summarize the material balances of biochemical processes and equipment. 3. Develop the energy balance calculations for various processes in chemical engineering. 4. Solve problems involving recycle, purge and bypass in a process or unit. 5. Asses different non-dimensional numbers and relating the variables using theorems. 6. Apply equations related to fluid flow and different types of flow measuring devices. 					
Module:1					
Units and Dimensions					7 hours
Dimension - Systems of Units, Conversion of Units, Composition of mixtures and solutions - Mass fraction, Mass percentage, Mole fraction, Mole percentage, Mass ratios, Molarity, Molality, Normality, Parts per million, Density and Specific gravity- Baume and API gravity scales.					
Module:2					
Ideal and Real Gas Equations					6 hours
Van der Waals equation, Compressibility factor equations, Composition of gases, Application to pure gas and gas mixtures, Partial pressures, Partial volumes, Air-water vapour systems, Humidity, Molar Humidity, Relative Humidity, Percentage saturation, Humid volume, Humidity chart, Wet and Dry bulb, Dew point temperatures.					
Module:3					
Material Balance					7 hours
Rules for solving material balance, Calculations involving distillation, Evaporation, Centrifugation, Drying, Filtration, Mixing and Crystallization, Processes involving recycle, Bypass and Purge, Material balance involving chemical reactions – Limiting reactant, Excess reactant, Yield, Conversion and Selectivity.					
Module:4					
Energy Balance					6 hours
Heat capacity of gases, Empirical equations for heat capacities, Mean heat capacities of gases, Sensible heat changes in liquid and solids, Heat capacity of liquid mixtures, Kopp's rule, Latent heats, Calculation of enthalpy from thermo-physical properties; Thermochemistry - Standard heat of reaction, Heat of formation, Hess's law, Standard heat of combustion, Effect of temperature on heat of reaction.					
Module:5					
Dimensional Analysis					6 hours
Derived quantities, Homogeneity, Methods of dimensional analysis, Rayleigh's method and method of repeating variables and the Buckingham Pi theorem, Concepts of Similarities.					
Module:6					
Basic Concepts of Fluid Mechanics					6 hours
Classification of fluids flows, Newtonian and non-Newtonian fluids, Pressure and its measurement – Simple manometer, U-tube manometer and Differential manometer, Basic equation of fluid flow, Continuity equation and Bernoulli equation.					
Module:7					
Flow Measurements and Machineries					5 hours
Orifice and Venturi meters, Pitot Tube, Weirs, Rotometers, Transportation of fluids, Pipe Fittings and valves, Pumps - Classification, Centrifugal and positive displacement type – peristaltic type.					
Module:8					
Contemporary Issues					2 hours

	Total Lecture hours:	45 hours	
Text Book(s)			
1.	Stoichiometry and Process Calculations by Narayanan K V, Lakshmikutty B, 2 nd Edition, 2016, PHI Learning, New Delhi, India.		
2.	Fluid Mechanics and Hydraulic Machines by Bansal R K, 10 th Edition, 2018, Laxmi Publications, India.		
Reference Books			
1.	Bioprocess Engineering Principles by Pauline M Doran, 2 nd Edition, 2012, Academic Press, USA.		
2.	Unit Operations of Chemical Engineering by Warren McCabe, Julian Smith. 7 th Edition, 2017, McGraw Hill Education, UK.		
3.	Basic Principles and Calculations in Chemical Engineering by Himmelblau, D H, 8 th Edition, 2015, Pearson Education, India.		
4.	Stoichiometry by Bhatt B I and Thakore S B, 5 th Edition, 2010, Tata McGraw Hill, India.		
Mode of Evaluation: CAT, Assignment, Quiz, Field visit, FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT201P	Chemical Engineering Lab			L	T	P	C	
				0	0	2	1	
Pre-requisite	Nil			Syllabus version				
				1.0				
Course Objective								
1. Perform calculations and measurements in the area of chemical engineering with emphasis in process calculations and fluid mechanics.								
Course Outcomes								
1. Demonstrate various operations in chemical engineering.								
2. Perform calculations and measurements pertaining to processes and various unit operations.								
Indicative Experiments								
1.	Determination of the efficiency of single stage leaching operation							
2.	Evaluation of the efficiency of multi-stage leaching operation							
3.	Single stage extraction process – efficiency analysis							
4.	Determination of the effectiveness of double pipe heat exchanger using co-current flow arrangements							
5.	Determination of the effectiveness of double heat exchanger using counter-current flow arrangements							
6.	Filtration in leaf filter							
7.	Determination of coefficient of discharge of orifice-meter and venturimeter							
8.	Filtration in plate and frame filter press (demonstration)							
9.	Determination of viscosity and specific gravity for different fluids							
10.	Demonstration of packed bed and fluidized beds systems							
11.	Recovery of metal ions from industrial effluents using appropriate techniques							
Total Laboratory hours:						30 hours		
Mode of assessment: Continuous assessment, FAT, and Oral examination								
Recommended by Board of Studies				18-02-2022				
Approved by Academic Council				No. 65	Date	17-03-2022		

BBIT205L	Bioinformatics	L	T	P	C
		2	0	0	2
Pre-requisite	BBIT202L, BBIT202P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Enumerate the basic concepts, methods and tools employed in Bioinformatics. 2. Solve biological problems using bioinformatics tools. 3. Formulate and discuss the use of a wide variety of proficient tools, servers, biological databases and for application in appropriate field. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Integrate multi-domain knowledge of the basic concepts of biology, computer science and mathematics. 2. Analyse the biological data through relevant computer algorithms. 3. Assess and evaluate structure-function relationships of biomolecules <i>in silico</i>. 4. Assign formulations to rapidly probe various aspects of bioinformatics. 5. Acquire insights about analyzing big datasets. 6. Interpret sequence analysis results. 					
Module: 1	Overview of Biological Database	5 hours			
Introduction to bioinformatics, Types of biological database, Data retrieval from biological database.					
Module: 2	Sequence Alignment Techniques	5 hours			
Pairwise sequence alignment methods, Dot-plot, Scoring matrices - Smith-Waterman algorithm, Needleman-Wunch algorithm.					
Module: 3	Multiple Sequence Alignment	3 hours			
Feng-Doolittle algorithm, Star alignment, Consensus string of multiple sequence alignment, Profile representation of multiple alignment.					
Module: 4	Heuristic Approach	3 hours			
BLAST and its types, PSI-BLAST, FASTA and its applications.					
Module: 5	Molecular Phylogenetics	4 hours			
Phylogenetics basics, Phylogenetic tree construction methods - Distance-based methods, Character-based methods, Phylogenetic tree evaluation.					
Module: 6	Gene and RNA Prediction Analysis	4 hours			
Gene prediction methods, Prediction of promoter and regulatory elements, RNA prediction.					
Module: 7	Structural Bioinformatics	3 hours			
Basics of protein structures, Prediction of secondary structure, Protein tertiary structure prediction, Drug discovery, Computer aided drug design.					
Module: 8	Numerical Modeling of Biological Data	3 hours			
Systems biology, Machine-learning algorithms, OMICS data analysis and numerical simulation of biological data.					
Total Lecture hours:					30 hours
Text Book(s)					
1.	Introduction to Bioinformatics, by Arthur Lesk, 5 th Edition, 2019, Oxford University Press, UK,				

2.	Bioinformatics, by Curran B G, Walker R J, 2017, CSB Publishers (P) Ltd, India,		
Reference Books			
1.	Bioinformatics: Concepts, Skills & Applications, by Rastogi S C, Namita Mendiratta, Parag Rastogi, 2 nd Edition, 2018, CSB Publishers (P) Ltd, India.		
2.	Bioinformatics Applications Based On Machine Learning, by Pablo Chamoso, 2021, Multidisciplinary Digital Publishing Institute, Switzerland.		
Mode of Evaluation: CAT, Assignments, Quiz and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT205P	Bioinformatics Lab			L	T	P	C
				0	0	2	1
Pre-requisite	BBIT202L, BBIT202P			Syllabus version			
				1.0			
Course Objective							
1. Develop a basic understanding and practical knowledge on bioinformatics tools, techniques and their functionalities.							
Course Outcome							
1. Apply relevant <i>in silico</i> tools to retrieve and analyse biological data.							
Indicative Experiments							
1.	Information retrieval from Bibliographic database						
2.	Information retrieval from Nucleic acid sequence database						
3.	Information retrieval from Protein sequence database						
4.	Information retrieval from Protein structural database						
5.	Pairwise alignment techniques						
6.	Multiple sequence alignment techniques						
7.	Sequence similarity search through database						
8.	Phylogenetic tree construction						
9.	Gene prediction and RNA prediction						
10.	Compute the hydrophobicity scales from protein sequence						
11.	Prediction of secondary structure and tertiary structure from protein sequence						
12.	Visualization of protein structure						
Total Laboratory hours:						30 hours	
Mode of assessment: Continuous assessment, FAT and Oral examination							
Reference Books:							
1. Introduction to Bioinformatics, by Arthur Lesk, 5 th Edition, 2019, Oxford University Press, UK.							
2. Bioinformatics: Concepts, Skills and Applications, by Rastogi S C, Namita Mendiratta, Parag Rastogi, 2 nd Edition, 2018, CSB Publishers (P) Ltd., India.							
3. Bioinformatics, by Curran B G, Walker R J, 2017, CSB Publishers (P) Ltd., India.							
Recommended by Board of Studies				18-02-2022			
Approved by Academic Council				No. 65	Date	17-03-2022	

BBIT301L	Principles of Bioprocess Engineering	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT201L, BBIT201P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Build a basic understanding of bioreactors and its mode of operations. 2. Inculcate fundamental concepts of different bioreactors and its design calculations. 3. Demonstrate applications of kinetics in microbial growth and product formation. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Design different types of bioreactors and their control systems. 2. Analyze the applications of bioreactors in microbial growth. 3. Evaluate the oxygen transfer rate in bioreactors. 4. Investigate the importance of scale-up and scale-down in microbial growth and product formation. 5. Create mathematical models for microbial growth. 					
Module:1	Bioreactors and their Types	6 hours			
Principles of continuous stirred tank bioreactors, Bubble column bioreactors, Airlift bioreactors, Fluidized bed bioreactors, Packed bed bioreactors and Photobioreactors; Basic criteria for design of bioreactor.					
Module:2	Instrumentation and Control of Bioreactors	6 hours			
Operation of a conventional bioreactor; Batch, Fed-batch, continuous and recycle system; Measurement and control of bioprocess parameters; Accessories for aseptic operation, Control modes and types of controllers.					
Module:3	Design of Batch and Fed-Batch Reactor	7 hours			
Design and operation of bioreactors; Batch operation of a stirred tank reactor, Total time for batch reaction cycle; Fed-batch operation of a stirred tank reactor.					
Module:4	Design of Continuous and Recycle Reactor	6 hours			
Continuous operation of a mixed reactor; Steady-state concentrations in a chemostat; Substrate conversion and biomass productivity in a chemostat; Chemostat with cell recycle; Comparison between major modes of reactor operation; Evaluation of kinetic and yield parameters in chemostat culture.					
Module:5	Oxygen Transfer in Bioreactors	6 hours			
Oxygen transfer to cells; Transfer resistances; Mass transfer coefficients; Determination of oxygen transfer coefficients; Factors affecting mass transfer coefficient; Power requirements for mixing: Gassed and ungassed fluids.					
Module:6	Scale – Up	6 hours			
Model, Prototype, Similitude, Reactor scale up, Scale up criteria - Constant p/v, Constant k_{la} , Constant tip speed, Constant N_{Re} , Constant mixing time.					
Module:7	Mathematical Models for Microbial Growth	6 hours			
Kinetic models for cell growth, Monod model, Growth of filamentous organism, Growth associated and non-growth associated- substrate and product inhibition on cell growth; Structured models, Model simulation.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Bioprocess Engineering, by Michael L Shuler, Kargi F, Matthew DeLisa, 3 rd Edition, 2017, Prentice Hall International Series. USA.				
2.	Principles of Fermentation Technology, by Stanbury P, Whitaker A. & Hall, SJ. 3 rd				

	Edition, 2016, Butterworth Heinemann, India.		
Reference Books			
1.	Bioprocess Engineering, Kinetics, Sustainability, and Reactor Design, by Shijie Liu, 3rd Edition, 2017, Elsevier, NY, USA.		
2.	Bioprocess Engineering Principles, by Pauline M Doran, 2nd Edition, 2013, Academic press, Australia.		
Mode of Evaluation: CAT, Assignment, Field visit, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT301P	Bioprocess Engineering Lab			L	T	P	C
				0	0	2	1
Pre-requisite	BBIT201L, BBIT201P			Syllabus version			
				1.0			
Course Objective							
1. Demonstrate the fundamental concepts of bioprocess engineering laboratory techniques within the context of the use of these techniques in industrial and laboratory settings.							
Course Outcomes							
1. Demonstrate their ability to design medium, conduct experiments, analyse and interpret data.							
2. Evaluate the oxygen transfer rate in bioreactors.							
3. Create mathematical models for microbial growth.							
Indicative Experiments							
1.	Enzyme activity measurement using DNSA method						
2.	Classical method of medium optimization – carbon source and nitrogen source						
3.	Classical method of medium optimization – temperature and pH						
4.	Statistical media optimization: Plackett–Burman design						
5.	Determination enzyme kinetics parameters						
6.	Sterilization kinetics						
7.	Batch microbial growth kinetics						
8.	Submerged fermentation						
9.	Statistical media optimization: response surface methodology (RSM)						
10.	Demonstration of fermenter and its accessories						
Total Laboratory hours:						30 hours	
Mode of assessment: Continuous assessment, FAT and Oral examination							
Recommended by Board of Studies				18-02-2022			
Approved by Academic Council				No. 65	Date	17-03-2022	

BBIT202L	Biochemistry			L	T	P	C
				3	0	0	3
Pre-requisite	Nil			Syllabus version			
				1.0			
Course Objectives							
<ol style="list-style-type: none"> 1. Sketch the chemical structure of biomolecules. 2. Compare and contrast the structure and function of macromolecules. 3. Construct metabolic pathways and to analyse metabolism. 							
Course Outcomes							
<ol style="list-style-type: none"> 1. Interpret cell behavior based on physical and chemical composition. 2. Relate interaction of water with macromolecules in biological system. 3. Analyze structure and function of biomolecules. 4. Infer metabolic reactions and their role in the cell. 5. Classify lipids and nucleic acids based on their composition. 6. Distinguish function of biomolecule based on its features. 							
Module:1	Foundations of Biochemistry			5 hours			
Properties of living system - Review on cellular, Chemical, Physical, Genetic and evolutionary backgrounds to biochemistry.							
Module:2	Water and Buffers			6 hours			
Structure of water, Solvent and ionization property of water, water as a reactant, pH and buffers and their importance.							
Module:3	Carbohydrates			6 hours			
Classification, Structure and function, Glycoconjugates - Proteoglycans, Glycoproteins and glycolipids.							
Module:4	Metabolism of Carbohydrates			6 hours			
Glycolysis, TCA cycle, Oxidative phosphorylation, Gluconeogenesis and Pentose phosphate pathway and their regulation.							
Module:5	Amino Acids			6 hours			
Classification, Structure and Biological importance of amino acids, Acid–base properties and Stereochemistry of amino acids, Amino acid synthesis – Precursors and routes of non-essential amino acids.							
Module:6	Proteins and their Structural Features			6 hours			
Classification and function of proteins, Structural elucidation of proteins - Primary, Secondary, Tertiary and Quaternary (Silk fibroin, Collagen, Myoglobin and Hemoglobin).							
Module:7	Fatty Acids and Lipids			5 hours			
Classification, Structure, Properties, Function and Metabolism of fatty acids; Classification, Structure, Properties and Biological function of simple lipids - Triacylglycerol and Waxes. Compound lipids - Phospholipids and Glycolipids, Cholesterol - Structure, Properties and Importance.							
Module:8	Nucleic Acids			5 hours			
Composition, Properties and Function of nucleic acids, Metabolism - Synthesis of purines and pyrimidines.							
			Total Lecture hours:	45 hours			
Text Book(s)							
1.	Lehninger Principles of Biochemistry: International Edition, by David L Nelson and Michael M Cox, 8 th Edition, 2019, W.H. Freeman & Co Ltd., USA.						
Reference Books							
1.	Biochemistry, by U Satyanarayan and U Chakrapani, 6 th Edition, 2021, Elsevier, India.						

2.	Voet's Biochemistry, Donald Voet and Judith G Voet, 4th Edition, 2021, Wiley India.		
3.	Biochemistry, by Jeremy M. Berg, Lubert Stryer, John Tymoczko and Gregory Gatto, 9th Edition, 2019, Macmillan International Higher Education, New York.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT202P	Biochemistry Lab			L	T	P	C
				0	0	2	1
Pre-requisite	Nil			Syllabus version			
				1.0			
Course Objective							
1. Infer properties of biomolecules based on qualitative and quantitative analysis.							
Course Outcome							
1. Solve numerical related to solution preparation and buffer preparation.							
2. Analyse biomolecules qualitatively and quantitatively.							
Indicative Experiments							
1.	Laboratory practices in biochemistry and reagent preparation (calculations)						
2.	Preparation of buffers						
3.	pKa estimation						
4.	Acid-base titration of amino acids						
5.	Qualitative analysis of carbohydrates						
6.	Qualitative analysis of amino acids						
7.	Estimation of proteins by Lowry's method						
8.	Estimation of reducing sugar by DNS method						
9.	Estimation of amino acids by Ninhydrin method						
10.	Estimation of total sugars by Anthrone method						
11.	Estimation of cholesterol by Zak's method						
Total Laboratory hours:						30 hours	
Mode of assessment: Continuous assessment, FAT and Oral examination							
Laboratory Manual in Biochemistry, Jayaraman J, 2 nd Edition, 2021, New Age International Publisher, India.							
Recommended by Board of Studies				18-02-2022			
Approved by Academic Council				No. 65	Date	17-03-2022	

BBIT203L	Microbiology			L	T	P	C
				3	0	0	3
Pre-requisite	Nil			Syllabus version			
				1.0			
Course Objectives							
<ol style="list-style-type: none"> 1. Build a basic understanding of general and applied microbiology. 2. Comprehend the fundamental concepts of classification, metabolism and growth of microbes. 3. Understand microbial culture methods. 							
Course Outcomes							
<ol style="list-style-type: none"> 1. Comprehend the basic principles of microscopy and staining techniques. 2. Outline the basic microbial structure and functions. 3. Analyse various media, applications and sterilization methods. 4. Describe the various methods for identification of novel microorganisms. 5. Understand the microbial growth, measurement, transport systems and the modes and mechanisms of energy conservation in microbial metabolism. 6. Distinguish the role of applied microbiology in industry, clinical and other relevant sectors. 							
Module:1	Microbes and Microscopy			7 hours			
Historical developments of microbiology as applied engineering science; Microscopy - Different types of microscopes and micrometry.							
Module:2	Culture Techniques			7 hours			
Sterilization - Principles, Physical and Chemical methods; Types of media, Enrichment techniques for isolation, Screening and Cultivation of microorganisms; Maintenance and preservation of microbial cultures.							
Module:3	Bacterial Morphology			5 hours			
Bacterial cell structure - Types of bacteria and cell components; Staining techniques: Simple, Differential and Specialized staining techniques, Sample preparation methods.							
Module:4	Microbial Taxonomy			6 hours			
Classification of microorganisms - bacterial classification schemes and Identification methods; Actinobacteria; Fungal classification and key identification characters; Algal characteristics, Groups, and Classification; Viruses - Types, Classification and Characters; Sources of microorganisms - Microbial type collection centers in India and abroad.							
Module:5	Microbial Metabolism			6 hours			
Respiratory metabolisms of microorganism - Aerobic and Anaerobic pathways of energy production; Fermentative pathways - Organisms, Substrates, Intermediates and End products; Membrane transport - Nutrient uptake and Protein secretion in bacteria.							
Module:6	Microbial Nutrition and Growth			6 hours			
Nutritional types of microorganisms; Growth curve; Mathematics of growth; Measurement of microbial growth; Batch culture and Continuous culture of microorganisms; Synchronous growth; Influence of environmental factors on growth.							
Module:7	Applications of Microbiology			6 hours			
Microorganisms as human pathogens - Role of bacteria, Fungi and Viruses in human diseases; Industrially important microbes.							
Module:8	Contemporary Topics			2 hours			
Total Lecture hours:							
						45 hours	
Text Book(s)							
1.	Microbiology: An Introduction, Tortora G J, Funke B R, Case C L, 4 th Edition, 2019, Pearson Education, India.						

