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

(2024-2025 admitted students)

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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, forimprovement 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 & universitiesfor 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 anddisseminate 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 biotechnologyand bio-sciences.
- To instill a spirit of innovation and creativity in young minds from across the globe with soundresearch aptitude.
- To foster ethically strong biologists who effectively contribute towards the growth of the nation.

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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

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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

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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

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CREDIT INFO		
S.no	**Catagory**	**Credits**
1	Foundation Core	52
2	Discipline-linked Engineering Sciences	11
3	Discipline Core	49
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 - 2021onwards	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

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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	BBIT209L	Molecular Biology	Theory Only	1.0	3	0	0	0	3.0
10	BBIT209P	Molecular Biology Lab	Lab Only	1.0	0	0	4	0	2.0
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	2.0

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

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Open Elective									
sl.no	Course Code	Course Title	Course Type	Version	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

39	CFOC105M	Emotional Intelligence	Online Course	1.0	0	0	0	0	2.0

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

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

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-monohybrid cross and dihybrid 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**

Text Book(s)	
1.	Biological Science. By Scott Freeman, Kim Quillin, Lizabeth Allison, Michael Black, Emily Taylor, 6th edition 2017, Prentice Hall, NJ, USA.
2.	Biology for Engineers, by G. K. Suraishkumar, 1st 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 14th, 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

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 :

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:6	**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.	AngÃ¨le 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, 4th edition – *Open access version*	
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

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_2O 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, 2nd Edition, Packt Publishing Limited, 2021.			
Reference Books				
1.	Harsh Bhasin, Python for beginners, 1st 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:

1. To introduce the core language features of Java and understand the fundamentals of Object -Oriented programming in Java.
2. 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:

1. Understand basic programming constructs; realize the fundamentals of Object Orientated Programming in Java; apply inheritance and interface concepts for enhancing code reusability.
2. 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-11th Edition, Pearson publisher, 2017.

Reference Books

1.	Herbert Schildt , The Complete Reference -Java, Tata McGraw-Hill publisher, 10th Edition, 2017.
2	Cay Horstmann,"Big Java", 4th edition, John Wiley & Sons publisher, 5th edition, 2015
3	E.Balagurusamy, "Programming with Java", Tata McGraw-Hill publishers, 6th edition, 2019

Course Code	Course Title	L	T	P	C
BEEE102L	Basic Electrical and Electronics Engineering	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Familiarize with various laws and theorems to solve electric and electronic circuits
2. Provide an overview on working principle of machines
3. Excel the concepts of semiconductor devices, op-amps and digital circuits

Course Outcomes

On completion of the course, the students will be able to:

1. Evaluate DC and AC circuit parameters using various laws and theorems
2. Comprehend the parameters of magnetic circuits
3. Classify and compare various types of electrical machines and its applications
4. Design basic combinational circuits in digital system
5. Analyze the characteristics and applications of semiconductor devices

Module:1	**DC Circuits**	**7 hours**
Basic circuit elements and sources; Ohms law; Kirchhoff's laws; Series and Parallel connection of circuit elements; Star-delta transformation; Mesh current analysis; Node voltage analysis; Theorems: Thevenin's, Maximum power transfer and Superposition theorem.		
Module:2	**AC Circuits**	**8 hours**
Alternating voltages and currents, RMS, average, maximum values, Single Phase RL, RC, RLC series circuits, Power in AC circuits, Power Factor, Three phase balanced systems, Star and delta Connections, Electrical Safety, Fuses and Earthing.		
Module:3	**Magnetic Circuits**	**7 hours**
Magnetic field; Toroidal core: Flux density, Flux linkage; Magnetic circuit with airgap; Reluctance in series and parallel circuits; Self and mutual inductance; Transformer: turn ratio determination.		
Module:4	**Electrical Machines**	**7 hours**
Construction, working principle and applications of DC Machines, Transformers, Three phase Induction motors, synchronous generators, single phase induction motors, special machines stepper motor, universal motor and BLDC motor.		
Module:5	**Digital Systems**	**7 hours**
Binary arithmetic; Number base conversion; Boolean algebra: simplification of Boolean functions using K-maps; Logic gates; Design of basic combinational circuits: adders, multiplexers, de-multiplexers.		
Module:6	**Semiconductor Devices and Applications**	**7 hours**
Characteristics: PN junction diode, Zener diode, BJT, MOSFET; Applications: Rectifier, Voltage regulator, Operational amplifier.		
Module:7	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1	Allan R. Hambley, "Electrical Engineering -Principles & Applications", 2019, 6th Edition, Pearson Education
2	V. D. Toro, Electrical Engineering Fundamentals, 2nd edition. PHI, 2014