2.	Textbook of Microbiology, Ananthanarayan R and Jayaram Paniker C K, Editor: Reba Kanungo, 11th Edition, 2020, Universities Press (India) Pvt. Ltd., India.		
Reference Books			
1.	Microbiology, Prescott L M, Harley J P and Klein D A, 9 th Edition, 2019, McGraw Hill, Newyork. USA.		
2.	Microbiology: Principles and Explorations, Jacquelyn G Black and Laura J Black, 10 th Edition, 2019, Wiley, USA.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT203P	Microbiology Lab			L	T	P	C	
				0	0	2	1	
Pre-requisite	Nil			Syllabus version				
				1.0				
Course Objective								
1. Understand various aspects of microbiology and become familiar with microbial culture techniques.								
Course Outcome								
1. Demonstrate practical skills in microscopy, handling techniques, staining procedures and pure culture techniques.								
Indicative Experiments								
1.	Light and electron microscopy (components, principle and working mechanism of microscope)							
2.	Simple and Differential staining - Gram's staining							
3.	Endospore staining, Negative staining and Capsule staining							
4.	Micrometry - Measurement of bacteria							
5.	Media Preparation and Sterilization							
6.	Pure culture techniques: Pour plate, Spread plate, Streak plate, and Serial dilution techniques							
7.	Biochemical tests for identification of bacteria							
8.	Growth curve - Generation and doubling time determination							
9.	Antibiotic profiling of microorganisms and Kirby-Bauer Test							
10.	Water Quality analysis - MPN method							
Total Laboratory hours:							30 hours	
Reference Book:								
Microbiology: A laboratory manual, Cappuccino J G, and Welsh C T, 12 th Edition, 2020. Pearson Education Limited, USA.								
Mode of Assessment: Continuous assessment, FAT and Oral examination								
Recommended by Board of Studies				18-02-2022				
Approved by Academic Council				No. 65	Date	17-03-2022		

BBIT204L	Cell Biology and Genetics	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Recall the basics of cell biology and genetics. 2. Summarize the concepts of membrane transport, signal transduction and heritable variations. 3. Describe Mendelian genetics, its deviations and role of population genetics. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Characterize the features of prokaryotic and eukaryotic cells, their composition, spatial and molecular organization of cellular organelles. 2. Summarize the types of transport mechanisms and throw light on process of cell division. 3. Describe the mechanisms of signal transduction. 4. Relate the principles of Mendelian genetics and non-Mendelian variations. 5. Outline the mechanisms of sex determination. 6. Understand the concepts of population genetics and human genetics in health and diseases. 					
Module:1	Cell Types, their Structure and Function	5 hours			
Cell - Unit of life, Cell morphology, Difference between bacterial, Plant and Animal cells, Structure and function of membranes, Membrane organization and composition, Structure and functions of cell organelles - Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes, Chloroplast and vacuoles.					
Module:2	Cytoskeleton and Cell Division	6 hours			
Cytoskeletal elements and architecture - Intermediate filaments, Microtubules, and Microfilaments, Microtrabecular system (lattice) of cytoplasm, Shaping of the cells and mechanical support - Cell to cell integration, Extracellular matrix, Cell locomotion (amoeboid, flagella, ciliary movement), Types of cell division, Mitosis and Meiosis, Cell cycle and Molecules that control cell cycle.					
Module:3	Cellular Transport Systems	6 hours			
Transport types - Passive and Active transport, Permeases, Na ⁺ /K ⁺ , Ca ²⁺ - ATPase pumps, ATP dependent proton pumps – Cotransport, Symport, Antiport, Role of lysosomal and vacuolar membrane in cellular transport, Transport into prokaryotic cells, Endocytosis and Exocytosis, Entry of viruses and toxins into the cells.					
Module:4	Cell Signaling	6 hours			
Types - Autocrine, Paracrine, and Endocrine signaling molecules, Secondary signaling molecules - G-protein coupled signal transduction pathways involving cAMP, cGMP, IP ₃ , DAG and Ca ²⁺ as second messengers.					
Module:5	Mendelian Genetics	5 hours			
Basic principles of heredity, Mendel's experiments, Genetic terminology, Mendel's laws of genetics, Monohybrid cross, Dihybrid cross; Deviations of Mendel's ratios - Genetic interactions, Epistasis, Pleiotropy, Penetrance and Expressivity, Multiple alleles.					
Module:6	Heritable Variations	6 hours			
Linkage, Crossing over and Chromosome mapping, Crossing over as physical basis of recombination, Gene mapping and Recombination frequencies, Coupling and Repulsion linkages, Calculating recombination frequency, Structural changes in chromosomes - Duplications, Deletions, Inversions and Translocations.					
Module:7	Sex Determination	6 hours			
Sex determination and Sex-linked characteristics - Chromosomal systems, Genic systems, Environmental sex determination, Sex-determination in <i>Drosophila melanogaster</i> and					

humans, Concept of dosage compensation, Mitochondrial and multifactorial inheritance and diseases, Sex-linked, Sex-influenced, and Sex-limited traits, Y-linked characteristics.			
Module:8	Population Genetics and Human Genetics		5 hours
Derivation of Hardy and Weinberg's equilibrium, Factors affecting the equilibrium, Role of Euphenics, Eugenics and euthenics, Human Pedigree - Autosomal and Allosomal; Genetic counseling and Prenatal diagnosis, Epigenetics and Genomic imprinting, Role of genes in cancer.			
		Total Lecture hours:	45 hours
Text Book(s)			
1.	The Cell: A Molecular Approach, by Geoffrey M Cooper, 8 th Edition. 2019, Oxford University Press, New York.		
2.	Genetics, by Monroe W. Strickberger, 3 rd Edition, 2015, Pearson Education, Delhi India.		
Reference Books			
1.	Cell And Molecular Biology, by De Robertis E D P, 8th Edition, 2011. Lippincott Williams & Wilkins, New York, USA.		
2.	Genetics: A Conceptual Approach, by Benjamin A. Pierce, 7th Edition 2020. W H Freeman & Co. New York, USA.		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT204P	Cell Biology and Genetics Lab			L	T	P	C	
				0	0	2	1	
Pre-requisite	Nil			Syllabus version				
				1.0				
Course Objective								
1. Explore the cell structure and tissue architecture using current techniques and demonstrate the ability to understand genetic problems.								
Course Outcome								
1. Use of common laboratory equipment, carry out preparation of reagents and employ statistical tools in genetics.								
2. Demonstrate the technical knowledge for various cell biology and genetics experiments and interpret human pedigree.								
Indicative Experiments								
1.	Study of eukaryotic cell types using permanent slides							
2.	Study the stages of mitosis in onion root tips using appropriate staining techniques							
3.	Observe the stages of meiosis and compare the meiosis I and meiosis II using permanent slides							
4.	Enumerating the RBCs and WBCs using hemacytometer and Neubauer chamber							
5.	Compare squamous cells of males and females for the presence of Barr bodies to confirm Lyon's Hypothesis							
6.	Analyse the outcome of changes in the osmotic pressure using appropriate cells							
7.	Study and compare polytene and mitotic chromosomes							
8.	Human pedigree analysis and Chi-square test							
9.	Calculate genotypic and recombination frequencies							
10.	Web-based tools to study human chromosomes							
Total Laboratory hours:						30 hours		
Mode of assessment: Continuous assessment, FAT and Oral examination								
Reference Book: Practical laboratory manual - CELL BIOLOGY, by Amit Gupta and Bipin Kumar Sati, 2019, LAP Lambert Academic Publishing, Saarbrücken, Germany.								
Recommended by Board of Studies				18-02-2022				
Approved by Academic Council				No. 65	Date	17-03-2022		

BBIT206L	Analytical Techniques in Biotechnology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT202L, BBIT202P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Acquire conceptual understanding of basic principles related to various analytical instruments. 2. Impart knowledge in using various analytical instruments. 3. Ability to assimilate the data and analyse it meticulously. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Illustration of solution preparations and application of different tools on quantification. 2. Enumerate the usage and maintenance of analytical instruments. 3. Distinguish the analytes by using appropriate tools. 4. Interpret the data to predict unknown compounds. 5. Suggest analytical technique/instrument to solve real-life problem. 					
Module:1	Basics of Chemical Analysis and Analytical Techniques	7 hours			
Basics of solutions preparation and calculations; Sampling – Methods and techniques – Heterogeneity and random sampling, Sample reduction techniques; Sources of errors in experimental results, Precision, Accuracy, Determinate and indeterminate errors; Titrimetric methods - Volumetric analysis - Back titration, Gravimetric analysis; Potentiometric titration - pH meter and Conductivity meter.					
Module:2	Spectroscopy Techniques - I	7 hours			
Fundamentals of spectroscopy; UV-Visible spectroscopy, Atomic absorption spectroscopy, Atomic emission spectroscopy, Spectrofluorimetry - Basic principle, Instrumentation, Sample preparation and applications.					
Module:3	Spectroscopy Techniques - II	6 hours			
Infrared spectroscopy, Fourier Transform infrared spectroscopy, Nuclear magnetic resonance spectroscopy; Mass spectrometry - Basic principle, Instrumentation, Sample preparation, Application and small molecule interpretation.					
Module:4	Centrifugation Techniques	4 hours			
Centrifugation - Basic principle, Mathematics and theory (Relative Centrifugal Field, sedimentation coefficient); Different types of centrifuges, Isocratic and gradient centrifugation, Analytical and preparative centrifugation, Ultracentrifugation methods.					
Module:5	Chromatographic Techniques	6 hours			
Theory of chromatography; Basic principle and types of chromatography, Applications of chromatography - Thin layer chromatography, Column chromatography, High-performance liquid chromatography and Gas chromatography.					
Module:6	Electrophoretic Techniques	6 hours			
Principle, Methodology and types, Buffer system for electrophoresis, Agarose gel electrophoresis, Poly acrylamide gel electrophoresis, Gradient gel electrophoresis, Capillary electrophoresis; Staining techniques.					
Module:7	Microscopic Techniques	5 hours			
Concept of microscopy, magnification, resolution; Principle and applications of various types of microscopic techniques - Light microscopy, Dark-field microscopy, Phase contrast microscopy, Fluorescence microscopy, Confocal microscopy, Electron microscopy (Transmission and Scanning electron microscopy).					
Module:8	Radiotracer Techniques	4 hours			
Radioactive and stable isotopes, pattern and rate of radioactive decay; Measurement of radioactivity - Physical principles of X-ray diagnosis, Geiger Muller and scintillation counter, Radioimmunoassay; Radiotracers for biotechnology applications; Alternative to radioactive substances.					

		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Principles and Techniques of Biochemistry and Molecular Biology, by Wilson K and Walker J, 8 th Edition, 2018, Cambridge University Press, UK.				
2.	Analytical Chemistry, by Gary D Christian, Purnendu K Dasgupta, Kevin A Schug, 2020, Wiley India Pvt. Ltd., India.				
Reference Books					
1.	Biochemistry Laboratory: Modern Theory and Techniques, by Rodney Boyer, 3rd Edition, 2018, Pearson Prentice Hall, Boston.				
2.	Medical Laboratory Technology, Procedure Manual for Routine Diagnostic Tests, by Kanai L Mukherjee and Anuradha Chakravarthy, 3rd Edition, 2017, McGraw Hill Education, India.				
Mode of Evaluation: CAT, Assignment, Quiz, and FAT					
Recommended by Board of Studies			18-02-2022		
Approved by Academic Council			No. 65	Date	17-03-2022

BBIT206P	Analytical Techniques in Biotechnology Lab		L	T	P	C
			0	0	2	1
Pre-requisite	BBIT202L, BBIT202P		Syllabus version			
			1.0			
Course Objective						
1. Impart knowledge and skills in using various analytical techniques and instruments.						
Course Outcomes						
1. Prepare standard solutions with good reproducibility.						
2. Separate, identify and estimate the biological samples.						
Indicative Experiments						
1.	Standard solution preparation, calibration of volumetric apparatus and analytical instruments					
2.	Study the effect of endpoint determining tools (pH meter and chemical indicator) in a strong acid strong base titration and their accuracy and precision analysis					
3.	Estimate the strength of ammonia solution by back titration using a standardized strong acid					
4.	Electrophoretic separation of proteins using PAGE (SDS and Native)					
5.	Estimation of protein concentration in the sample by ultraviolet spectroscopy					
6.	Preparation of sample and estimation of elements by atomic absorption spectroscopy					
7.	Study of hyperchromic and hypochromic effect in DNA by spectrophotometry					
8.	Separation of sugars and amino acids by thin-layer chromatography/ high performance thin layer chromatography					
9.	Titrimetric determination of acetylsalicylic acid content in aspirin tablets					
10.	Analysis of functional group by Fourier Transform Infrared Spectroscopy					
11.	Separation of cells, cellular components/ biomolecules by differential centrifugation					
Total Laboratory hours:						30 hours
Mode of assessment: Continuous assessment, FAT and Oral examination						
Reference Book: Analytical Chemistry Skill Enhancement Course, by Chattopadhyay K, Mandal M, 1 st Edition, 2021, CBS Publishers and Distributors, India.						
Recommended by Board of Studies			18-02-2022			
Approved by Academic Council			No. 65	Date	17-03-2022	

BBIT207L	Molecular Biology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT202L, BBIT202P, BBIT204L, BBIT204P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Build a basic understanding of origin and development of molecular biology. 2. Introduce fundamental concepts of molecular biology. 3. Exemplify applications of molecular biology in other disciplines. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Formulate the basic concepts of molecular biology. 2. Describe the design principles of molecular biology. 3. Examine the fundamental molecular processes involved in central dogma. 4. Identify the problems in nucleic acids and protein metabolism. 5. Evaluate the concepts learnt in regulation of gene expression. 6. Apply the techniques to relate biological macromolecules and their function. 					
Module:1	Genome Organization	6 hours			
Structure of DNA - Nucleotides, Nucleosides, Sugar, Bases, Bonds involved in doublestranded DNA; Chargaff's rule; Genome organization in prokaryotes and eukaryotes; Chromosome structure – Different types of histones and chromosome packing; Central dogma of life; DNA and RNA as genetic material; Differences between DNA and RNA.					
Module:2	DNA Replication	6 hours			
Classical experiments to understand mechanism of DNA replication; Proteins involved in replication, Replication in prokaryotes; End replication problem; Different models of DNA replication; Differences between prokaryotic and eukaryotic replication; Inhibitors of DNA replication.					
Module:3	DNA Damage and Repair Mechanisms	6 hours			
Endogenous - Replication errors, DNA base mismatches and topoisomerase-DNA complexes, Spontaneous base deamination, Abasic sites, Oxidative DNA damage, DNA methylation; Exogenous- Environmental, Physical and Chemical agents; Ionizing radiation, Ultraviolet radiation, Alkylating agents, Aromatic amines, Toxins; DNA repair pathways - Base excision repair, Nucleotide excision repair, Mismatch repair, Homologous recombination and Non-homologous end joining.					
Module:4	Transcription	7 hours			
Events occurring in promoter region, Mechanism of RNA synthesis - Initiation, Elongation, Termination and Transcription cycle; Differences between prokaryotic and eukaryotic transcription; Post-transcriptional modifications of mRNA, tRNA and rRNA; RNA splicing, Alternative splicing; Inhibitors of transcription.					
Module:5	Translation	7 hours			
Features of genetic code, Deciphering genetic code; Structure of mRNA, tRNA and Ribosomes; Translation process - Initiation, Elongation and Termination; Post translational modification of proteins and their significance; Inhibitors of translation.					
Module:6	Prokaryotic Gene Regulation	4 hours			
Promoter, Repressor, Operator and Inducer; Operon concept - Lac and Trp operon.					
Module:7	Recombination and Reverse Transcription	5 hours			
Recombination - Conjugation, Transformation, Transduction and sexduction; Reverse transcription – Classification and life cycle of retrovirus, Structure and function of reverse transcriptase, Mechanism of reverse transcription.					
Module:8	Techniques in Molecular Biology and Applications	4 hours			
Electrophoretic mobility-shift assay, DNase footprinting assay, Chromatin immunoprecipitation, CRISPR-Cas9, RNA interference.					

		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Molecular Biology, by David Freifelder, 2 nd Edition, Reprint 2020, Narosa Publishers, New Delhi, India.				
2.	Lehninger Principles of Biochemistry, by David L Nelson and Michael M Cox, 8 th Edition, 2021, W H Freeman publisher, USA.				
Reference Books					
1.	Molecular Cell Biology, by Harvey Lodish, Arnold Berk, Chris A Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Kelsey C Martin, Michael Yaffe, and Angelika Amon, 9 th Edition, 2020, WH Freeman Publisher, New York, USA.				
2.	Molecular Biology, by Michael M Cox, Jennifer Doudna and Michael O'Donnell, 2 nd Edition, 2015, WH Freeman publisher, USA.				
3.	Molecular Biology of the Cell, by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter, 7 th Edition, 2022, Garland Science, New York.				
Mode of Evaluation: CAT, Quiz, Assignment and FAT					
Recommended by Board of Studies			18-02-2022		
Approved by Academic Council			No. 65	Date	17-03-2022

BBIT207P	Molecular Biology Lab			L	T	P	C
				0	0	2	1
Pre-requisite	BBIT202L, BBIT202P, BBIT204L, BBIT204P			Syllabus version			
				1.0			
Course Objectives							
1. Develop analytical skills. 2. Analyse biomacromolecules.							
Course Outcomes							
1. Demonstrate the process of isolating biomacromolecules. 2. Evaluate the quality and quantity of biomacromolecules .							
Indicative Experiments							
1.	Micropipette usage and calibration						
2.	Preparation of buffers and reagents for molecular biology						
3.	Spectrophotometric analysis of DNA, RNA and Protein						
4.	Quality check and quantitation of DNA by spectrophotometry						
5.	Bacterial Genomic DNA isolation						
6	Separation of DNA by agarose gel electrophoresis						
7	Plant Genomic DNA isolation						
8	Human Genomic DNA isolation						
9	Total cellular RNA isolation by Trizol method.						
10	Isolation of protein from different sources						
11	Separation of proteins by SDS-PAGE						
Total Laboratory hours:						30 hours	
Mode of assessment: Continuous assessment, FAT and Oral examination							
Reference Book: Molecular Biology Techniques: A Classroom Laboratory Manual, by Sue Carson, Heather Miller, Melissa Srougi, Scott Witherow D, 4 th Edition, 2019, Elsevier, London, UK							
Recommended by Board of Studies				18-02-2022			
Approved by Academic Council				No. 65	Date	17-03-2022	

BBIT302L	Genetic Engineering		L	T	P	C
			3	0	0	3
Pre-requisite	BBIT207L, BBIT207P		Syllabus version			
			1.0			
Course Objectives						
<ol style="list-style-type: none"> 1. Relate the components required for gene manipulation. 2. Apply the knowledge of genetic material and their transformation to create vectors. 3. Construct new genetic material and transgenic organisms. 						
Course Outcome						
<ol style="list-style-type: none"> 1. Use appropriate enzymes required for gene manipulation. 2. Choose appropriate vectors needed for genetic engineering. 3. Apply concepts of transformation and screening. 4. Design PCR and sequencing techniques. 5. Apply the basics of genetic engineering to create recombinant organisms. 						
Module:1	Enzymes for Gene Manipulation		6 hours			
Nuclease, Ligase, Polymerase, Reverse transcriptase, Modifying enzymes; Blunt and sticky ends, Adaptor and linker; Restriction mapping.						
Module:2	Vectors for Gene Cloning - Prokaryotes		6 hours			
Plasmids, Bacteriophages, Cloning vectors based on <i>E. coli</i> plasmids (pBR322, pUC), Lambda phage; M13, Cosmids, BAC.						
Module:3	Vectors for Gene Cloning – Eukaryotes		6 hours			
Vectors for yeast, Fungi, Plants, and Animal; Virus as cloning vectors, Expression vectors.						
Module:4	Transformation		6 hours			
Transformation into <i>E coli</i> cells, transfection <i>in-vitro</i> packing; Screening of recombinant bacteria and phages; Chemical transformation; Electroporation; Microinjection.						
Module:5	Gene Library and Screening		6 hours			
Genomic DNA library, cDNA library, Screening of library, Probe synthesis (DNA and RNA).						
Module:6	Polymerase Chain Reaction		6 hours			
Principle, Components, Types of polymerase chain reaction (PCR, colony PCR, hot start PCR, inverse PCR, reverse transcriptase PCR, nested PCR, <i>in situ</i> PCR, RACE PCR), Real time PCR, Primer design.						
Module:7	Recombinant Protein Production and Applications		7 hours			
Vectors, Promoters, Cassettes and gene fusions, Issues in recombinant protein production, Recombinant products; Regulations in recombinant technology, Risk assessment, Biosafety regulations and guidelines.						
Module:8	Contemporary Issues		2 hours			
			Total Lecture hours:		45 hours	
Text Book(s)						
1.	Gene Cloning and DNA Analysis: An Introduction, by Brown T A, 8 th Edition, 2020, Wiley-Blackwell, UK,					
Reference Books						
1.	Principles of Gene Manipulation and Genomics, Primrose S B and Twyman R M, 8 th Edition, 2012, Blackwell Publishing Co. UK.					
2.	Gene Cloning and Manipulation, by Christopher Howe, 2nd Edition, 2017, Cambridge University Press, UK.					
3.	https://ibkp.dbtindia.gov.in/Content/Rules					
Mode of Evaluation: CAT, Assignment, Quiz, FAT						
Recommended by Board of Studies			18-02-2022			
Approved by Academic Council			No. 65	Date	17-03-2022	

BBIT302P	Genetic Engineering Lab			L	T	P	C
				0	0	2	1
Pre-requisite	BBIT207L, BBIT207P			Syllabus version			
				1.0			
Course Objective							
1. Impart skills related to cloning and transformation.							
Course Outcome							
1. Construct the recombinant vector and transform.							
Indicative Experiments							
1.	Plasmid DNA isolation and analysis						
2.	Restriction digestion of vector and insert						
3.	Gel elution of the insert						
4.	Ligation						
5.	Competent cell preparation						
6.	Transformation						
7.	PCR amplification (colony PCR)						
8.	Real time PCR						
9.	Restriction mapping, using online NEB cutter tools						
10.	Primer design using online tools						
11.	RAPD						
Total Laboratory hours:						30 hours	
Mode of assessment: Continuous assessment, FAT and Oral examination							
Reference Book: Molecular Cloning: A laboratory manual, by Michael R Green and Joseph Sambrook, 4 th Edition, 2012, Cold Spring Harbor, New York.							
Recommended by Board of Studies				18-02-2022			
Approved by Academic Council				No. 65	Date	17-03-2022	

BBIT303L	Genomics and Proteomics	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT202L, BBIT202P, BBIT204L, BBIT204P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Develop knowledge on the basics of Genomics and Proteomics and their versatile applications. 2. Integration of the Genomics and Proteomics approaches in various biological models. 3. Technical skills and knowledge development on versatile techniques. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Analyse the principle of gene and protein sequencing. 2. Compare genomics and gene expression profiling. 3. Distinguish the principle of functional and structural genomics. 4. Identify proteins based on their functional and structural properties. 5. Analyse protein interaction networks. 6. Apply genomic and proteomic patterns in industrial and medicinal diagnostics and Treatment. 					
Module:1	Gene Structure and Sequencing	8 hours			
Sequence complexity - Introns and Exons, Genome structure in viruses and prokaryotes, Organelle genomes and nuclear DNA in eukaryotes, Chain terminator sequencing, Automated DNA sequencing, High throughput sequencing, Alternate DNA sequencing methods.					
Module:2	Comparative Genomics and Global Expression Profiling	8 hours			
Protein evolution by exon shuffling, Comparative genomics of prokaryotes and eukaryotes, Horizontal and lateral gene transfer, Traditional approaches to expression profiling, Global analysis of RNA expression - Spotted DNA arrays, Printed oligonucleotide chips, Data acquisition and analysis, Serial analysis of gene expression, Massively parallel signature sequencing.					
Module:3	Functional and Structural Genomics	8 hours			
Functional genomics by systematic gene knockout, Genome wide random mutagenesis, Use of chemical mutagens and phenocopy libraries, Determining gene function by sequence comparison, Structure prediction methods, Domain fusion method for functional annotation.					
Module:4	Proteome Sequencing and Post-Translational Modification	5 hours			
Gel electrophoresis (1DE and 2DE), Liquid chromatography and mass spectrometers for protein and peptide analysis, Routes in proteome analysis, Protein digestion techniques, Protein identification by mass fingerprinting, Analysis of posttranslational modifications, Signal peptide cleavages, Tagging of proteins with chemical and genetic approaches.					
Module:5	Protein Mining	4 hours			
Sequence analysis by tandem mass spectrometry, Databases and algorithms in protein identification.					
Module:6	Protein Expression Analysis I	4 hours			
Comparative proteomics, Use of isotope tags, Yeast two hybrid systems, Immunoprecipitation and western blot analysis, Shotgun identification of multiprotein complex, Bait and reverse bait analysis.					
Module:7	Protein Expression Analysis II	6 hours			
Protein-Protein interaction, Identifying the protein interaction regions, Protein interaction network, Sample enrichment for detecting protein modifications, Integration of different algorithms to map protein modification, Glycoprotein analysis, Protein arrays, Intrinsically disordered proteins and their importance in understanding disease processes.					
Module:8	Contemporary Issues	2 hours			

	Total Lecture hours:	45 hours	
Text Book(s)			
1.	Arthur M Lesk, Introduction to Genomics, 2 nd Edition, 2017, Oxford University press, United Kingdom.		
Reference Books			
1.	Discovering genomics, proteomics and bioinformatics, by Malcolm Campbell A and Laurie J Heyer, 1 st Edition 2002, Cold Spring Harbor Laboratory Press, United States.		
2.	Principles of genome analysis and genomics, by SB Primrose and RM Twyman, 3 rd Edition, 2003, Blackwell publishing, USA.		
3.	Introduction to proteomics: Tools for the new biology, by Daniel C Liebler, 1 st Edition, 2002, Humana Press, USA.		
Mode of Evaluation:		CAT, Assignment, Mini project, Quiz and FAT	
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT304L	Biochemical Engineering	L	T	P	C
		2	1	0	3
Pre-requisite	BBIT201L, BBIT201P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Develop the basic principles of reactor design for bioprocess and biotechnology applications. 2. Apply the kinetic parameters for enzymatic reactions. 3. Relate the reaction mechanism among the different type of reactors. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Interpret the kinetics of different types of reactions. 2. Analyse the effects of temperature and concentration on rate reactions. 3. Compare the reaction mechanism and evaluate the kinetic expression. 4. Examine the reactors for different type of reactions. 5. Integrate the different type of reactors and reactor assembly. 6. Apply the kinetics of biochemical reactions for designing bioreactors. 					
Module:1	Kinetic Theory	6 hours			
Classification of reactions, Rate of reaction, Elementary and non-elementary reactions, Molecularity and order of reaction, Rate constant, Kinetic theory of non-elementary reactions, Temperature dependency from Arrhenius law.					
Module:2	Chemical Reaction Thermodynamics	6 hours			
Work and heat, Concept of internal energy, Laws of thermodynamics, Enthalpy, Entropy, Gibbs free energy, Chemical equilibrium, Relationship between Gibbs free energy and equilibrium constant.					
Module:3	Chemical Reaction Kinetics	6 hours			
Constant-volume batch reactor, Integral method of analysis of data, Irreversible zero-order reactions, Unimolecular reactions, Second order reaction; Empirical rate equations of nth order, Half-life period, Reactions in parallel, Series reaction.					
Module:4	Enzyme Kinetics	6 hours			
Characteristics of an enzyme, Application of enzymes, Kinetics of enzyme substrate reaction - Michaelis–Menten approach, Estimation of the kinetic parameters, Differential method of analysis for enzyme kinetics.					
Module:5	Inhibition Kinetics	6 hours			
Enzyme inhibition, Types of reversible inhibition, Non-competitive inhibition, Un-competitive inhibition, Mixed inhibition, Determination of inhibitor constants; Factors affecting enzymatic reactions - Effect of pH, Temperature and Shear.					
Module:6	Chemical Reactor Analysis and Modeling	7 hours			
Isothermal batch reactor, Batch reactor sizing, Space-time, Space-velocity, Continuous stirred tank reactor, Plug flow reactor; Design equation; Graphical solutions of batch, PFR and CSTR Using batch concentration/conversion data.					
Module:7	Applications of Biochemical Engineering	6 hours			
Applications in agricultural bioprocesses, Biopharmaceuticals applications, Food and dairy applications, Environmental applications.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Biochemical Engineering: An Introductory Textbook, by Debabrata Das and Debayan Das, 2019, Jenny Stanford Publishing, Singapore.				
Reference Books					

1.	Bioprocess Engineering, Kinetics, Sustainability, and Reactor Design, by Shijie Liu, 3 rd Edition, 2020, Elsevier, Netherland.		
2.	Essentials of Enzymology, by RO Okotore, 2015, Xlibris, USA.		
3.	Engineering Principles in Biotechnology, by Wei-Shou Hu, 2017, Wiley, USA.		
Mode of Evaluation: CAT, Assignments, Quiz and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT305L	Immunology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT203L, BBIT203P, BBIT207L, BBIT207P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Create an understanding of key concepts in immunology. 2. Summarize the overall organization of the immune system. 3. Interpret immunodiagnostics and therapeutics. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Infer immunological processes at a cellular and molecular level. 2. Outline mechanisms of innate and adaptive immunity. 3. Relate the basis for immunological diversity and adaptive immune response. 4. Summarize the events in antigen processing and presentation. 5. Demonstrate the basis of immunological diseases and disorders. 6. Interpret the principles of immune techniques and vaccines. 					
Module:1	Immune System	6 hours			
Overview and significance of Immunology, Hematopoiesis, Origin and differentiation of Lymphocytes and phagocytic cells, Receptors and signals, Cytokines; Cells and organs of the immune system.					
Module:2	Types of Immunity	5 hours			
Innate and acquired immunity, Elements of Immunity - B lymphocytes and thymus derived (T) Lymphocytes, Immunogens and antigens, Complement system.					
Module:3	Humoral and Cellular Immunity	7 hours			
Immunoglobulins - Classes and subclasses, Immunoglobulin gene rearrangement, Antibody diversity, B-cell development and activation; TCR- TCR diversity, T-cell receptor gene rearrangement, T-cell development and activation.					
Module:4	Antigen Processing and Presentation	5 hours			
MHC- MHC/HLA Genetic loci, Molecular Structure and Assembly of MHC Molecules, Antigen Presenting Cells, Antigen Processing and Presentation.					
Module:5	Immunological Disorders	6 hours			
Overview of immune response to infectious diseases, Hypersensitivity, Immunological tolerance, Autoimmunity, Mechanisms of autoimmunity.					
Module:6	Tumor and Transplantation Immunology	6 hours			
Tumors, Tumor antigens, Tumors types, Transplantation types, Mechanisms of graft rejection, Strategies to prevent graft rejection, Role of immunosuppressive drugs.					
Module:7	Immunological Techniques & Immunodiagnostics and Therapeutics	8 hours			
Production of Monoclonal Antibodies, Polyclonal Antibodies, Antibody Engineering, Immuno Techniques- ELISA, ELISPOT, Immuno fluorescence, Flow cytometry. Vaccines, Recombinant cytokines					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					
45 hours					
Text Book(s)					
1.	Cellular and Molecular Immunology, by Abbas K A, Litchman A H, 10 th Edition. South Asia Edition, 2021, Elsevier, Netherlands.				
2.	Immunology, by David Male, R Stokes, Peebles, Victoria Male, International edition,				

	2020 Elsevier, Netherlands.		
Reference Books			
1.	Roitt's Essential Immunology, by Peter J Delves, Seamus J Martin, Dennis R Burton, Ivan M Roitt, 13 th Edition, 2016, Wiley Blackwell, USA.		
2.	Immunology, by Judy Owen, Jenni Punt, Sharon Stranford, Patricia Jones Kuby, 8 th Edition. 2018, W.H. Freeman and Co., USA.		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT305P	Immunology Lab			L	T	P	C
				0	0	2	1
Pre-requisite	BBIT203L, BBIT203P, BBIT207L, BBIT207P			Syllabus version			
				1.0			
Course Objective							
1. Summarize the immunological principles involved in clinical/applied science.							
Course Outcome							
1. Demonstrate the use of appropriate techniques related to immunology.							
Indicative Experiments							
1.	Cells of the immune system- Examine the cells (counts and morphology); Blood components- serum, plasma, complement inactivation of serum						
2.	Precipitation assays- Immunodiffusion, immunoelectrophoresis						
3.	Serotyping- Slide, tube agglutination and latex agglutination						
4.	Complement fixation test						
5.	ELISA						
6.	Immunization- animal handling, inoculation of antigens to raise antibodies						
7.	Purification of antibodies- Collection of blood, serum preparation, purification of IgG						
8.	Western blotting						
9.	Flow cytometry (Demo)						
Total Laboratory hours:						30 hours	
Mode of assessment: Internal assessment, FAT and Oral examination							
Reference Book: Manual of Molecular and Clinical Laboratory Immunology, by Barbara Detrick, Robert G. Hamilton, John L Schmitz, 8 th Edition, 2016, Taylor and Francis.							
Recommended by Board of Studies				18-02-2022			
Approved by Academic Council				No. 65	Date	17-03-2022	

BBIT306L	Animal Biotechnology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT302L, BBIT302P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Explain and recall the important aspects of animal cell culture as well as the various genetic modification techniques in animal cells and embryos. 2. Recognize the challenges and select the best methodologies for the production, characterization and validation of laboratory and farm animals, considering appropriate ethical, legal and social protocols. 3. Deduce and choose the best methods for wildlife conservation as well as applying genetically modified animal models for understanding human health and diseases. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Explain fundamental concepts of animal cell culture and relate them to their applications and relevance to animal biotechnology. 2. Compare strengths and limitations of different genetic modification procedures in animal cells. 3. Apply the fundamental knowledge of breeding and genetic modification-related technologies in laboratory, farm animals and wildlife conservation. 4. Use different animal models in understanding human disease and use them for research as well as drug development process. 5. Obtain holistic perspective of the ethical, legal and social aspects of use of animals for research purposes. 					
Module:1	Animal Cell Culture and Applications	8 hours			
Introduction, Importance of animal cell culture media, Primary and secondary cell culture, Cell immortalization techniques, Scaling up of animal cell culture, Immobilization of cells, Cell line characterization and managing contaminants in culture, Cryopreservation, Application of animal cell culture for in vitro testing of drugs, Toxicity studies of environmental pollutants, Cell culture derived human and animal viral vaccines and pharmaceutical proteins.					
Module:2	Genetic Modification Techniques in Animal Cells	8 hours			
Methods and efficiency in gene transfer - Physical methods (Electroporation, Hydrodynamic injection, Sonoporation, Gene gun and Micro-injection), Chemical methods (Calcium phosphate and Liposomes), Biological methods (Viral mediated - Adeno- and Retro-viruses); Transient and stable transgene expression in cells; Selectable markers and their mode of action in animal cells. Cellular gene silencing - siRNA and shRNA technique; Gene editing - Meganucleases, TALEN, ZFN, and CRISPR-Cas9.					
Module:3	Genetic Modification Techniques in Lab Animals	6 hours			
Production and breeding of Transgenic, Knock out, Cre-LoxP animals; Constitutive and inducible expression of transgenes in animals, Knockout mice by Cre/LoxP.					
Module:4	Animal Breeding Methods for Better Traits in Farm Animals	7 hours			
Cryopreservation of sperms and ova of livestock, Artificial insemination-estrous synchronization; Super-ovulation; Embryo transfer, Immunological methods to control reproduction, Monitoring reproductive status, in vitro fertilization, Prenatal genetic testing.					
Module:5	Innovations for Sustainability and Conservation of Wildlife Species	6 hours			
Animal genome projects, Molecular techniques (NGS, RFLP, RAPD) used in genetic conservation of farm animals; Cloning and gene manipulations in conservation of wild animals.					
Module:6	Genetically Modified Animals and their Applications in Biomedical Research	6 hours			
Genetically modified animal models used in biomedical research (Cancer, Diabetes, Immunology and Toxicology); Technical aspects and applications of Bio-pharming.					

Module:7	Ethics, Legal, and Social Implications	2 hours
Ethical, Legal and social implications of animal biotechnology and genetically modified animals.		
Module:8	Contemporary Topics	2 hours
Total Lecture hours:		45 hours
Text Book(s)		
1.	Animal Biotechnology: Models in Discovery and Translation, by Ashish Verma, Anchal Singh, 2nd Edition, 2020, Academic Press, USA.	
2.	Principles of Gene Manipulation and Genomics by Sandy Primrose and Richard Twyman, 8th Edition, 2016, Wiley-Blackwell publishing, Oxford, UK.	
Reference Books		
1.	Reproductive Technologies in Farm Animals by Ian Gordon, 2nd Edition, 2017, CABI Publishers, Cambridge, USA.	
2.	Culture of Animal Cells: A manual of basic technique, and specialized applications, by R Ian Freshney, Amanda Capes-Davis, Carl Gregory, and Stefan Przyborski, 7th Edition, 2016, Wiley-Blackwell, New Jersey.	
Mode of Evaluation: CAT, Assignment, Quiz, and FAT		
Recommended by Board of Studies	18-02-2022	
Approved by Academic Council	No. 65	Date 17-03-2022

BBIT307L	Plant Biotechnology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT207L, BBIT207P	Syllabus version			
		1.0			
Course Objectives					
1. Explain the plant tissue culture methods. 2. Build knowledge of biotechnological tools which help in modifying plants suited to agriculture. 3. Elaborate the production of biopharmaceuticals in plants.					
Course Outcomes					
1. Develop key concepts on genome organization in plants. 2. Apply plant tissue culture to develop genetically engineered plants. 3. Analyze the various components involved in developing transgenic plants. 4. Elaborate the production of new biomolecules in plant using transgenic technology. 5. Compare and apply molecular marker technology in plant breeding.					
Module:1	Plant Genome Organization and Expression	5 hours			
Introduction to gene structure and gene expression, Regulation of gene expression; Protein targeting; Genome size and organization; Chloroplast and Mitochondrial genome.					
Module:2	Plant Tissue Culture	6 hours			
Plasticity and totipotency; Culture environment, Culture media, Plant growth regulators and their applications; Culture types, Regeneration (somatic embryogenesis and organogenesis) and hardening; Applications of plant tissue culture.					
Module:3	Techniques for Plant Transformation	6 hours			
Plant transformation - Direct methods (particle bombardment, PEG mediated transformation, Electroporation, Silicon carbide fibre), Indirect methods (<i>Agrobacterium</i> , hairy root and <i>in planta</i> transformation).					
Module:4	Vectors for Plant Transformation	6 hours			
Binary vectors, Gateway cloning and RNAi vectors, Promoters, Terminators, Markers involved in designing an expression cassette, Reporter genes, Gene silencing, Clean gene technology, Plastid transformation.					
Module:5	Transgenes for Herbicide, Pest and Disease Tolerance	6 hours			
Herbicide tolerance (Glyphosate, Phosphinothricin, Imidazolinone), Pest resistance (<i>Cry</i> gene, copy nature strategy), Disease resistance (BASF potato).					
Module:6	Transgenes for Stress Tolerance and High Crop Yield	6 hours			
Stress tolerance (Biotic and Abiotic stress), Crop yield and quality (flavr savr tomato, golden rice).					
Module:7	Molecular Farming & Molecular Markers	5 hours			
Carbohydrates and lipids (Starch, Polyfructans and Bioplastics), Proteins (Hirudin and Insulin), Custom made antibodies, Edible vaccines, Production of secondary metabolites. RAPD, RFLP, AFLP, SSR, ISSR, QTL mapping, Marker assisted selection and map based cloning.					
Module:8	Contemporary Issues	5 hours			
Total Lecture hours:					45 hours
Text Book(s)					
1.	Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater, Scott N W, Fowler M, 2 nd Edition, 2015, Oxford University Press, New Delhi, India.				
Reference Book(s)					

1.	Plant Biotechnology: Principles and Applications by Malik Zainul Abdin, Usha Kiran, M. Kamaluddin, Athar Ali, 1 st Edition, 2017, Springer Nature, Singapore.		
2.	Plant Biotechnology: Recent Advancements and Developments by Suresh Kumar Gahlawat, Raj Kumar Salar, Priyanka Siwach, Joginder Singh Duhan, Suresh Kumar and Pawan Kaur, 1 st Edition, 2017, Springer Nature, Singapore.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT308L	Industrial Biotechnology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT203L, BBIT203P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Understanding the basic of upstream processing and the economics of bioprocess. 2. Optimize industrial upstream processes. 3. Comprehend the production of industrial bioproducts. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Conceive the basic concepts of fermentation and bioprocess economics. 2. Formulate medium for the production of biocatalysts. 3. Learn to design thermal and filter sterilization process. 4. Outline the design principles of strain improvement required for the production of bioproducts. 5. Interpret and analyze the basic concepts of metabolic stoichiometry and its calculations. 6. Understand the overall fermentative productions of representative bioproducts. 					
Module:1	Overview of Industrial Biotechnology	5 hours			
History of Industrial biotechnology, Types of fermentation, Solid state fermentation, Submerged fermentation; Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheet- Bioreactor design strategies as a function of cost determining factors.					
Module:2	Medium Formulation and Optimization	7 hours			
Medium requirements for fermentation processes, Carbon sources, Nitrogen sources, Inducers, precursors, Inhibitors, Antifoaming agents and other complex nutrients; Medium optimization by classical method (OFTA method) and statistical method, Plackett Burman and Response surface method.					
Module:3	Sterilization and Kinetics	6 hours			
Batch and continuous thermal sterilization, Thermal death kinetics and design of batch and continuous sterilization; Filter sterilization of air and medium.					
Module:4	Strain Improvement	5 hours			
Techniques of strain improvement - Random mutation, Auxotrophic mutation, rDNA technology and protoplasmic fusion; Overproduction of primary and secondary metabolites; Case studies.					
Module:5	Metabolic Stoichiometry	6 hours			
Stoichiometry of Cell growth and product formation, Elemental balances, Degrees of reduction, Yield coefficients of biomass and product formation and heat evolution in aerobic cultures.					
Module:6	Production of Primary Metabolites using Genetically Engineered Microbes	7 hours			
Production of commercially important primary metabolites like Citric acid, Acetic acid, Ethanol, Acetone, Butanol, Glutamic acid and Lysine.					
Module:7	Production of Secondary Metabolites using Genetically Engineered Microbes	7 hours			
Production of commercially important secondary metabolites like Antibiotics (penicillin), Vitamins (cyanocobalamin) and Steroids (biotransformation); Production of commercially important bioproducts like Biopreservative (nisin), Biopolymer (xanthan gum), Biofertilizers and Biopesticides.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					45 hours

Text Book(s)			
1.	Principles of Fermentation technology, by Peter Stanbury, 3 rd Edition, 2016, Butterworth- Heinemann, USA.		
2.	Biotechnology, by Satyanarayana U, 1 st Edition, 2020, Books & Allied Pvt, Ltd, India.		
Reference Books			
1.	A Textbook of Industrial Microbiology, by Cruger Wulf and Anneliese Crueger, 3 rd Edition, 2017, Medtech, India.		
2.	Bioprocess Engineering, by Michael Shuler, Fikret Kargi, Matthew DeLisa, 3 rd Edition, 2017, Pearson Education, India.		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT309L	Downstream Processing	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT201L, BBIT201P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Apply the fundamental concepts of bio separation engineering. 2. Design a downstream process for product isolation and purification. 3. Recognize and troubleshoot problems associated with purification of bio products. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Appraise the fundamentals and understand the market demand of bio products and bio separation. 2. Choose appropriate unit operations for the separation of insoluble from fermentation broth. 3. Examine traditional, modern and emerging technologies to apply mass transfer operation in the bio separation processes. 4. Design, operate, and scale-up up the processes to purify biomolecules. 5. Choose appropriate bio separation processes to purify biomolecules. 6. Develop polishing and formulation of bio products. 					
Module:1	Overview and Market Demand	4 hours			
Range and characteristics of bio products, Different stages and integrated process development, Criteria for process development, Process and product quality, Pathway to market based on demand.					
Module:2	Cell Lysis	3 hours			
Mechanical and non-mechanical methods of cell disruption, Cell disruption kinetics for a bead mill and high-pressure homogenizer.					
Module:3	Separation of Insolubles	7 hours			
Characteristics of Fermentation broth, Pretreatment, Flocculation and Sedimentation, Principles and operation of industrial centrifuges, Flow rate and sigma analysis in tubular bowl and disc centrifuge, Filtration types, Filter media, Theory on filtration rates on incompressible and compressible cakes; Industrial filters, Scale- up.					
Module:4	Extraction and Precipitation	10 hours			
Extraction - Phase separation and partitioning equilibria, Extractors, Operating modes, Stage estimation, Advance methods - Aqueous two-phase, Reverse micellar and supercritical fluid extraction, Precipitation - Colloidal stability of proteins, Factors affecting precipitation, Cohn's equation and different methods of precipitation.					
Module:5	Membrane Separation and Adsorption	7 hours			
Membrane separation - Principles and membrane properties, Estimation of flux and concentration polarization, Pressure-driven, Concentration driven and electrically-driven processes, Diafiltration, Adsorption-Adsorbents, Isotherms, Design of batch and continuous adsorption process.					
Module:6	Chromatographic Methods	7 hours			
Interactive and non-interactive chromatographic separation processes, Plate theory, Separation parameters and column efficiency, Van Deemter's equation, Parameter estimation and scale up operation, Recombinant techniques as advanced methods of separation.					
Module:7	Finishing Operations	5 hours			
Crystallization, Drying, Lyophilisation and Formulation.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					45 hours

Text Book(s)			
1.	Bioseparation Science and Engineering, by Harrison RG, Todd PW, Rudge SR, and Petrides DI, 2 nd Edition, 2015, Oxford University Press, NY, USA.		
Reference Books			
1.	Bio Separations: Downstream Processing for Biotechnology, by Belter PA, Cussler EL, Hu WS, 2011, John Wiley & Sons, Inc. New York, USA.		
2.	Principles of Bio separation Engineering by Ghosh R, 2006, World Scientific Publishing Company, Singapore.		
3.	Bio Separation Engineering: Principles, Practice and Economics, by Ladisch MR, 2001, Wiley Interscience, New York, USA.		
Mode of Evaluation: CAT, Quiz, Assignment, Field visit and FAT.			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT309P	Downstream Processing Lab			L	T	P	C
				0	0	2	1
Pre-requisite	BBIT201L, BBIT201P			Syllabus version			
				1.0			
Course Objective							
1. Develop practical knowledge of extraction, separation and purification of bio-products.							
Course Outcome							
1. Demonstrate the skills in extraction and separation of bio products.							
2. Analyze and interpret the experimental data to develop purification strategies.							
Indicative Experiments							
1.	Homogenization and preparation of extracts						
2.	Partial purification of desired protein by fractional precipitation using salt						
3.	Desalting of partially purified desired protein by dialysis						
4.	Partial purification of proteins by precipitation using organic solvent						
5.	Separation of proteins using liquid-liquid extraction – Aqueous two phase						
6.	Separation of proteins using liquid-liquid extraction – Reverse micellar process						
7.	Separation of proteins based on molecular mass - Gel filtration						
8.	Separation of proteins based on surface charge density – Ion exchange chromatography						
9.	Separation of proteins by affinity chromatography						
10.	Fractionation of proteins by ultracentrifugation						
11.	Concentration of proteins by ultrafiltration						
12.	Lyophilisation of biomolecules						
Total Laboratory hours:						30 hours	
Mode of assessment: Continuous assessment, FAT and Oral examination							
Reference Book: Protein Purification, by Philip LR Bonner, 1 st Edition, 2007, Taylor & Francis, UK.							
Recommended by Board of Studies				18-02-2022			
Approved by Academic Council				No. 65	Date	17-03-2022	

BBIT310L	AI in Biology			L	T	P	C
				3	0	0	3
Pre-requisite	NIL			Syllabus version			
				1.0			
Course Objectives							
<ol style="list-style-type: none"> 1. Explore the applications of AI with particular focus on applications in biology. 2. Provide a basic understanding of machine learning on molecular data. 3. Learn how to use deep learning for understanding biophysical systems. 							
Course Outcomes							
<ol style="list-style-type: none"> 1. Identify patterns and relationships in data using deep learning. 2. Apply deep learning in a genetics, drug discovery, and medical diagnosis. 3. Predict the interaction of drug-like molecules with proteins. 4. Use deep learning to model directly from data. 5. Use deep learning to build predictive models. 							
Module:1	The Fundamentals of Machine Learning			7 hours			
Machine learning landscape, Types of machine learning systems - Supervised/Unsupervised learning, Main challenges of machine learning - Insufficient quantity of training data, Testing and validating.							
Module:2	Deep Learning Principles			6 hours			
Linear models, Multilayer perceptrons, Training models, Validation, Regularization, hyperparameter optimization, Other types of models - Convolutional neural networks, Recurrent neural networks.							
Module:3	Machine Learning with DeepChem			7 hours			
Deepchem datasets, Training a model to predict toxicity of molecules, Case study, Training an MNIST model - The MNIST digit recognition dataset-a convolutional architecture for MNIST.							
Module:4	Machine Learning for Molecules			6 hours			
Molecule and molecular bonds, Molecular graphs, Molecular conformations, Chirality of molecules, Featurizing a molecule, SMILES strings and RDKit, Extended-connectivity fingerprints, Molecular descriptors.							
Module:5	Biophysical Machine Learning			6 hours			
Protein structures, Protein sequences, A short primer on protein binding, Biophysical featurizations, Grid featurization, Atomic featurization, The PDBBind case study, PDBBind dataset, Featurizing the PDBBind dataset.							
Module:6	Deep Learning for Genomics			6 hours			
DNA, RNA, and proteins, Micro RNAs and Short interfering RNA (siRNA) , Transcription factor binding, A convolutional model for Transcription Factor (TF) binding, Chromatin accessibility, RNA interference							
Module:7	Deep Learning for Medicine			5 hours			
Computer-aided diagnostics, Probabilistic diagnoses with Bayesian networks, Electronic health record data, Deep radiology, X-Ray scans and CT scans, Histology, MRI scans.							
Module:8	Contemporary Issues			2 hours			
			Total Lecture hours:			45 hours	
Text Book(s)							
1.	Deep learning for the life sciences: Applying deep learning to genomics, microscopy, drug discovery, and more, by Ramsundar, B., Eastman, P., Walters, P., and Pande, V, 2019, O'Reilly Media, Inc., Sebastopol, California, USA.						
Reference Books							
1.	Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools,						

	and techniques to build intelligent systems, by Aurélien Geron, 2019, O'Reilly Media, Inc., Sebastopol, California, USA.		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BBIT311L	Biobusiness	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> 1. Illustrate the basics of biobusiness in the various emerging biological field. 2. Build critical thinking capability and design methodologies for bio entrepreneurs. 3. Create the ability for planning, commencing, execute, and manage a biobusiness. 					
Course Outcomes:					
<ol style="list-style-type: none"> 1. Identify basic terminologies related to biobusiness correctly and contextually. 2. Compare planning and management of various biobusiness endeavours. 3. Evaluate and develop critical thinking leading to protect the intellectual property with respect to business. 4. Learning the nuances of human resource management and financial management. 5. Examine and utilise effective negotiation and acquisition skills for biobusiness. 6. Develop newer strategies for acquiring funds for biobusiness ventures. 					
Module:1	Overview of Biobusiness	6 hours			
Global biobusiness, Biobusiness and entrepreneurship, Profiling, types, Opportunity; From scientist to CEO.					
Module:2	Planning and Management of Biobusiness	6 hours			
Biobusiness planning for high-tech start-ups, Clinical development, Private sector, Public sector, Joint sector, Proprietorship, Drafting of partnership deeds, The concept for new-age business ownership, Legal provisions, Commercialization process and strategy.					
Module:3	Intellectual Property Rights in Biobusiness	6 hours			
Registering new molecule in European Union, Intellectual Property, Patents, Patent registration procedure in India, Trademarks, Copyrights, Geographical Indication, Integrated circuits, Plant varieties and farmer's rights, Trade secrets, IP analytics, Idea to market, Licensing, Innovation management, IP portfolio development, Product development, Enforcing intellectual property.					
Module:4	Biobusiness Financial Management	6 hours			
Stages of the investment process, Approaches to management capital, Cost of equity and risk, Working capital, Working capital cycle, Operating cycle, Cash cycle, Blueprint for good working capital management policy, Financial planning and budgets, Classification of assets, Balance sheet formats, Measuring and reporting financial performance, Types of account, Break-even analysis, Cost-component.					
Module:5	Human Resource and Marketing Management	6 hours			
Fundamental of sales and marketing, Workforce planning, Human resource management functions, Challenges faced, Requirements of the HR Manager, Training and development; Marketing- market segments, Marketing mix, Product life cycle, Branding, Marketing limitations for start-ups.					
Module:6	Negotiation Skills in Biobusiness	6 hours			
Mergers and acquisitions, Importance of negotiation, Outcomes of negotiation, Healthy business relationship, Effective communication, Handling conflict, Disclosure of information, Negotiation approaches - 5 stage approach.					
Module:7	Funding Opportunities and Government Initiatives for Biobusiness	7 hours			
Funding opportunities for a start-up- Bootstrap, Angel investment, Venture Capital, Bank Loans, Microfinance providers, Government grants, Small business innovation research initiative (BIRAC), Biotechnology Ignition Grant (BIG), Schemes of the Ministry of Micro, Small and Medium enterprises; Biotech Parks, Technology Incubator Centre, Business Support facilities.					
Module:8	Contemporary Issues	2 hours			

	Total Lecture hours:		45 hours
Text Book			
1.	Bio- and MedTech Entrepreneurship: From Start-up to Exit, by Heidrun Flaadt Cervini and Jörg Dogwiler, 2020, Publisher Stampfil Verlag, Italy.		
Reference Book			
1.	Bio entrepreneurship development – resource book, by Ms. Shreya Sanghvi Malik, Dr. Shiv Kant Shukla, 2018, Biotech Consortium India Limited (BCIL), New Delhi, India.		
Mode of Evaluation: CAT, Assignment, Case study, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT312L	Pharmaceutical Biotechnology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT202L, BBIT202P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Understand the pharmacology of biotechnology based drugs and their applications in the manufacturing of biopharmaceuticals and biomedical research 2. Develop the basic skills necessary for employing biotechnology principles in medicine 3. Evaluate the different pharmaceutical parameters of the current and future biotechnology related products on the market 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Understand the basics involved in human-drug interactions 2. Compare the mechanisms involved in common drugs 3. Delineate the process involved in drug formulations 4. Evaluate the pharmacokinetics and dynamics of conventional and non-conventional drugs 5. Apply knowledge on regulatory affairs related to drug administrations 					
Module:1	Pharmacokinetics	7 hours			
Development of drugs, Pharmacokinetics and Pharmacodynamics, Routes of drug administration, Bioavailability curve, Drug receptor interaction, Adverse drug reaction, Prescription.					
Module:2	Pharmacology	6 hours			
Mechanism of action of local and general anaesthetics, Opioid analgesics and antagonists, NSAIDs, Antihistamines, Pharmacotherapy of hypertension, Electrolytes, Diuretics, Pharmacotherapy of peptic ulcer, Drug combinations and adverse drug reactions.					
Module:3	Overview of Biotechnology Based Drugs	6 hours			
Pharmacokinetics and pharmacodynamics of peptide and protein drugs. Routes of drug administration of conventional and biotechnology drugs - comparisons.					
Module:4	Formulating Biotech Drugs	6 hours			
Excipients used in Biotech products, Shelf-life of protein based drugs, Controlled and site specific delivery of protein drugs, Peptide nano-materials in drug delivery, Liposomes, Dextrimers.					
Module:5	Pharmacotherapy using Biosimilars	6 hours			
Pharmacotherapy using cytokines, Interleukins and interferon-gama, Insulin and insulin analogues in diabetes treatment, Growth hormone.					
Module:6	Antibody Therapeutics	6 hours			
Modern vaccines - Subunit vaccines, r-DNA vaccines; Development of antibody based drug therapy, Monoclonal antibody, Humanized antibody and engineered antibodies.					
Module:7	Regulatory Affairs	6 hours			
Drug regulations - FDA regulations (General) and Indian drug regulations, Adulterated, Spurious, and Misbranded drugs, GMP, Clinical trials - Classification, Phases of clinical trials, Clinical trials design, Double blind studies, Placebo effects, Informed consent.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					45 hours
Text Book(s)					
1.	Pharmacology and Pharmacotherapeutics, by Satoskar RS, Bhandarkar SD, Rege NN, 26 th Edition, 2020, Elsevier, New Delhi.				
2.	Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, by Allen V Loyd, Howard C Ansel, 11 th Edition, 2018, Lippincott Williams & Wilkins, Philadelphia.				

Reference Books			
1.	Goodman and Gilman's The Pharmacological Basis of Therapeutics, by Laurence Brunton, Bruce Chabner, Bjorn Knollman, 13 th Edition, 2017, McGraw-Hill. New York, USA		
Mode of Evaluation: CAT, Assignment, Field visit, FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT313L	Regenerative Medicine	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT204L, BBIT204P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Overview on the current state in regenerative medicine. 2. Understand the correlation between embryology and regenerative medicine. 3. Interpret the transformative implications of regenerative medicine for future biomedical applications and health care. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Explain an overview developmental biology and regenerative medicine approaches. 2. Summarize the process of injury and wound healing. 3. Paraphrase the morphogenetic concepts and role of positional information relevant to regeneration. 4. Discuss relevance of morphogen molecules and extracellular matrix in regeneration. 5. Identify the source, differentiation and de-differentiation of cells in regeneration. 6. Restate the mechanisms of organ regeneration and identify various current and future practices in regenerative medicine. 					
Module:1	Embryology and Regeneration	6 hours			
Principles of Development; Fertilization, Development and death; Conserved mechanism of embryonic development and regenerative process, Types of regeneration, Physiological, Reparative Regeneration, Inductive, Hypertrophy and morphallaxis, Emergent complexity of cells during Development, Blueprint of regeneration for cells, Cellular crosstalk.					
Module:2	Injury and Healing	7 hours			
Signaling events associated with Injury; ROS, Hydrogen peroxide, NOX; Nerve Ending and Wound repair; Inflammation, Immune cells, and inflammatory signaling; Granulation tissue; Wound Healing, Repair vs Regeneration; Blastema formation in amphibian and mice models.					
Module:3	Positional Information	6 hours			
Basic of positional information theory, Positional information in development and regeneration, Morphogen, Gradients and Cellular Migration; Positional information grids, Retinoic acid, microRNA; Extracellular matrix (e.g. collagen, heparin sulfate); Role of signaling centres in organ development, Early development of Drosophila.					
Module:4	Morphogens	6 hours			
Morphogenetic phenomena and morphogens; Morphogen Gradient, Thresholds, Switches and Feedback loops; Signal amplification and multiplication; Transcription factors and thresholds; Scaling morphogens, Morphogen production and dispersal; Morphogen stability and half life; ECM and morphogens; Scaling mechanism and size compensations; Limb regeneration in tadpoles.					
Module:5	Cell Differentiation	6 hours			
Pluripotent cells directed differentiation; Dedifferentiation as a cell Source for organ regeneration, Cell dedifferentiation and gene expression heterogeneity; Epigenetic control; Developmental plasticity and tissue Integration.					
Module:6	Organ Regeneration	6 hours			
Ectodermal organ generation, Organ germ method, Mammalian fingertip regeneration, Spinal cord repair and regeneration, Heart regeneration, Skin regeneration, Eye regeneration.					
Module:7	Regeneration Models and Regenerative Practices	6 hours			
Distraction osteogenesis, Electrically mediated fracture healing, Regeneration of skeletal muscle, nervous system, angiogenesis, regenerating limb and morphallaxis, Adult and iPSC stem cells in regeneration, Tissue engineering.					

Module:8	Contemporary Issues	2 hours
Total Lecture hours: 45 hours		
Text Book(s)		
1.	Regenerative Engineering and Developmental Biology, by David M Gardiner (Ed.), 2017, CRC Press, Boca Raton, FL, USA.	
2.	Developmental Biology, by Scott F Gilbert and Michael J F Barresi, 12 th Edition, 2020, Sinauer Associates, An imprint of Oxford University Press, USA.	
Reference Books		
1.	Foundations of Regenerative Biology and Medicine, by David L Stocum, 2018, IOP Expanding Physics Publishing, USA.	
2.	Regenerative Medicine and Stem Cell Biology, by Nagwa El-Badri (Ed.) 2020, Springer International Publishing, USA.	
Mode of Evaluation: Assignments, Quiz, CAT and FAT		
Recommended by Board of Studies		18-02-2022
Approved by Academic Council		No. 65 Date 17-03-2022

BBIT314L	Stem Cell Technology	L	T	P	C
		3	0	0	3
Pre-requisites	BBIT204L, BBIT204P, BBIT207L, BBIT207P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Relate fundamental concepts and basic terminologies that are widely used in the field. 2. Interpret signal transduction and crosstalk in the determination of various stem cell fates. 3. Defend recent advances in the field from ethical and social points of view. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Recall different cellular states, levels of potency, and differentiation pathways of stem cells. 2. Compare molecular determinants of various stem cell states and their significance. 3. Apply various signal transduction pathways and their crosstalk in lineage commitment. 4. Examine key signal transduction pathways that lead to differentiation from the ectoderm. 5. Determine various types of stem cells and their progeny emerging from the mesoderm. 6. Formulate some mechanisms that could lead to targeted differentiation from the endoderm. 					
Module:1	Overview of Stem Cells	6 hours			
Definitions and concepts, Classification of stem cells, Role of stem cell niche, Political debate on the use of embryonic stem cells.					
Module:2	Molecular Determinants of Stem Cell State	6 hours			
Molecular determinants of pluripotency, Cell cycle regulation; Nuclear reprogramming methods, Epigenetic regulation of stem cell fate.					
Module:3	Signal Transduction Pathways and Crosstalk	9 hours			
Major signal transduction pathways, Molecular crosstalk; Cancer stem cells, Detection, Isolation, and functional characterization of stem cells.					
Module:4	Ectodermal Lineage Stem Cells	6 hours			
Skin, hair follicle, and neural stem cells, Proliferation and differentiation methods, Molecular techniques in detection, Isolation, and characterization.					
Module:5	Mesodermal Lineage Stem Cells	6 hours			
Hematopoietic and mesenchymal stem cells, Proliferation and differentiation methods, Molecular techniques in detection, Isolation, and characterization.					
Module:6	Endodermal Lineage Stem Cells	6 hours			
Intestinal and muscle stem cells, Proliferation and differentiation methods, Molecular techniques in detection, Isolation, and characterization.					
Module:7	Advances in Induced Pluripotent Stem Cell Technology	4 hours			
Generation of induced pluripotent stem cells (iPSCs) using viral and non-viral methods, Feeder-dependent and feeder-free stem cell culture methods, Applications of iPSCs.					
Module:8	Contemporary Issues	2 hours			
Total Lectures Hours					
					45 hours

Text Book(s)			
1.	Stem Cells: Biology and Applications, by Clarke M and Frampton J, 1 st Edition, 2020, Routledge, USA.		
Reference Book(s)			
1.	Stem Cells: A Short Course, by Burgess R. 1 st Edition, 2015, Wiley-Blackwell, USA.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT315L	Environmental Biotechnology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT203L, BBIT203P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Build a basic knowledge on environmental pollution and to develop sustainable technologies to remove the pollutants. 2. Inculcate fundamental concepts for understanding microbial metabolism of environmental pollutants. 3. Apply scientific and technological concepts to solve environmental problems. 					
Course outcomes					
<ol style="list-style-type: none"> 1. Describe biological treatment process to treat solid waste. 2. Conceive the basic concepts of microbial potential for degradation of organic pollutants. 3. Outline the type of bioremediation involved in wastewater treatment. 4. Interpret the role of microbes in specific pollution problems and in producing bioproducts. 5. Identify the importance of plant biomass which can be converted to fermentable substances and transformed into biofuels. 					
Module: 1	Waste Management	6 hours			
Sources of pollution- Pollutants in solid and liquid waste –types and characterization.					
Module:2	Biodegradation of Toxic Pollutants	6 hours			
Biodegradation of xenobiotic compounds, hydrocarbon- Biodegradation of In-situ and Ex situ microplastics- Testing for biodegradability - Effective Microbe Technology (PGPR)-Biofilms and quorum sensing.					
Module 3:	Bioremediation	6 hours			
Phytoremediation, Phycoremediation, Mycoremediation, Bioaugmentation, Genetically Engineered Microbes (GEM'S) in treatment of waste, Biosafety.					
Module 4:	Waste Water Treatment and Disposal	7 hours			
Aerated process, Activated sludge process (suspended growth), Trickling filters (Attached growth), Rotating biological contactors, Anaerobic process, Removal of nitrogen and phosphorous, Biosensors in environmental analysis.					
Module5 :	Emerging Techniques in Specific Pollution Problems	6 hours			
Biopulping, Treatment of tannery wastewater, Mining and metal microbe interaction, Metagenomics in microbial diversity, Bioreactors in bioremediation.					
Module 6 :	Bioenergy	6 hours			
Bio mass resources for fuel generation, Biogas and biodiesel as energy source, Alcohol as fuel, Biological hydrogen generation, Microbial fuel cell, Waste to energy.					
Module 7:	Eco friendly Bioproducts for Environmental Health	6 hours			
Biopesticides, Biofertilizers, Bioplastics, Recent advances in environmental biotechnology, Pollution monitoring and recent developments in products.					
Module 8 :	Contemporary Issues	2 hours			
	Total lecture hours:	45 hours			
Text Book(s)					
1.	Microbial Bioremediation, by Rajendran P and Gunasekaran P, 2019, MJP Publishers, India.				
2.	Text Book of Environmental Biotechnology, by Kumar P and Kumar V, 2018, Woodhead Publishing India.				
Reference Books					

1.	Advances in Environmental Biotechnology, by Kumar R, Sharma A K, 2017, Springer, Singapore.		
2.	Environmental Biotechnology: A new Approach, by Gupta RK and Singh SS, 2018, Daya Publishing House , Delhi.		
Mode of Evaluation: CAT, Assignment, Quiz, Mini project and FAT			
Recommended by Board of studies	18-02-2022		
Approved by Academic council	No. 65	Date	17-03-2022

BBIT316L	Nanobiotechnology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT206L, BBIT206P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Recalling relevant knowledge on basic understanding of various routes of synthesis of Nanomaterials. 2. Understanding the concepts of designing functional nanomaterials for biomedical and environmental applications. 3. Analyzing, evaluating the impact of nanomaterials on the environment and human health. 					
Course Outcome					
<ol style="list-style-type: none"> 1. Remembering and Compare the different synthesis techniques of nanomaterials. 2. Understanding the fate of nanomaterials in different environmental and biological matrices. 3. Summarize different applications of nanomaterial for various industrial sectors. 4. Analyzing the biological safety of nanomaterials. 5. Evaluate the impact of environmentally released nanomaterials on ecosystem. 6. Creating the innovative functional nanomaterial for specific application. 					
Module:1	Overview of Nanobiotechnology	5 hours			
Definition of nanotechnology, Small-strange and useful, Significance of nanobiotechnology – unique properties of nanomaterials, History of nanotechnology, Present and future of nanotechnology, Development of nanobiotechnology-timelines and progress.					
Module:2	Nanomaterials in Biotechnology	6 hours			
Metallic, Bimetallic and metal oxide nanoparticles, Quantum dots, Carbon particles and nanotubes, Various types of polymeric nanoparticles, Magnetic particles surrounded by polymers, Magnetosomes, Nano emulsions, DNA origami, Protein nanostructures, Biological applications.					
Module:3	Nanomaterial Synthesis	6 hours			
Synthesis by physical, chemical and biological methods, Their advantages and disadvantages, Top-down approaches - Mechanical milling, Etching, Laser ablation, Sputtering, Electro-explosion; Bottom-up approaches - Supercritical fluid synthesis, Spinning, Sol-Gel process, Laser pyrolysis, Chemical vapor deposition, Molecular condensation, Chemical reduction; Green or biological synthesis with appropriate examples.					
Module:4	Nanomaterial Characterization	6 hours			
Importance of material characterization, Applications of dynamic light scattering, Atomic force microscopy, Electron microscopy, Energy dispersive X-ray analysis and X-rays diffraction, Data analysis and interpretation.					
Module:5	Functionalization of Nanomaterials for Biological Applications	6 hours			
Covalent and non-covalent methods for conjugation of various nanoparticles - Physical adsorption, Electrostatic interaction; Covalent coupling to carboxylate particles, Amine particles, Hydroxyl particles, Hydrazone particles, Epoxy particles, Aldehyde particles, Case study of nanobioconjugate design for biosensing and therapeutic applications.					
Module:6	Biomedical Application of Nanomaterials	6 hours			
Scientific principles and applications of nanomedicine; Applications in Gene, Drug, and Biomolecule delivery; Antimicrobial therapy, Antitumor therapy, Prodrug activation, Photothermal therapy, Bioimaging, Tissue engineering, Regenerative medicine, Theranostics.					
Module:7	Agricultural and Environmental Application of Nanomaterials. Nanomaterial Health and Environmental Impact	8 hours			

Nanomaterial interactions - Soil, Water, and Organics; Nano pesticides, Nanofertilizers, Preparation characterization and application strategies, Environmental biosafety, Earthworm, Soil microbes, Algae as models.			
Nanotoxicology of selected materials used in different applications, Food industries, Cosmetic industries and other daily use consumer products, Risk assessment criteria.			
Module:8	Contemporary Issues	2 hours	
		Total lecture hours:	45 hours
Text Book(s)			
1.	An Introduction to Nanomaterials and Nanoscience, by Das A K and Das M, 1 st Edition, 2017, CBS Publishers and Distributors, India.		
2.	Nanobiotechnology I: Concepts, Applications and Perspectives, Eds. CM Niemeyer, CA Mirkin, 2015, Wiley-VCH Verlag GmbH & Co. KGaA Weinheim, Germany.		
Reference Books			
1.	Bionanotechnology: Lessons from Nature, by David S Goodsell, John, 1 st Edition 2015, A John Wiley & Sons, INC., Publication, UK.		
2.	Bioconjugate Techniques, by Greg Hermanson, 3 rd Edition, 2013, Academic Press, London.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT.			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT317L	Tissue Engineering	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Identify, formulate and adapt tissue engineering solutions to unmet healthcare needs. 2. Construct the scaffolds using fabrication techniques and their characterization techniques. 3. Integrate tissue engineering framework for related clinical activities and treating different tissue defects. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Interpret the multidisciplinary aspects in tissue engineering and its usefulness to solve healthcare problems. 2. Identify the sources of cells, and culture models. 3. Design and develop scaffolds using conventional and advanced fabrication methods. 4. Formulate the different tissue engineering strategies for various tissue defect repair. 5. Evaluate the 3D culture using characterisation techniques. 6. Describe the regulatory aspects to commercialize products. 					
Module:1	Overview	5 hours			
Cells, Tissues, Organization, Function, Need for Tissue Banks, Limitations; Principle, Concept, History and Scope of tissue engineering; Role of biomaterials growth factors and drug delivery concepts in tissue engineering applications.					
Module:2	Cells and Extracellular Matrix	6 hours			
Concepts of Cell adhesion, Proliferation, Differentiation, Cell adaptation and injury process; Mammalian Cells in tissue engineering, Cell culture types and basic protocol, Comparison of 2D and 3D culture, Example of co-cultures, Spheroids, and Organoids, Extra cellular Matrix - Composition and properties; Applications of stem cells in tissue engineering.					
Module:3	Scaffold Fabrication	6 hours			
Conventional methods for ceramics and polymers, Textile-based techniques for medical applications, Controlled scaffold architecture, 3D scaffold designing and engineering tools; Various 3D printing technology.					
Module:4	Skin, Bone, Cartilage Tissue Engineering	6 hours			
Skin structure, Injury mechanism, Wound repair - Established tissue engineering methods and new approaches; Natural bone -fracture healing model, Criteria and vision for bone regeneration using scaffolds; Articular cartilage injury and repair with tissue engineering approaches.					
Module:5	Cardiac and Vascular Tissue Engineering	6 hours			
Cardiac tissue - Structure and Physiology, Engineered cardiac tissue - Design principle and key components, Scaffolds, in vivo applications, Tissue engineered heart valve, Status of vascular grafts, Therapeutic angiogenesis and arteriogenesis, Tissue engineered vascular grafts, Stents.					
Module:6	Scaffold Characterization	6 hours			
Physio-chemical characterization, Porosity measurement and mechanical test, Histochemical and immuno-histochemical staining methods for cells, Extracellular matrix and engineered tissues from in vitro culture of scaffolds, In vivo monitoring of inflammation, Immune response, Fibrous capsule formation, Degradation products and functional performance.					
Module:7	Bioreactors, Bioprinting, Ethics and Regulations	8 hours			
Bioreactor - Concept, Principle, and Design; Types of bioreactors and applications; Scaffold					

free tissue engineering, Bioprinting technology, Cell-laden scaffolds; Ethics and regulatory process, Commercialization of products, Barriers in commercialization.			
Module:8	Contemporary Issues		2 hours
Total Lecture hours:			45 hours
Text Book			
1.	Tissue Engineering – Principles and Practice, by John P Fisher, Antonios G Mikos, Joseph D Bronzino, Donald R Peterson, 2019, CRC Press, Florida, USA.		
2.	Biomaterials Science and Tissue Engineering, by Bikramjit Basu, 1 st Edition, 2017, Cambridge University Press, Cambridge, United Kingdom.		
Reference Book			
1.	Principles of Tissue Engineering, by Robert Lanza, Anthony Atala Joseph Vacanti, Robert Langer, 5 th Edition, 2020, Academic Press, Elsevier, Cambridge, Massachusetts, USA.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT318L	Forensic Science and Technology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT207L, BBIT207P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Describe the overall understanding of investigative principles and procedures. 2. Appropriate use of forensic protocols while solving criminal cases. 3. Systemic evaluation using multi-directional approaches in crime scene studies. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Summarize the principles of forensic science correctly and contextually. 2. Outline the organizational structures and procedures in forensic sciences. 3. Identify the concepts, principles, and significance of impression evidence. 4. Evaluate the practices behind collection, analysis, and interpretation of evidence. 5. Compile recent developments and techniques for analyzing evidence. 					
Module:1	Overview on Forensic Science	6 hours			
History and Significance, Crime scene investigation (CSI), Experts associated with forensic investigations, Locard's Exchange Principle, Forensic laboratories and procedures, National and Global laboratories, CSI procedures in India, Body farms, Recent advances.					
Module:2	Crime Scene Profiling and Instrumentation	6 hours			
Types of evidence - Physical, Chemical, Biological, and Miscellaneous evidences, Indoor and outdoor mapping, First responders, Evidence collection, Packing, Preservation, Documentation, Chain of custody, Instrumentation in forensic analysis.					
Module:3	Fingerprints in Forensic Investigation	6 hours			
Fingerprints, Principle, Types, Latent print lifting techniques, Modus operandi sheet, Fingerprint recorders, Biometric system in detecting individual variation, Optical, Capacitance based and other fingerprint recorders, Integrated automated fingerprint identification system (IAFIS) database.					
Module:4	Impressions, Documents and Evidence in Forensic Analysis	6 hours			
Impression based evidence analysis, Principle tool markings, Tire, Footwear markings and associated databases, Handwriting analysis, Question documents, Polymers, Hair and Fibers.					
Module:5	Ballistic Applications in Forensic Procedures	6 hours			
Types, Application, Forensic ballistic procedures (Internal, External and Terminal ballistics) and Identification of firearms, Gunshot residue analysis, Ballistic databases.					
Module:6	Biological Samples and DNA Profiling in Forensic Evaluation	7 hours			
Serological analysis, Samples, Blood Spatter-origin of impact, Area of convergence, Drugs, Alcohol, Metals, and Poisons analysis, Entomology, Collection and examination of insects, Time of death analysis and pathology in death analysis, Bite-mark analysis, Forensic medicine, DNA analysis, Polymerase chain reaction (PCR), Short tandem repeat-Combined DNA index system (CODIS) in DNA profiling.					
Module:7	Digital Forensics	6 hours			
Forensic photography, Principle and application of digital imaging, CCTV in forensic analysis, Camera techniques for evidence visualization, Forensic facial reconstruction, Cyber forensics, Computer and Mobile phone data analysis, Ethical hacking, Drones in surveillance, Deception detection tests (DDT), Polygraph, Narco-analysis and Brain mapping analysis.					

Module:8	Contemporary Issues	2 hours	
	Total Lecture Hours:	45 hours	
Text Book(s)			
1.	Criminalistics: An Introduction to Forensic Science, by Richard Saferstein, 12 th Edition, 2018, Pearson, UK.		
Reference Books			
1.	Forensic Chemistry: Fundamentals and Applications, by Jay Siegel, 2015, Wiley-Blackwell, USA.		
2.	Forensic Science In Criminal Investigation And Trials, by B R Sharma, 6 th Edition, 2020, Lexis Nexis, India.		
Mode of Evaluation: Quiz, CAT, Group discussion/Assignment and FAT.			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT319L	Food Process Engineering	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT202L, BBIT202P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Understand the basic principles involved in food process engineering. 2. Analyze the various techniques and procedures involved in food packaging. 3. Develop skills for experimenting with food systems and to test various approaches for manipulating the chemical and functional properties of foods. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Understand the general aspects of food properties and its quality. 2. Interpret the principles, techniques, procedures involved in food processing, preservation and packaging. 3. Infer the steps involved in food product development for extending the shelf-life of product. 4. Evaluate the approaches that may be used to control the reactivity of those food components that are likely to impact the overall quality of finished products. 5. Apply the principles of food process and food preservation for quality assurance. 					
Module:1	Food Processing Industries	6 hours			
Concepts on global and Indian food industry, Food demand, Food composition, and Quality aspects, Unit operations in food, Organoleptic properties of food, Principles of food preservation and processing.					
Module:2	Energy in Food Processing	5 hours			
Steam, Fuel Utilization, Retorting, Process controls in Food Processing, Systems for heating, Cooling of various food products and food calculations.					
Module:3	Rheology and Thermal Properties of Foods	6 hours			
Food rheology, Viscoelastic properties of food, Microbial survivor curves, Influence of external agents, Thermal death time and food spoilage, Modes of heat and mass transfer - Freezing systems and concepts in freezing.					
Module:4	Food Process and Preservation	6 hours			
High temperature processing, Blanching, Pasteurization, Sterilization, Evaporation and Concentration, Low temperature preservation, Dehydration, Frying, Fermentation and Pickling, Application of microwave and radiation in food preservation and extrusion.					
Module:5	Advances in Food Processing	6 hours			
High pressure processing of foods, Enzyme assisted food processing, Pulse electric field technology and green technologies.					
Module:6	Food Packaging and Quality Assurance	8 hours			
Types and functions of food packaging; Raw material preparation and quality assurance, Packaging materials, Mass transfer in packaging materials, Edible coatings/films; Size reduction and processing.					
Module:7	Food Regulation and Nanotechnology	6 hours			
Regulatory systems for food- International and National, Nano materials as components in food and packaging; Policies on usage of nanomaterials in foods.					
Module:8	Contemporary Issues	2 hours			
	Total Lecture hours:	45 hours			

Text Book(s)			
1.	Food Processing Technology, by PJ Fellows, 4 th Edition, 2017, Woodhead publishing limited, USA.		
2.	Fundamentals of Food Process Engineering, by Romeo T Toledo, 3 rd Edition, 2018, CBS Publishers and Distributors Pvt. Ltd. New Delhi.		
Reference Books			
1.	Food Process Engineering Safety Assurance and Complements, by F Xavier Malcata, 2020, CRC Press,USA.		
2.	Advances in Biotechnology for Food Industry by Alina Maria Holban, Alexandru Mihai Grumezescu, 5 th Edition, 2018, Academic Press, London.		
3	Food Process Engineering and Technology, by Zeki Berk, 3 rd Edition, 2018, Academic Press, Elsevier, ISBN: 9780128120187 eBook		
4	Advances in Agri-Food Biotechnology, by Tilak Raj Sharma, Rupesh Deshmukh, Humira Soanah, 1 st Edition 2020, Springer Nature, Singapore.		
Mode of Evaluation: CAT, Mini Project, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT320L	Medical Diagnostics	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT207L, BBIT207P, BBIT305L, BBIT305P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Identify the various types of specimens received in the diagnostic laboratory. 2. Demonstrate the procedures carried out in laboratory analysis. 3. Distinguish the molecular diagnostic and imaging tools to assist the clinical diagnosis.. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Explain the need for understanding diseases with clinical tests and sample collection. 2. Discuss the various techniques in haematological laboratory. 3. Describe the process to diagnose the microbial infections. 4. Classify the recent rapid immune-based diagnostic tests. 5. Examine the abnormality in tissue using histopathology and cytochemistry. 6. Compare the different imaging techniques, sensors for their clinical applications. 					
Module:1	Overview of Diagnostics	5 hours			
Medical diagnostics and its relevance, Patient preparation-pretest and post- test care, Specimen collection, Biopsy, Storage, Transport, Ethical consideration.					
Module:2	Diagnosis in Haematology	6 hours			
Phlebotomy, Composition of blood, Smear test, Complete Blood Count profile, Hematocrit, PCV, Hemoglobin, MCV, MCH, RDW, ESR: Platelet count, MPV, Bleeding time, Coagulation time and diagnosis of related disorders.					
Module:3	Diagnosis in Pathogenic Diseases	6 hours			
Clinical sample collection, Culturing, Strain identification procedures: for respiratory tract infection, Urinary tract infection, gastric infection, blood and skin infection. Specimen collection for viral diseases, Cultivation and assays for virus, Viral identification by cell culture, PCR, RT-PCR, Serological tests and immunohistochemistry, Rapid diagnostic tests.					
Module:4	Diagnosis in Immunological Diseases	6 hours			
Detection of various allergic agents and immunopathology of allergy, Rheumatological diseases: Tissue typing for kidney and bone marrow transplant, Rapid tests – TORCH profile test, Myco dot, IgG, IgA, IgM and IgE testing, Hepatitis B antigen.					
Module:5	Histopathology and Cytology	6 hours			
Sample collection, Preservation, Grossing methods, Fixatives, Tissue processing of the tissues including bone, Embedding, Sectioning, Staining, Mounting, and basic Haemotoxylin and Eosin staining, Preparation of fluids for Cytological Examination, Fine needle access cytology, Imprints smear, Vaginal and Buccal smear, Swabs. Basics Immuno histochemistry.					
Module:6	Diagnostic Imaging	7 hours			
Concepts of imaging physics and image acquisition and diagnostic relevance: X-ray radiology, Fluoroscopy, Ultrasound, Endoscopy studies, Applications of diagnostic Computer tomography and Magnetic resonance Imaging, Nuclear medicine and molecular imaging.					
Module:7	Advanced Diagnostic Techniques	7 hours			
DNA fingerprinting, EEG – Seizure/Epilepsy analysis, Sleep studies – polysomnography, sleepiness studies, Cardiac monitoring – stress test. Autoanalysers, Clinical laboratory management system, Ethics and Regulatory challenges in diagnostic industry.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					
					45 hours
Text Books					
1.	A Manual of Laboratory and Diagnostic Tests, by Frances Talaska Fischbach, Marshall				

	Barnett Dunning (III), 10 th Edition , 2017, Wolters Kluwer Health, Philadelphia, USA.		
Reference Books			
1.	Manual of Diagnostic and Laboratory Tests, by Kathleen Deska Pagana, Timothy J Pagana, Mosby's, 6 th Edition, 2018, Elsevier Health Science, USA.		
2.	Clinical Diagnosis and Management by Laboratory Methods, by Richard A. McPherson, Matthew R. Pincus, Henry's 2017. 23 rd Edition, Elsevier Health Sciences, USA.		
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT321L	Food Biotechnology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT203L, BBIT203P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> Analyse the various dimensions of food biotechnology. Integrate the biotechnological principles applied to food production. Apply the modern food biotechnological aspects involved in processing of food. 					
Course Outcomes					
<ol style="list-style-type: none"> Illustrate the concepts of biotechnology to the science of food. Appraise the sources and substitutes of foods. Identify the role of biotechnology in primary food produce. Combine the knowledge about adulterants, allergens with the production of food. Interpret the principles of novel food biotechnology aspects related to process of food. Suggest appropriate microbial products used as additives and design of novel functional foods. 					
Module:1	Concepts of World Food Resources	6 hours			
Food resources, Plant, Animal and microbes, Overview of current food production systems, Constraints and necessity of novel strategies.					
Module:2	Biotechnology of Modern Food Production	7 hours			
Improvement of plant nutritional and functional quality- Starch, Protein, Fatty acid, and Sugar substitutes and their modification, Overview of bio fortification, Design of functional foods and modern concepts related to genomic analysis of food nutrients in plant produce, Global perspective of consumers on genetically modified food and regulatory agencies, Major concerns of transgenic foods - Labeling, Bioavailability, and Safety aspects.					
Module:3	Animal Food Biotechnology	6 hours			
Improved milk, Enhancing egg and meat quality by using biotechnological interventions, Application of transgenic fish technology in sea food production.					
Module:4	Microbes as Food Resource	6 hours			
Single cell protein and algal protein, Mushrooms, Food yeasts, and Lactic acid bacteria.					
Module:5	Food Fermentations	6 hours			
Types of fermentation, Overview of diverse fermented foods, Production process of selected fermented foods - Soya sauce, Sauerkraut, Beer, Wine, Yogurt, Cheese, Yeast breads, and Sausages, Starter cultures in food industry.					
Module:6	Biotechnology of Food Additives	5 hours			
Bioflavors and colors, Microbial polysaccharides and Recombinant enzymes in food sector.					
Module:7	Food Quality, Assessment and Food Waste Treatment Technologies	7 hours			
Role of allergens and food allergies, Pathogenic microbes and food poisoning, Adulterants - Natural and Man-made, Mislabeled produce, GM ingredients in food products - evaluation and assessment study to identify allergens and adulterant, Characteristics of food wastes- Treatment methods and recovery of value added products.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					45 hours
Text Book(s)					

1.	Fundamentals of Food Biotechnology, by Byong H. Lee., 2 nd Edition, 2021, Wiley- Blackwell Publishers, USA.		
2.	Food Biotechnology, by Foster G.N, 5 th Edition, 2020, CBS Publishers and Distributors Pvt. Ltd., New Delhi.		
Reference Books			
1.	Advances in Agri-Food Biotechnology, by Tilak Raj Sharma, Rupesh Deshmukh, Humira Soanah, 1 st Edition 2020, Springer Nature, Singapore.		
2.	Advances in Biotechnology for Food Industry, Hand Book of Food Engineering, by Alina Mariaholban, Alexandrumihai Grumezescu, 5 th Edition, 2018, Academic Press, London.		
3	Fundamentals of Food Process Engineering, by Romeo T. Toledo, 3 rd Edition, 2018, CBS Publishers and Distributors Pvt. Ltd. New Delhi.		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT322L	Cancer Biology and Informatics	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT205L, BBIT205P, BBIT207L, BBIT207P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Describe overall cancer pathology. 2. Analyze the strategies followed in diagnostics and treatment. 3. Demonstrate the systemic approach in identification, prevention, and treatment of cancer. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Outline the basis on cancer cause, and initiation. 2. Demonstrate cancer cell signaling and abnormal cell growth. 3. Elaborate the process of cancer metastasis. 4. Evaluate the emerging concepts for systemic understanding and treatment. 5. Combine different disciplines for the diagnostics, treatment, and prognostics in cancer. 					
Module:1	Overview of Cancer Pathogenesis	5 hours			
Hallmark events of cancer, Mutagens, Carcinogens, Transformation, Epidemiology, and methods in studying cancer.					
Module:2	Genetic and Cell Cycle Alterations	6 hours			
Oncogene activation, Tumor suppressor inactivation, and signaling abnormalities in cancer, Cell cycle regulation, DNA damage and checkpoints, DNA repair dysregulation.					
Module:3	Apoptosis and Cancer	4 hours			
Involvement of apoptotic pathways and other cell death events in cancer, B-cell lymphoma 2 (Bcl-2) protein family, Inhibitors of apoptosis proteins (IAP); X-linked inhibitor of apoptosis.					
Module:4	Angiogenesis, Metastasis and Tumor Microenvironment	7 hours			
Angiogenesis, Mechanism and significance in tumor progression, Metastasis, Overview, seed-and-soil theory, Epithelial to mesenchymal transition, and signaling pathways in metastasis.					
Module:5	Genomic Instability	4 hours			
Epigenetics; DNA methylation, Histone modifications, Epigenetic role of RNA, Genomic Instability; Hayflick limit, Telomerase activation, Chromosomal instability, Microsatellite Instability.					
Module:6	Emerging Concepts in Tumorigenesis	8 hours			
Evidence and Origin of cancer stem cells, Tumor heterogeneity, Markers of cancer stem cells, cancer control through stem cells, Briefing on Inflammation, Evading Immune system, The Warburg effect.					
Module:7	Cancer Diagnosis and Therapeutics & Cancer Informatics	9 hours			
Cancer Diagnosis: Conventional and new imaging techniques, Molecular markers, Circulatory tumor cells for liquid biopsy, Chemotherapy, Immunotherapy, Targeted therapy, Hormone therapy, Stem cell transplantation, Xenograft model, Knockout mouse models for cancer drug discovery. Cancer informatics their applications in pathology, diagnosis, treatment, and prognosis; Applications of high-throughput technologies in cancer, and current trends in cancer diagnosis and therapeutics.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					45 hours
Textbook(s)					

1.	The Biology of Cancer, by Weinberg Robert A, 2 nd Edition, 2014, Blackwell Ltd, USA		
Reference Books			
1.	The Molecular Basis of Cancer by Mendelsohn, Howley, Israel, Gray, Thompson, 2015, 4 th Edition, Elsevier Inc., USA		
2	Cancer Biology by Roger J.B. King, Mike W. Robins, 3 rd Edition, 2006, Pearson, UK		
3	Anticancer: A New Way of Life by David Servan-Schreiber, 2011, Penguin, UK		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT323L	Protein Engineering and Design	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT207L, BBIT207P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Understand and analyse the different aspects of protein structure. 2. Gain comprehensive understanding and an up-to-date knowledge about the techniques used in protein analysis. 3. Design new proteins for biotechnological/biomedical applications. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Understand the basics of protein structure. 2. Analyze protein structure using appropriate analytical techniques. 3. Formulate strategies for the production of recombinant proteins. 4. Design new proteins using rational and <i>de novo</i> strategies. 5. Apply protein engineering strategies to develop new proteins to meet the industrial requirements. 					
Module:1	Protein Structure and Stability	9 hours			
Overview of proteins - Classification, Structure and functions; Motifs and Super secondary structures, Protein stability - Ionic interactions, Van der Waal interactions, Hydrophobic interactions, Protein denaturation, Denaturation and Folding energy landscape; Structure determination of proteins - X-Ray crystallography, Nuclear magnetic resonance spectroscopy (NMR) and Cryo-electron microscopy; Structural analysis of proteins – Circular dichroism, fluorescence and X-Ray scattering.					
Module:2	Laboratory Evolution of Proteins	7 hours			
Directed evolution, Random mutagenesis, Focused mutagenesis; Site saturation mutagenesis (SSM), Homologous recombination, In-vivo homologous recombination, In-vitro Non-homologous recombination methods, Screening and selection techniques, Proteins designed using directed evolution (DE) methods. Cell-free expression system.					
Module:3	Rational Design of Novel Proteins	6 hours			
Computational designing of Proteins, Rational designing of proteins, Multiple sequence alignment Tools for designing Proteins, Co-evolutionary analysis, Structure based designing of novel proteins; Use of non-natural amino acids.					
Module:4	De novo Design of Proteins	6 hours			
Building Backbone, Sequence Design and Optimization, In silico and Experimental validation, Negative design methods, Combinatorial approach for protein designing.					
Module:5	Biotechnological Applications	6 hours			
Diversified applications of protein engineering techniques in relation to industrial and environmental applications; Case studies on protein engineering for stability and substrate specificity.					
Module:6	Biomedical and Nanotechnology Applications	5 hours			
Engineered proteins and protein scaffolds as therapeutics, Applications in nanotechnology, Biosensors and virus engineering; Case studies on protein and peptide based nanoparticles and biosensors.					
Module:7	Biomaterial Applications	4 hours			
Elastin like polypeptides, Silk motifs, Coiled-coil motifs, Calmodulin motifs, β -Sheet forming ionic oligopeptides; Case studies on protein based biomaterials.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					

BBIT391J	Technical Answers to Real Problems Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> To gain an understanding of real-life issues faced by society. To study appropriate technologies in order to find a solution to real life issues. Students will design system components intended to solve a real-life issue. 					
Course Outcome:					
<ol style="list-style-type: none"> Identify real life issue(s) faced by society. Apply appropriate technologies to suggest a solution to the identified issue(s). Design the related system components/processes intended to provide a solution to the identified issue(s). 					
Module Content					
<p>Students are expected to perform a survey and interact with society to find out the real life issues. Logical steps with the application of appropriate technologies should be suggested to solve the identified issues.</p> <p>Subsequently the student should design the related system components or processes which is intended to provide the solution to the identified real-life issues.</p>					
General Guidelines:					
<ol style="list-style-type: none"> Identification of real-life problems Field visits can be arranged by the faculty concerned Maximum of 3 students can form a team (within the same/different discipline) Minimum of eight hours on self-managed team activity Appropriate scientific methodologies to be utilized to solve the identified issue Solution should be in the form of fabrication/coding/modelling/product design/process design/relevant scientific methodology(ies) Consolidated report to be submitted for assessment Participation, involvement and contribution in group discussions during the contact hours will be used as the modalities for the continuous assessment of the theory component Project outcome to be evaluated in terms of technical, economical, social, environmental, political and demographic feasibility Contribution of each group member to be assessed 					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews					
Recommended by Board of Studies		09-03-2022			
Approved by Academic Council		No.65	Date	17-03-2022	

BBIT392J	Design Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> 1. Students will be able to upgrade a prototype to a design prototype. 2. Describe and demonstrate the techniques and skills necessary for the project. 3. Acquire knowledge and better understanding of design systems. 					
Course Outcome:					
<ol style="list-style-type: none"> 1. Develop new skills and demonstrate the ability to upgrade a prototype to a design prototype or working model. 2. Utilize the techniques, skills, and modern tools necessary for the project. 3. Synthesize knowledge and use insight and creativity to better understand and improve design systems. 					
Module Content					
Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		09-03-2022			
Approved by Academic Council		No. 65	Date	17-03-2022	

BBIT393J	Laboratory Project			L	T	P	C
				0	0	0	3
Pre-requisite	NIL			Syllabus version			
				1.0			
Course Objectives:							
<ol style="list-style-type: none"> 1. The student will be able to conduct experiments on the concepts already learnt. 2. Analyse experimental data. 3. Present the results with appropriate interpretation. 							
Course Outcome:							
<ol style="list-style-type: none"> 1. Design and conduct experiments in order to gain hands-on experience on the concepts already studied. 2. Analyse and interpret experimental data. 3. Write clear and concise technical reports and research articles 							
Module Content							
<p>Students are expected to perform experiments and gain hands-on experience on the theory courses they have already studied or registered in the ongoing semester. The theory course registered is not expected to have laboratory component and the student is expected to register with the same faculty who handled the theory course. This is mostly applicable to the elective courses. The nature of the laboratory experiments is depended on the course.</p>							
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.							
Recommended by Board of Studies				09-03-2022			
Approved by Academic Council				No. 65	Date	17-03-2022	

1.	Protein Engineering Techniques: Gateways to Synthetic Protein Universe, by Poluri K M and Gulati K 1 st Edition, 2017, Springer Nature, Singapore.		
Reference Books			
1.	Peptide and Protein Engineering: From Concepts to Biotechnological Applications, by Olga I and Roque A C, 1 st Edition, 2020, Springer-Verlac New York Inc. USA.		
2.	Proteins: Biochemistry and Biotechnology, by Walsh, G, 2 nd Edition, 2017, Wiley Blackwell, Oxford, UK.		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT394J	Product Development Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> 1. Students will be able to translate a prototype to a useful product. 2. Apply relevant codes and standards during product development. 3. The student will be able to present his results by means of clear technical reports. 					
Course Outcome:					
<ol style="list-style-type: none"> 1. Demonstrate the ability to translate the developed prototype/working model to a viable product useful to society/industry. 2. Apply the appropriate codes/regulations/standards during product development. 3. Write clear and concise technical reports and research articles 					
Module Content					
Students are expected to translate the developed prototypes / working models into a product which has application to society or industry.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews					
Recommended by Board of Studies		09-03-2022			
Approved by Academic Council		No.65	Date	17-03-2022	

BBIT395J	Computer Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> 1. Students will be able to analyse complex engineering processes. 2. Describe the applications and limitations of a given engineering process. 3. Present the results in written reports and oral presentations. 					
Course Outcome:					
<ol style="list-style-type: none"> 1. Utilize programming skills/modelling to analyse complex engineering processes/problems. 2. Demonstrate the ability to evaluate the applicability and limitations of the given engineering process. 3. Communicate effectively through written reports, oral presentations, and discussion. 					
Module Content					
Students are expected to use programming skills or modelling to analyse complex engineering processes. The student should be able to evaluate the application and limitations of the said engineering processes.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.					
Recommended by Board of Studies			09-03-2022		
Approved by Academic Council			No.65	Date	17-03-2022

BBIT396J	Reading Course			L	T	P	C
				0	0	0	3
Pre-requisite	NIL			Syllabus version			
				1.0			
Course Objectives:							
<ol style="list-style-type: none"> 1. The student will be able to analyse and interpret published literature for information pertaining to niche areas. 2. Scrutinize technical literature and arrive at conclusions. 3. Use insight and creativity for a better understanding of the domain of interest. 							
Course Outcome:							
<ol style="list-style-type: none"> 1. Retrieve, analyse, and interpret published literature/books providing information related to niche areas/focused domains. 2. Examine technical literature, resolve ambiguity, and develop conclusions. 3. Synthesize knowledge and use insight and creativity to better understand the domain of interest. 							
Module Content							
This is oriented towards reading published literature or books related to niche areas or focussed domains under the guidance of a faculty.							
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.							
Recommended by Board of Studies				09-03-2022			
Approved by Academic Council				No.65	Date	17-03-2022	

BBIT397J	Special Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> 1. Students will be able to identify and solve problems in a time-bound manner. 2. Describe major approaches and findings in the area of interest. 3. Present the results in a clear and concise manner. 					
Course Outcome:					
<ol style="list-style-type: none"> 1. To identify, formulate, and solve problems using appropriate information and approaches in a time-bound manner. 2. To demonstrate an understanding of major approaches, concepts, and current research findings in the area of interest. 3. Write clear and concise research articles for publication in conference proceedings/peer-reviewed journals. 					
Module Content					
This is an open-ended course in which the student is expected to work on a time bound research project under the supervision of a faculty. The result may be a tangible output in terms of publication of research articles in a conference proceeding or in a peer-reviewed Scopus indexed journal.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		09-03-2022			
Approved by Academic Council		No. 65	Date	17-03-2022	

BBIT398J	Simulation Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
<ol style="list-style-type: none"> 1. Students will be able to simulate a real system. 2. Identify the variables which affect the system. 3. Describe the performance of a real system. 					
Course Outcome:					
<ol style="list-style-type: none"> 1. Demonstrate the ability to simulate and critically analyse the working of a real system. 2. Identify and study the different variables which affect the system elaborately. 3. Evaluate the impact and performance of the real system. 					
Module Content					
The student is expected to simulate and critically analyse the working of a real system. Role of different variables which affect the system has to be studied extensively such that the impact of each step in the process is understood, thereby the performance of each step of the engineering process is evaluated.					
Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		09-03-2022			
Approved by Academic Council		No. 65	Date	17-03-2022	

BBIT401L	Molecular Modelling and Drug Design	L	T	P	C
		3	0	0	3
Pre-Requisite	BBIT205L, BBIT205P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Elaborate the methods in molecular mechanics and quantum mechanics. 2. Illustrate the concept of molecular simulation and modelling techniques. 3. Explain various lead seeking methods and lead optimization. 4. Generalize the statistical modeling principles & optimization using computer applications. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Derive the various force fields and quantum mechanical equations. 2. Explore the concept of geometry optimization and molecular dynamics. 3. Interpret the physicochemical properties and the techniques involved in QSAR. 4. Validate the diversity of drug targets. 5. Relate the applications of computers in pharmaceutical product development. 6. Use the various chemical, biochemical and pharmaceutical databases. 					
Module: 1	Quantum Mechanics	8 Hours			
Experimental basis of quantum physics, Computing of physical principles, Bohr's model, Schrodinger wave equation, Born-Oppenheimer approximation, Quantum mechanical methods, Molecular orbital theory, Single point energy calculation, Bio-organic reaction mechanism, Applications of quantum mechanics.					
Module: 2	Molecular Mechanics	7 Hours			
Overview of Molecular mechanics, Principles of stereoisomerism, Concept of hydrophobic and hydrophilic interactions, Energy contribution and distance of non-covalent interactions, Allosteric mechanism, Force fields and types.					
Module: 3	Molecular Simulation	7 Hours			
Geometry optimization, Steepest descent and conjugate gradient method, Molecular dynamics, Integration of equation of motion - Verlet algorithm, Monte-carlo simulation and applications, Geometric similarity of structures.					
Module: 4	Drug Discovery	6 Hours			
Drug design process, Drug targets, Properties of drugs, Overview of clinical trials, Pharmacogenomics.					
Module: 5	Lead Based Drug Design	5 Hours			
Virtual screening, Pharmacophore mapping, Analog based drug design, Types of descriptors, QSAR modelling, ADMET prediction, Peptidomimetics.					
Module: 6	Target Based Drug Design	5 Hours			
Modeling of drug targets, Target identification and validation, Molecular docking, <i>De novo</i> drug design.					
Module: 7	Drug Discovery Resources	5 Hours			
Knowledge, Skills, and basics of chemoinformatics – SMILES, Internal coordinates, Z-matrix, Cartesian coordinate system, Characterizing potential energy surface, Molecular visualization, Computational resources for molecular modelling and drug designing – databases and software.					

Module: 8	Contemporary Issues	2 hours	
	Total Lecture hours	45 hours	
Text books			
1.	In Silico Drug Discovery and Design: Theory, Methods, Challenges, and Applications, by Claudio N. Cavasotto, 1 st Edition, 2015, CRC Press Florida, USA,		
2.	Computational Methods to Study the Structure and Dynamics of Biomolecules and Biomolecular Processes: From Bioinformatics to Molecular Quantum Mechanics, by Adam Liwo, 2 nd Edition, 2018, Springer, Switzerland,		
Reference books			
1.	In Silico Medicinal Chemistry: Computational Methods to Support Drug Design, by Nathan Brown, Illustrated Edition, 2015, Royal Society of Chemistry; UK,		
2.	Concepts and Experimental Protocols of Modelling and Informatics in Drug Design, by Om Silakari, 1 st Edition, 2020, Academic Press Inc, USA.		
3.	The Organic Chemistry of Drug Design and Drug Action By Richard B. Silverman, Mark W. Holladay, 3 rd Edition, 2014, Academic Press, Elsevier, CA, USA.		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT402L	Neurobiology and Cognitive Science	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT202L, BBIT202P, BBIT204L, BBIT204P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Acquaint the students with understanding of the cellular and molecular principles of neuronal communication. 2. Foster the knowledge of the role of neurons in higher order functions. 3. Apply the acquired knowledge to formulate research questions. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Explain the molecular and cellular organization of the nervous system. 2. Elaborate the properties of cells that make up the nervous system including the propagation of electrical signals used for cellular communication. 3. Identify key steps in the development of the nervous system. 4. Distinguish the basis of sensory perception at the receptor level. 5. Classify neural diseases. 6. Relate the performance of complex neural tasks of learning and memory. 					
Module:1	Overview	6 hours			
Brief history of neuroscience, Introduction to nervous system, Anatomical organization of the central nervous system, Structure of neurons and glia.					
Module:2	Electrical Properties of Neurons	7 hours			
Ion channels, Membrane potential and action potential.					
Module:3	Neurotransmission	7 hours			
Electrical synaptic transmission, Chemical synaptic transmission, Synaptic potentials and end plate potentials, Neurotransmitters - Biosynthesis, Function and Clearance.					
Module:4	Development of Nervous System	7 hours			
Neurogenesis, Axon pathfinding, Molecules involved in axon growth, Synapse formation and synaptic pruning, Neuronal survival, Repairing the damaged brain.					
Module:5	Sensory Systems	6 hours			
Anatomy of spinal cord, Pain, Visual processing, Sleep and cognition.					
Module:6	Diseases of Nervous System	6 hours			
Neurodegenerative diseases and cognitive impairments - Alzheimer's disease, Parkinson's disease, Autism spectrum disorder, Epilepsy.					
Module:7	Techniques in Neurobiology, Learning and memory	5 hours			
Techniques - Electrophysiology (extracellular, intracellular, whole cell patch clamp recordings), Memory systems, Role of engram cells in the systems consolidation of memory.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					45 hours
Text Book(s)					
1.	Lippincott Illustrated Reviews: Neuroscience, by Claudia Krebs, Joanne Weinberg, Elizabeth Akesson, Esma Dilli, 2 nd Edition, 2018, Wolters Kluwer, China.				
2.	Principles of Neural Science, by Eric R. Kandel, John D. Koester, Sarah H. Mack, Steven A. Siegelbaum, 6 th Edition, 2021, McGraw Hill, USA.				
Reference Books					
1.	Neuroscience – Exploring the Brain, by Mark F Bear, Barry W Connors, Michael A Paradiso, 4 th Edition, 2020, Jones & Bartlett Learning, USA.				
2.	Neuroscience by Dale Purves, George J. Augustine, David Fitzpatrick, William C Hall, Anthony-Samuel La-Mantia, Richard D Mooney, Michael L Platt, Leonard E White, 6 th				

	Edition, 2017, Oxford University Press, USA.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BBIT403L	Industrial Enzymology	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT202L, BBIT202P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Understand enzyme nomenclature, catalytic and kinetic behaviour. 2. Demonstrate extraction, purification and formulation of enzymes. 3. Explore application of enzymes and engineered enzymes in various industries. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Outline the chemical and biological features of enzyme reaction. 2. Solve the kinetics and mechanism of enzyme action. 3. Construct strategies in enzyme isolation and purification. 4. Explicate applications of enzymes. 5. Perceive formulations, regulatory and safety aspects of enzymes. 					
Module:1	Overview of Enzymes	5 hours			
Enzyme nature and its properties, Enzyme commission system of classification and nomenclature of enzymes, Specificity of enzymes - Types, Interaction between enzyme and substrate - Lock and key model, Induced fit model; Active site and its features, Activation energy, Transition state complex, Reaction coordinate diagram; Factors affecting enzyme reaction.					
Module:2	Enzyme Kinetics and Mechanisms	6 hours			
Importance of analyzing enzyme kinetics - Derivation of Michaelis Menten equation and assumptions, Analysis of kinetics - K_m and V_{max} determination, LB plot and its significance; Catalytic efficiency determination, related numerical. Enzyme inhibitors and its types, Effect of inhibitors on kinetic parameters; Catalytic mechanisms - Proximity effect, Rate enhancement through transition state stabilization, Metal-ion catalysis, Covalent catalysis, Acid base catalysis with respective examples of enzymes for each mechanism.					
Module:3	Extraction and Purification of Enzymes	6 hours			
Intracellular and extracellular enzymes, Isolation of enzymes from natural sources - Microbial, Plant and Animal origin, Strategies in enzyme isolation and purification, Assessment of purity of isolated enzymes, Enzyme assays using natural and synthetic substrates, Specific activity assessment.					
Module:4	Applications of Enzymes in Food Industry	6 hours			
Process involved in beer and wine production, Process involved in cheese manufacture, Enzymes in cheese manufacture, Enzyme modified cheese (EMC); Processing of whey, Process involved in fruit juice production; Enzymes in meat processing industry, Immobilized enzymes and their applications in food industry.					
Module:5	Enzymes in Leather and Detergent Industry	5 hours			
Leather processing steps and enzyme application in Curing, Soaking, Dehairing, Dewooling, Bating, Tanning and effluent treatment; Enzymes in detergent industry.					
Module:6	Enzymes in Paper and Textile Industry	5 hours			
Process and production of pulp for paper, Applications of enzymes for paper and pulp; Textile processing (cellulose, silk and wool) - Use of enzymes in desizing, Scouring, Bleaching and polishing; Applications of cellulases, Pectinases, Hemicellulases, Lipases and catalases; Enzymatic treatment of textile effluents.					
Module:7	Therapeutic and Diagnostic Applications of Enzymes & Enzyme Formulations and Regulations	10 hours			
Enzyme as analytical, Diagnostic and therapeutic agents - Use of enzyme coupled assays in the determination of metabolites like Glucose, Urea, Cholesterol; Isoenzymes in diagnosis - LDH, CK, ALP, ACP, ALT, AST, GGT; Therapeutic effect of enzymes - Asparaginase, Urokinase, Hyaluronidase, Streptokinase, Adenosine deaminase, Lactamase, Trypsin;					

Enzymes in sensors.			
Need for enzyme formulations, Basis of enzyme formulations; Modification of industrial enzyme function and stability by enzyme engineering approaches (directed evolution to semi-rational or rational design) - Case studies; Safety and regulatory aspects, Ethics in the use of enzymes in food products, Medical and dietary considerations, Evaluation of enzyme safety and toxicity. Contemporary topics.			
Module:8	Contemporary Issues		2 hours
Total Lecture hours:			45 hours
Text Book(s)			
1.	Fundamentals of Enzymology, by Jo Phillips, 1 st Edition, 2020, ED TECH Press, UK.		
Reference Books			
1.	Enzymes: Novel Biotechnological Approaches for the Food Industry, by Selim Kermasha and Michael N A Eskin, 1 st Edition, 2020, Academic Press, United States.		
2.	Microbial Fermentation and Enzyme Technology, by Hrudayanath Thatoi, Pradeep K Das Mohapatra, Sonali Mohapatra, Keshab C Mondal, 1 st Edition, 2020, CRC Press. Boca Raton.		
3.	Industrial enzyme application, by Andreas Vogel and Oliver May, 1 st Edition, 2019, Wiley-VCH Verlag GmbH & Co. Germany.		
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT404L	Emerging and Re-emerging Infectious Diseases	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT203L, BBIT203P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Relate the different infectious agents and diseases. 2. Appraise the concepts about emerging and re-emerging infectious diseases. 3. Judge the importance and implications of emerging bacterial, fungal, parasitic and viral infections. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Understand the concepts about infectious diseases. 2. Devise the characteristics of infectious agents. 3. Categorize and analyze the pathogenesis and clinical manifestations of emerging and re-emerging infectious diseases. 4. Value the laboratory diagnosis and preventive measures for emerging and re-emerging infectious diseases. 5. Suggest therapeutic options for emerging and re-emerging infectious diseases. 					
Module:1	Overview of Emerging and Re-emerging Infections	5 hours			
Microbes and epidemiology, Factors contributing to emergence of emerging infectious diseases and Re-emerging infectious diseases, Zoonotic infections, Hospital-acquired infection, Neglected infectious Diseases, Antimicrobial drug resistance, Global Outbreak Alert and Response Network, Infection prevention and control.					
Module:2	Bacterial Infections	9 hours			
Major Gram negative and Gram positive pathogenic bacteria, ESKAPE pathogens, Priority pathogens - WHO & India, Bacillus anthracis, Yersinia pestis, Corynebacterium diphtheriae, Mycobacterium tuberculosis, Vibrio cholera, Burkholderia pseudomallei; Common types of virulence factors found in bacteria, Modes of bacterial gene transfer, Emergence of Multi- drug resistance (MDR) in pathogens and consequences – MDR mechanisms and their preventive approaches, Pathogen-Host cell interactions during bacterial infection. Alternative to antibiotics.					
Module:3	Viral Infections and Prions	8 hours			
Infectious life cycle, Mode of viral gene transfer, Types of viral infections, Antiviral agents and mechanism of action, Drug resistance in viruses; Factors causing the emergence and re-emergence of viral infectious diseases, Emerging viral infections Zika, Ebola, Marburg, Kyasanur forest disease – Mode of transmission, Clinical manifestations, Diagnostic measures, Biological basis of pathogenic effects; Emergence and re-emergence of SARS and novel mutant variants, MERS, Measles, Nipah infections; Prions - Creutzfeldt-Jakob disease.					
Module:4	Fungal Infections	5 hours			
Epidemiology of invasive fungal infections - Factors contributing to emergence, New species and changes in fungal taxonomy - Emerging Yeasts (Drug-resistant Yeast: Candida sp., Cryptococcus sp., Pneumocystis carinii, Trichosporon sp.), Emerging Molds (Mucor, Azole resistant Aspergillus; Anti-fungal resistant Zygomycetes).					
Module:5	Parasitic Infections	5 hours			
Types, Major Parasitic Infections - Malaria, Leishmaniasis, Trichomoniasis, Cryptosporidiosis, Microsporidium, Toxoplasmosis, Different Symptoms of Parasitic Infections; Drug resistance in parasites.					
Module:6	Control and Preventive Measures	6 hours			

Clinical characteristics of Infectious diseases, Controlling measures within the community. Measures in Outbreak of Infectious Diseases: Measures in livestock, Quarantine, Screening and Immunization; Medical applications - Antibiotics, Vaccinations, Antivirals, Phage therapy and Novel strategies.			
Module:7	Diagnosis	5 hours	
Traditional methods of Identification - Microscopy, Biochemical Tests; Immunological Techniques in identification - Haem-agglutination (HA), HAI, Neutralization, ELISA, Immunofluorescence, Western blot; Molecular methods of Identification - PCR-types, FISH, Automated analysis and identification systems.			
Module:8	Contemporary Issues	2 hours	
Total Lecture hours:			45 hours
Text Book(s)			
1.	Textbook of Microbiology, by Ananthanarayan and Paniker, 11 th Edition, 2020, University Press (India) Pvt. Ltd., India.		
2	Textbook of Medical Parasitology, by Paniker, 9 th Edition, 2021, Jaypee Bros, India.		
Reference Books			
1.	Emerging and Re-emerging Infectious Diseases of Livestock, by Bayry J, 2017, Springer, France.		
2	Medical Microbiology, by Jawetz, Melnick and Adelberg, 28 th edition, 2020, McGraw Hill - LANGE Publications, India.		
Mode of Evaluation: CAT, assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT405L	Biological Data Analysis and Simulation	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Demonstrate the types of biological databases and their data formats. 2. Build a strong understanding of various omics experiments, data generation techniques and data management strategies. 3. Design experiments and to effectively utilize Machine learning algorithms in analyzing biological datasets. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Decipher the differences in the types of databases and their data formats. 2. Apply the knowledge of various omics experiments, data generation techniques, data management concepts, data mining strategies and their effective utilization. 3. Comprehend the aspects of data integration, data management, data mining for defined applications. 4. Describe the methods and algorithms in big data analysis. 5. Identify the importance of data analysis in understanding and analyzing biological data. 6. Explore the applications of biological data analysis. 					
Module:1	Introduction to Genome Informatics	7 hours			
<p>Microarray analysis definition, types, Life cycle, Data analysis, Tools, Databases and Software. Major biological databases and classification, Sequence databases, NGS Databases - SRA, DRA, ENA; File/Data formats overview - FASTA, FASTQ, FNA, CSFASTA, GFF, SAM and BAM; Genome alignment and analysis tools - BWA (Burrows-Wheeler Aligner), SAMtools, GATK (The Genome Analysis Toolkit), IGV (Integrative Genomics Viewer), HISAT, StringTie, Cuffcompare, Velvet, Oases, Trinity, Advantage and disadvantage of NGS Technology.</p>					
Module:2	Data Preprocessing	6 hours			
<p>Data Preprocessing, Data normalization, Measuring Dissimilarity of Expression Pattern- Distance Motifs and Dissimilarity measures, Visualizing MicroArray Data, Principal Component Analysis, NCBI and MicroArray Data Management, GEO (Gene Expression Omnibus), MAML, The benefits of GEO and MAML, The Promise of MicroArray Technology in Treating Diseases; Data Mining for specific applications.</p>					
Module:3	NGS Data Analysis	6 hours			
<p>Importance of omic technologies, NGS data collection and bioinformatics principles - Data standards for omic data; The basis of data sharing and reuse; Omic data management and annotation; Data and knowledge management in cross omics research projects; Statistical analysis principles for omic data; Statistical methods and models for bridging Omics data levels; Analysis of time course omic datasets; The use and abuse of Omics; Computational analysis of High Throughput Sequencing Data Analysis of SNP in case control studies; Bioinformatics for Genomics; The ENCODE project consortium; Data mining for specific applications.</p>					
Module:4	De novo Assembly	6 hours			
<p>Overlap-layout-consensus (OLC) approach (Arachne, Phusion), de Bruijn and Euler path approach (Euler, SOAPdenovo), string graph assembler (SGA). Scaffolding - Supercontig, contig orientation, Contig ordering, Contig distancing and Gap closing using SOAP denovo, ABySS, OPERA and RACA.</p>					
Module:5	Big Data and R Language in NGS Analysis	6 hours			
<p>Elements of big data and R, Introduction to bioconductor, Reading of RNA-seq data (Short read, Rsamtools, Genomic ranges), Annotation (Biomart, Genome intervals), Reads coverage and assign counts (IRanges, Genomic Features), Differential expression (DESeq).</p>					

Module:6	Machine Learning Techniques in Analyzing Biological Data	6 hours	
Naive Bayes, Decision tree, Random forest, Neural network using biological problems, Developments and applications of deep networks probabilistic models- including Markov models, Hidden Markov models, and Bayesian networks for biological sequence analysis and systems biology.			
Module:7	Clinical Applications	6 hours	
Patient derived xenografts (PDX), Modeling precision medicine for breast cancer, Biomarker Selection in Alzheimer's disease, Relationship between geography and genomic variation.			
Module:8	Contemporary Issues	2 hours	
		Total Lecture hours:	45 hours
Text Book(s)			
1.	Bioinformatics Database Systems, by Kevin Byron, Katherine G Herbert, Jason T L Wang, 1 st Edition, 2017, CRC Press, USA.		
Reference Books			
1.	Microarray Bioinformatics, by DovStekel, 1 st Edition, 2003, Cambridge University Press, USA.		
2.	Data Analysis tools for DNA Microarray, by Draghic S, Chapman, 2 nd Edition, 2002, CRC Press, USA.		
3.	Biological Data Mining, by Jake Y Chen, Stefano Lonardi, 2 nd Edition, 2017, CRC Press, USA.		
4.	Bioinformatics for Omics Data, Methods and Protocols, by Bernd Mayer (Editor) 1 st Edition, 2011, Humana Press, USA.		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT406L	Computational Biology	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Recognize and articulate the concepts of engineering, computer science, and the life sciences. 2. Relate and connect mathematical theories with biological concepts. 3. Solve problems in emerging areas of genomics using computational approaches. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Explain mathematical concepts involved in biology. 2. Gain basic knowledge of modern molecular biology and genomics. 3. Develop an algorithm for analysis of biological sequences. 4. Apply molecular methods to study genetic variation within and between species. 5. Explain and evaluate different phylogenetic optimal criteria. 6. Choose systems biology tools that will help in reconstructing and redefining complex biological processes. 					
Module:1	Overview of Databases and Strings	6 hours			
Studying genomes, maps and sequences, specific techniques, the human genome project, sequence databases; Strings, Graphs, and Algorithms; Understanding the Basics of NGS - From Mechanism to Variant Calling					
Module:2	Sequence Comparison and Database Search Algorithms	6 hours			
Comparing two sequences, Global comparison the basic algorithm, Database search, PAM matrices, BLAST, FASTA, other issues, Similarity and distance, Parameter choice in sequence comparison, String matching and exact sequence comparison.					
Module:3	DNA Sequencing	7 hours			
The ideal case example, Complications, Pyrosequencing, Ion torrent, Reversible dye- terminator sequencing and Ion semiconductor sequencing, Nanopore sequencing, Shortest common superstring, Reconstruction, Multicontig, Algorithms, Representing overlaps, Paths originating.					
Module:4	Fragment Assembly of DNA	7 hours			
Superstrings, Shortest superstrings as paths, Heuristics, Finding overlaps, Ordering fragments, Alignment and Consensus, The Maximum Overlap Graph, Graph formulation of Shortest Common Superstrings.					
Module:5	Gene Expression Analysis and Transcript Discovery	7 hours			
Expression microarrays, Methods for Measuring Gene Expression, Clustering Algorithms, Classification Techniques - Bayesian, Support Vector Machines, Semi-supervised learning, Epigenomics - Epigenetic information, Epigenomic assays, Primary processing of ChIP data.					
Module:6	Biological Networks and Organism Remodeling	5 hours			
Introduction to biological networks, Interactions between networks, Representation, Centrality measures, Communities and modules, Regulatory networks – Introduction, Structural inference, Abstract mathematical representation, Structural properties, Synthetic biology.					
Module:7	Phylogeny – Construction and Validation	5 hours			
Character states and the perfect phylogeny problem, Binary character states, Two characters, Parsimony and compatibility in phylogenies, Algorithms for distance matrices,					

Reconstructing additive trees, Reconstructing ultrametric trees, Agreement between phylogenies, Validation of phylogeny trees.			
Module:8	Contemporary Issues		2 hours
		Total Lecture Hours:	45 hours
Text Books			
1.	Computational Biology: Genomes, Networks, Evolution, by Manolis Kellis. 2016, Massachusetts Institute of Technology LibreTexts Online Textbook, Cambridge, Massachusetts, USA.		
2.	Compact Handbook of Computational Biology, by Konopka A K, M James C Crabbe, 2019, CRC Press, Florida USA.		
Reference Books			
1.	Bioinformatics Algorithms - An Active Learning Approach, by Phillip Compeau, Pavel Pevzner, 2018, Active Learning Publishers, NY, USA.		
2.	Bioinformatics and Functional Genomics, by Jonathan Pevsner, 2015, 3 rd Edition, Wiley-Blackwell, West Sussex, UK		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT407L	Biomaterials	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Understand concepts and principles of biomaterials and develop strategies for their biomedical applications. 2. Evaluate how the implanted biomaterial influences the surrounding tissue. 3. Understand regulatory guidelines and international standards for biomaterial product development. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Define biomaterials and understand the basic concepts and terms related to biomaterials. 2. Classify types of biomaterials and identify their biomedical applications . 3. Identify key properties of biomaterials and apply various modifications strategies to manipulate these properties. 4. Determine the physiological consequences of biomaterial-tissue interaction and choose methods for <i>in vitro</i> and <i>in vivo</i> testing of biomaterials. 5. Examine biological events associated to biomaterials at cellular and molecular level. 6. Infer current biomaterials research towards biomaterial implant development and agree with regulatory guidelines to commercialize biomaterial products. 					
Module:1	Overview of Biomaterials	3 hours			
History of implants and biomaterials, Interdisciplinary nature of biomaterials science, Defining biomaterials and related terms, Biocompatibility, Biodegradability, Bioactivity, Generations of biomaterials, Biomaterial industry.					
Module:2	Types of Biomaterials	6 hours			
Classes of biomaterials - Metal, Ceramic, Polymer, and Composites; Physical, chemical and Biological properties; Classification of biomaterials based on host interactions - Bioinert, Biodegradable, Bioresorbable, and Bioactive biomaterials, Smart biomaterials - Biological, Chemical and Physical stimuli based.					
Module:3	Biopolymers and Biocomposites	6 hours			
Extra cellular matrix – Composition and Properties; Natural polymers – Collagen, Alginate, Cellulose and others; Peptides based materials, Natural fiber reinforced composite, Natural composites, Biomimetic composites.					
Module:4	Properties and Characterization of Biomaterials	7 hours			
Basic properties of biomaterials, Bulk properties, Mechanical properties, Surface properties and surface chemistry, Degradation properties of biomaterials, Surface modification of biomaterial to tailor the properties, Characterization of biomaterials, Mechanical, Electrochemical and surface properties.					
Module:5	Biological Properties of Biomaterials	7 hours			
Sterilization of biomaterials, Shelf life and aging effect, Biocompatibility test - ISO standards, <i>In vitro</i> and <i>in vivo</i> tests, Inflammatory and immunological response, Graft rejection, Host response to biomaterials.					
Module:6	Cell-Biomaterial Interactions	5 hours			
Protein adsorption on biomaterial surface, Cell adhesion and surface interactions, Quantifying cell response, Biomaterial associated tumorigenesis, Thrombosis and infection, Biomaterials as drug delivery systems.					
Module:7	Biomaterial Medical Implants	9 hours			
Different forms of biomaterial scaffold - Fibrous, 3-Dimensional, Hydrogel, Injectable,					

Cement; Conventional methods of biomaterial fabrication, Casting of metals, Processing of ceramics, Consolidation of polymers, Additive manufacturing methods of biomaterial fabrication, Orthopedic, Dental and cardiovascular implants, Regulatory aspects of biomaterial based products.			
Module:8	Contemporary Issues	2 hours	
		Total Lecture Hours:	45 hours
Text Book(s)			
1.	Biomaterials Science and Tissue Engineering: Principles and Methods, by Bikramjit Basu, 2017, Cambridge IISc Series, IISc Press, India.		
Reference Book			
1.	Biomaterials Science: An Introduction to Materials in Medicine, by William Wagner, Shelly Sakiyama-Elbert, Guigen Zhang, Michael Yaszemski, 4 th Edition, 2020, Academic Press, UK.		
Mode of Evaluation: CAT, Assignment, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT408L	Anatomy and Physiology	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Build basic understanding of the structure of human body and medical terminology. 2. Inculcate fundamental concepts of the functioning of organ systems of human body. 3. Demonstrate the physiological basis of disease and treatment. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Conceive basic medical terminologies, body functions, interact with clinicians. 2. Interpret and analyse the basis of clinical investigations using blood. 3. Outline the design principles of digestive and excretory systems. 4. Summarise the hormones regulation, functions of other systems and reproduction. 5. Describe the mechanics of respiratory and cardiovascular system in health and disease. 6. Identify, interpret and analyse the knowledge about the functions of brain and spinal cord. 					
Module:1	Fundamentals of Human Anatomy and Physiology	7 hours			
Introduction to human anatomy and physiology, Medical terminologies, Structure of cell, Primary tissues of body, Organs and systems; Structure and functions of bones and muscles; Anatomy of skeletal systems; Joints and their types; Physiology of homeostasis.					
Module:2	Blood	6 hours			
Composition and functions of blood, plasma proteins; Structure, functions and variations of red blood cells, Functions of white blood cells, Blood clotting and anticoagulants. Blood groups and Role of lymphocytes in immunity of the body.					
Module:3	Digestive and Excretory Systems	6 hours			
Organs of digestive systems - Composition, Functions, Regulation of salivary, Gastric, and Pancreatic secretion, Composition and functions of bile, Absorption of carbohydrates, proteins and lipids; Movements in digestive tract; Organs of urinary systems; Structure and functions of nephrons; Structure and functions of skin.					
Module:4	Endocrine Systems	6 hours			
Exocrine and endocrine organs; Chemical nature of hormones and receptors; Hormones of adenohypophysis, neurohypophysis and their functions; Thyroid hormones; Functions, Regulation and clinical conditions; Hormones of islets of Langerhans, Basis for the symptoms of diabetes mellitus, Blood glucose regulation; Hormones of adrenal cortex and medulla.					
Module:5	Reproductive Systems	4 hours			
Female reproductive organs and their functions; Sources and functions of estrogen, progesterone androgens; Male reproductive organs and their functions.					
Module:6	Respiratory System	6 hours			
Organs of respiratory system and their functions; Mechanics of inspiration and expiration; Lung volumes and capacities; Transport of oxygen and carbon dioxide in blood; Regulation of respiration; Hypoxia and dyspnoea; Artificial respiration.					
Module:7	Cardiovascular System & Nervous system	6 hours			
Structure of heart and blood vessels, Origin and spread of cardiac impulse, Electrocardiogram, Heart rate and blood pressure; Factors maintaining arterial blood pressure, Regulation of arterial blood pressure, Circulatory shock.					
Structure of nephron, Synaptic transmission, Neurotransmitter, Reflex action, Divisions of brain, Function of cerebrum, Basal ganglion, Thalamus, Hypothalamus, Cerebellum and medulla, Electroencephalogram.					
Module:8	Contemporary Issues	4 hours			

	Total Lecture hours	45 hours	
Text Book(s)			
1.	Textbook of Anatomy and Physiology for Health Care Professionals, by Indu Khurana and Arushi Khurana, 3 rd Edition, 2019, CBS Publishers & Distributors, India.		
Reference Books			
1.	Anatomy and Physiology in Health and Illness, by Waugh, Anne, Allison Grant, and Janet S. Ross. Ross and Wilson , 13 th Edition, 2018, Edinburgh: Churchill Livingstone, New York.		
2.	Principles of Anatomy & Physiology, by Gerard J. Tortora and Bryan Derrickson, 15 th Edition, 2017, John Wiley & Sons, New York.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT409L	Clinical Data Management			L	T	P	C
				3	0	0	3
Pre-requisite	NIL			Syllabus version			
				1.0			
Course Objectives							
<ol style="list-style-type: none"> 1. Introduce critical concepts and practical methods to support planning, collection, storage, and dissemination of data in clinical research. 2. Impart a strong working knowledge and skill set in data management principles and practice to increase productivity. 3. Apply the best practices for clinical data management. 							
Course Outcomes:							
<ol style="list-style-type: none"> 1. Understand best practices for designing clinical research data collection. 2. Explain the data processes that occur during the running of a study, including an overview of key data quality operations. 3. Summarise the conduct, management and analysis of studies across the spectrum of clinical Research. 4. Relate the statistical methods to analyse the clinical data. 5. Examine the role of data collection and manipulation in clinical research. 6. Apply the knowledge of clinical research in medical writing. 							
Module:1	Clinical Trials			6 hours			
Introduction to clinical trials, Brief history and need of clinical trials, Types of clinical trials, Type of analyses; intention-to-treat (ITT), Modified intention-to-treat analysis (mITT) and Per-protocol (PP).							
Module:2	Data Collection and Reporting			6 hours			
Types of clinical data, Clinical databases, Definition of data management and its benefits, Data manipulation recruitment of study participants, Strategies and sources, Monitoring, Problems, reasons for participation, Reducing dropout rates, Assessing and reporting adverse events, Data collection and quality control, Techniques to reduce variability, Data entry, Quality monitoring.							
Module:3	Clinical Research Site Management			6 hours			
Preparation of protocol, Audits and inspection of trial sites, Budgeting of clinical trials, Multicentric clinical Trials, Study management, Performance measures, Quality assurance and clinical data management plan, Data management standards in clinical research and monitoring database audits, Quality Assurance group, Clinical monitoring, Good clinical data management practices.							
Module:4	Inferential Statistics			6 hours			
Test of significance, Statistical hypotheses, Simple and composite, Statistical tests, Critical region, Type I and Type II errors, Power of a test interval estimation, Concepts of confidence interval and confidence coefficient, Testing of hypothesis, Definition of most powerful, Uniformly most powerful, Neyman pearson lemma, Monotone likelihood ratio property, Likelihood ratio test.							
Module:5	Medical Writing			6 hours			
Medical Writing, Tables, Figures, Copyright, Permissions, Citations, Publication practices and authorship, Scientific integrity, Misconduct in research, Ethics of authorship, Plagiarism and other forms of misconduct in research, In-text citation styles, Mendeley and other open access software to formalize citations, Medico-marketing writing, Standard operating procedures (SOP) - SOP writing for biotech industry and pharmaceutical industry, Pharmaceutical marketing, MedDRA.							
Module:6	Data Computing			6 hours			
Concepts of computing, Data and information, Data entry, Transcribing data, Clinical Data coding, Database creation, Logical checks, Importing and exporting files, Merging database, Data review, Data validation, Discrepancy management, Data privacy, Database quality control, Cleaning data, Missing list, Electronic data capture, CRF form design, Database design, Edit check and Edit check testing, Publishing and sharing data.							

Module:7	Software in Clinical Data Management	7 hours	
Introduction to clinical data management software like SPSS, STRATA, EpiData, Double data entry and validation, Exporting data to other analysis software, Data safety and security.			
Module:8	Contemporary Issues	2 hours	
		Total Lecture hours:	45 hours
Text Book(s)			
1.	Practical Guide to Clinical Data Management, by Susanne Prokscha, 3 rd Edition, 2016, CRC Press, Taylor & Francis, USA		
2.	Management of Data in Clinical Trials, by Mcfadden E, 2 nd Edition, 2015, Wiley, USA		
Reference Books			
1.	Clinical Data Management, by Richard K. Rondel, Sheila A. Varley, Colin F. Webb, 2 nd Edition, 2008, Wiley, USA		
Mode of Evaluation:		CAT, Quiz, Assignment, Case studies and FAT	
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT410L	Pharmacoinformatics	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT205L, BBIT205P, BBIT207L, BBIT207P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Outline the drug discovery and development process. 2. Understand emerging strategies and tools of computer-aided drug design. 3. Illustrate the principles of chemoinformatics in drug discovery. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Provide deeper understanding of drug discovery process. 2. Understand the workflow in structure based drug design. 3. Conceptualize different topics in chemistry and become active learners. 4. Understand the fundamental issues and challenges of machine learning. 5. Identify opportunities for healthcare informatics interventions. 6. Identify criteria's to fit one's own intellectual work in particular form of IPRs. 					
Module:1	Introduction to Drug Discovery	5 hours			
Drug discovery process, Target identification, Target validation, Hit identification and lead discovery, Lead optimization, Precise medicine, Clinical testing and beyond.					
Module:2	Data Types and Resources	6 hours			
Chemical compounds - SDF format, InChI and InChI key format, SMILES and SMART formats, Fingerprint format, Other descriptors, Similarity measures, Data resources – Toxicity related database, Drug safety database.					
Module:3	Target Identification and Validation	7 hours			
Target identification predictions, Gene prioritization methods, Machine learning and knowledge graphs in drug discovery, Data, Data mining and natural language processing for information extraction.					
Module:4	Hit Discovery	7 hours			
Chemical space, Screening methods, High-throughput screening, Computer aided drug discovery, Virtual screening, Candidate learning algorithms – Naïve Bayes, k-nearest neighbors, Support vector machine .					
Module:5	Lead Optimization	7 hours			
Lead optimization, Applications of machine learning in lead optimization, Assessing ADMET and biological activities properties, Matched molecular pairs.					
Module:6	Evaluating safety and Toxicity	6 hours			
<i>In silico</i> nonclinical drug safety, Machine learning approaches to toxicity prediction, k-nearest neighbors, Logistic regression, Pharmacovigilance and drug safety, Data sources, Disproportionality analysis.					
Module:7	Health Informatics	5 hours			
Health care information - Health care data quality, Health care information systems- History and evolution of health care information systems, Information technology - Technologies that support health care information systems.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					45 hours
Text Book					
1.	The Era of Artificial Intelligence, Machine Learning, and Data Science in the Pharmaceutical Industry, by Ashenden SK, 2021, Academic Press, An imprint of Elsevier, London, UK.				

Reference Books			
1.	Health care information systems: A practical approach for health care management, by Wager K A, Lee, F W, & Glaser J P, 4 th Edition, 2017, Jossey-Bass, A Wiley Brand, San Francisco, California, USA.		
Mode of Evaluation: CAT, Assignment/mini-project, Quiz, and FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT411L	Preclinical Drug Discovery and Development	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Explain the basics and applications of preclinical drug discovery and development. 2. Develop insights on drug discovery process for students from pharmacological and pathophysiological area. 3. Apply the principles of animal models to understand the mechanism of action of drugs. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Recall the knowledge on the sources of drugs and their screening processes. 2. Apply <i>in silico</i> molecular modelling and dynamics to study proteins and ligands. 3. Infer knowledge on laboratory animal models, animal handling and mode of drug administrations. 4. Develop sample collection protocols from laboratory animals and conduct various analyses. 5. Demonstrate the pharmacodynamics and pharmacokinetics in drug discovery process. 6. Design the drug toxicology studies using animal models. 					
Module:1	Drug Discovery and Development Process	4 hours			
Overview of drug discovery, Sources of drugs, Databases for drug discovery, Drug designing, Screening and lead molecule identification.					
Module:2	Ex Vivo Methods for Drug Development	4 hours			
Preclinical Research Tool Box, Molecular modelling and drug discovery, Molecular dynamics and simulation, Cheminformatics, Cell culture methods.					
Module:3	Laboratory Animals for Preclinical Testing	4 hours			
Animal models for biomedical research, Introduction to genetically modified animal models to study common human diseases viz. Cancers, Atherosclerosis, Diabetes, Alternate animal models - Zebra fish, Insects.					
Module:4	Drug Administration and Laboratory Animal Studies	6 hours			
Administration of drugs by peroral, intramuscular, intraperitoneal, subcutaneous routes in laboratory animals, Anaesthesia and analgesia in laboratory animals; Behavioural studies and assessment using rodents.					
Module:5	Sample Collection and Analysis	6 hours			
Blood collection from eye, Heart and tail veins; Harvest of organs / tissues for histology and histopathology analysis; Euthanasia, Statistical methods for preclinical analysis.					
Module:6	Pharmacodynamics and Pharmacokinetics	5 hours			
Pharmacodynamics - Agonists, Partial agonists and antagonists and pharmacodynamic analysis; Pharmacokinetics - Absorption, Distribution, Bioavailability and bioequivalence, Drug metabolism and excretion.					
Module:7	Toxicological Analysis	6 hours			
Dose formulation analysis - LD ₅₀ /ED ₅₀ , Safety pharmacology, Tissue distribution studies; Drug residue studies, Mutagenicity assays, Carcinogenicity studies, Repeated dose toxicity, Reproductive toxicity.					
Module:8	Contemporary Issues	2 hours			
		Total Lecture hours:		45 hours	
Text Book(s)					
1.	Preclinical Drug Development, by Mark Rogge, David R Taft, 2 nd Edition, 2017, CRC press, Taylor & Francis, USA.				
2.	Handbook on Laboratory Animals, by Desai PV, Saravanan P, 2 nd Edition, 2015, Jaypee Brothers Medical Publishers, India.				
Reference Books					

1.	Drug Discovery and Development, Technology in Transition, by Raymond G Hill, Duncan Richards, 3 rd Edition 2021, Elsevier, UK.		
2.	Hayes' Principles and Methods of Toxicology, by A Wallace Hayes, Claire L Kruger, 6 th Edition 2018, CRC Press, Taylor & Francis, USA.		
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT412L	Heat and Mass Transfer	L	T	P	C
		3	0	0	3
Pre-requisite	BBIT201L, BBIT201P	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Inculcate fundamental concepts of heat and mass transfer operations in bioprocess industries 2. Evaluate the heat and mass transfer coefficients of different unit operations used in bioprocess industries 3. Develop knowledge on design of heat and mass transfer equipment. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Apply principles of heat and mass transfer to predict transfer coefficients. 2. Design heat and mass transfer equipment. 3. Create simple material and energy balance analysis in the process engineering context. 4. Analyze and understand the basic modes of heat and mass transfer. 5. Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications. 					
Module:1	Overview of Heat Transfer	6 hours			
Modes of heat transfer, Fourier's law of heat conduction, Steady state conduction, Thermal conductivity, Compound resistances in series; Convection, Individual and overall heat transfer coefficients, Heat transfer by radiation.					
Module:2	Heat Exchangers	6 hours			
Parallel and counter flow heat exchangers, Shell and tube heat exchanger, Plate type heat exchanger, Design steps for shell and tube heat exchanger.					
Module:3	Evaporation	6 hours			
Types of evaporation, Single effect and multiple effect evaporation, Design calculations for single and multiple effect evaporation.					
Module:4	Diffusion and Mass Transfer	7 hours			
Molecular diffusion, Fick's law; Diffusion in Gases, liquids and solids; Mass transfer coefficients, Interphase mass transfer and Film theory.					
Module:5	Adsorption	6 hours			
Types of adsorption, Adsorbents and their applications, Single stage operations, Multistage cross-current and counter-current operations.					
Module:6	Drying	6 hours			
Heat and Mass transfer in dryers, Drying test; Rate of drying, Classification and selection of dryers, Drying time calculations.					
Module:7	Crystallization	6 hours			
Solubility, Mechanism of crystal formation, Method of supersaturation and yields, Classification of crystallizer, Material and energy balance calculations of crystallization process.					
Module:8	Contemporary Issues	2 hours			
Total Lecture hours:					
					45 hours
Text Book(s)					
1.	Unit Operations-II (Heat and Mass Transfer), by Gavhane, K A, 32 nd Edition, 2016, Nirali Publication, India.				

2.	Heat and Mass Transfer, by Rajput, R K, 7 th Edition, 2019, S Chand Publishing, India.		
Reference Books			
1.	Heat and Mass Transfer, by Nag P, 3 rd Edition, 2011, McGraw Hill Education, India.		
2.	Fundamentals of Heat & Mass Transfer, by Roy G K, 6 th Edition, 2017, Khanna Publishers, India		
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies		18-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

BBIT399J	Summer Industrial Internship	L	T	P	C
		0	0	0	1
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
1. The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns.					
Course Outcome:					
1. Demonstrate professional and ethical responsibility.					
2. Understand the impact of engineering solutions in a global, economic, environmental and societal context.					
3. Develop the ability to engage in research and to involve in life-long learning.					
4. Comprehend contemporary issues.					
Module Content					
Four weeks of work at industry site. Supervised by an expert at the industry.					
Mode of Evaluation: Internship Report, Presentation and Project Review					
Recommended by Board of Studies		09-03-2022			
Approved by Academic Council		No. 65	Date	17-03-2022	

BBIT497J	Project - I	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.					
Course Outcome:					
<ol style="list-style-type: none"> 1. Demonstrate professional and ethical responsibility. 2. Evaluate evidence to determine and implement best practice. 3. Mentor and support peers to achieve excellence in practice of the discipline. 4. Work in multi-disciplinary teams and provide solutions to problems that arise in multi-disciplinary work. 					
Module Content					
<p>Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.</p> <p>Can be individual work or a group project, with a maximum of 3 students.</p> <p>In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.</p> <p>Carried out inside or outside the university, in any relevant industry or research institution.</p> <p>Publications in the peer reviewed journals / International Conferences will be an added advantage.</p>					
Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews					
Recommended by Board of Studies		09-03-2022			
Approved by Academic Council		No. 65	Date	17-03-2022	

BBIT498J	Project – II / Internship	L	T	P	C
		0	0	0	5
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives:					
To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.					
Course Outcome:					
<ol style="list-style-type: none"> 1. Formulate specific problem statements for well-defined real life problems with reasonable assumptions and constraints. 2. Perform literature search and / or patent search in the area of interest. 3. Conduct experiments / Design and Analysis / solution iterations and document the results. 4. Perform error analysis / benchmarking / costing. 5. Synthesize the results and arrive at scientific conclusions / products / solution. 6. Document the results in the form of technical report / presentation. 					
Module Content					
<ol style="list-style-type: none"> 1. Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities. 2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations. 3. Can be individual work or a group project, with a maximum of 3 students. 4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project. 5. Carried out inside or outside the university, in any relevant industry or research institution. 6. Publications in the peer reviewed journals / International Conferences will be an added advantage. 					
Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews.					
Recommended by Board of Studies		09-03-2022			
Approved by Academic Council		No. 65	Date	17-03-2022	

BBIT101N	Introduction to Engineering			L	T	P	C
				0	0	0	1
Pre-requisite	Nil			Syllabus version			
				1.0			
Course Objective:							
<ul style="list-style-type: none"> • To make the student comfortable and get familiarized with the facilities available on campus • To make the student aware of the exciting opportunities and usefulness of engineering to society • To make the student understand the philosophy of engineering 							
Course Outcome:							
<ul style="list-style-type: none"> • To know the infrastructure facilities available on campus • To rationally utilize the facilities during their term for their professional growth • To appreciate the engineering principles, involve in life-long learning and take up engineering practice as a service to society 							
General Guidelines							
<ol style="list-style-type: none"> 1. Student should observe and involve in the activities during the induction programme. Both general activities and those which are discipline-specific should be included here. 2. Student should get familiarized with the infrastructure facilities available on campus during the general induction, school induction programme and also from the institutional website. 3. Student should attend the lecture by industries, including those on career opportunities, organized by the School and probably involve in 'Do-it-yourself' projects or projects involving reverse-engineering. 4. Activities under 'Do-it-Yourself' will be detailed by the School. 5. Student should prepare a report on the activities and observations, as per the specified format, and submit the same in institutional LMS, VTOP for further evaluation <p>General instruction on formatting: Document to be prepared with the titles given in the template; Arial type with font size of 12 to be used; photographs can be included in the document as per the requirement; 1.5 line spacing to be used.</p>							
Mode of Evaluation: Evaluation of the submitted report and interaction with the students							
Recommended by Board of Studies				02.07.2021			
Approved by Academic Council				No. 63	Date	23.09.2021	

BHUM101N		Ethics and Values		L	T	P	C
				0	0	0	2
Pre-requisite	Nil	Syllabus version					
		1.0					
Course Objectives:							
<ol style="list-style-type: none"> To understand and appreciate the ethical issues faced by an individual in profession, society and polity. To understand the negative health impacts of certain unhealthy behavior. To appreciate the need and importance of physical, emotional health and social health. 							
Expected Course Outcomes:							
<ol style="list-style-type: none"> Students will be able to: Follow sound morals and ethical values scrupulously to prove as good citizens. Understand various social problems and learn to act ethically. Understand the concept of addiction and how it will affect the physical and mental health. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects. Identify the main typologies, characteristics, activities, actors and forms of cybercrime. 							
Module:1		Being Good and Responsible					
Gandhian values such as truth and non-violence – Comparative analysis on leaders of past and present – Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society.							
Module:2		Social Issues 1					
Harassment – Types - Prevention of harassment, Violence and Terrorism.							
Module:3		Social Issues 2					
Corruption: Ethical values, causes, impact, laws, prevention – Electoral malpractices; White collar crimes - Tax evasions – Unfair trade practices.							
Module:4		Addiction and Health					
Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides; Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases.							
Module:5		Drug Abuse					
Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention.							
Module:6		Personal and Professional Ethics					
Dishonesty - Stealing - Malpractices in Examinations – Plagiarism.							
Module:7		Abuse of Technologies					
Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networking websites.							
Total Lecture Hours:						60 hours	
Text Books :							
1.	R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2019, 2nd Revised Edition, Excel Books, New Delhi.						
2.	Hartmann, N., "Moral Values", 2017, United Kingdom: Taylor & Francis.						
Reference Books :							
1.	Rachels, James & Stuart Rachels, "The Elements of Moral Philosophy", 9th edition, 2019, New York: McGraw-Hill Education.						

2.	Blackburn, S. "Ethics: A Very Short Introduction", 2001, Oxford University Press.
3.	Dhaliwal, K.K , "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts", 2016, Writers Choice, New Delhi, India.
4	Ministry of Social Justice and Empowerment, "Magnitude of Substance Use in India", 2019, Government of India.
5.	Ministry of Home Affairs, "Accidental Deaths and Suicides in India", 2019, Government of India.
6.	Ministry of Home Affairs, "A Handbook for Adolescents/ Students on Cyber Safety", 2018, Government of India.
Mode of Evaluation: Poster making, Quiz and Term End - Quiz	
Recommended by Board of Studies	27-10-2021
Approved by Academic Council	No. 64 Date 16-12-2021