Reference Books

1	R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11th edition.

	Pearson, 2012			
2	DP Kothari & Nagrath, “Basic Electric Engineering”, 2019, Tata McGraw Hill			
Recommended by Board of Studies		28-05-2022		
Approved by Academic Council		No. 67	Date	08-08-2022

Course code	Course Title	L	T	P	C
BEEE102P	**Basic Electrical and Electronics Engineering Lab**	**0**	**0**	**2**	**1**
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objective

1. Design and solve the fundamental electrical and electronics circuits

Course Outcomes

1. Identify appropriate method of solving the fundamental electrical and electronics circuits
2. Design and conduct experiments on electrical and electronics circuits

Experiments (Indicative)	
1	Verification of Kirchoff's law
2	Verification of Maximum Power Transfer Theorem
3	Staircase wiring circuit layout for multi storage building
4	Lamp dimmer circuit (Darlington pair circuit using transistors) used in cars.
5	Measurement of Earth resistance using Megger
6	Sinusoidal steady state response of RLC circuits
7	Three phase power measurement for ac loads
8	Design of half-adder and full-adder digital circuits
9	Synthesis of 8x1 multiplexer and 1x8 de-multiplexers
10	Characteristics of PN diode and acts as switch
11	Realization of single-phase rectifier
12	Design of regulated power supply using Zener diode.
13	Characteristics of MOSFET
14	Characteristics of BJT
15	Measurement of energy using single-phase energy meter
16	Measurement of power in a 1-phase circuit by using CTs and PTs
Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment, FAT			
Recommended by Board of Studies	28-05-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

BENG101L	Technical English Communication	L	T	P	C
		2	0	0	2
Pre-requisite	NIL	**Syllabus version**			
		1.0			

Course Objectives:

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:

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). *Technical Communication: Principles and Practice*, (3rd Edition). India: Oxford University Press.

Reference Books

1. Taylor, Shirley & Chandra .V. (2010). *Communication for Business A Practical Approach* 4th Edition. India: Pearson Longman.
2. Kumar, Sanjay & Pushpalatha. (2018). *English Language and Communication Skills for Engineers.* India: Oxford University Press.
3. Koneru Aruna. (2020). *English Language Skills for Engineers.* India: McGraw Hill Education.
4. Rizvi, M. Ashraf. (2018). *Effective Technical Communication* 2nd Edition. Chennai: McGraw Hill Education.
5. Mishra, Sunitha & Muralikrishna,C. (2014). *Communication Skills for Engineers*. India: Pearson Education.

6.	Watkins, P. (2018). *Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers*. 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

BENG101P	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 - lnfographics **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 - AbstracUSummary- Introduction - Materials andMethods- 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/Presentaions/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 + 2hours**
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: **Total Tutorial hours :**	**45 hours** **15 hours**
Text Book(s)		
1. Engineering Mathematics, K. A. Stroud and Dexter J. Booth, 7th 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, 6th Edition, Tata McGraw -Hill (2017). 3. S. Lipschutz and J. Schiller Introduction to Probability and Statistics, , 3rd 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

1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.
2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.
3. Enhance to use technology to model the physical situations into mathematical problems, experiment, interpret results, and verify conclusions.

Course Outcomes

At the end of the course the student should be able to:
1. Apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions
2. Evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints
3. Evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.
4. Use special functions to evaluate various types of integrals.
5. Understand gradient, directional derivatives, divergence, curl, Green's, Stokes and Gauss Divergence theorems.

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	
		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 :

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:

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, 9th Edition, Pearson Education.

Reference Books

1. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, 2016, 6th Edition, John Wiley & Sons.
2. E. Balagurusamy, Reliability Engineering, 2017, Tata McGraw Hill, Tenth reprint.
3. J. L. Devore, Probability and Statistics, 2012, 8th 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, 3rd 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:

1. To enable the students for having experimental knowledge of basic concepts of statistics using R programming.
2. To study the relationship of real-time data and decision making through testing methods using R.
3. 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:

1. Demonstrate R programming for statistical data.
2. 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:

1. The Book of R: A First course in Programming and Statistics, by Tilman M Davies, William Pollock, 2016.
2. R for Data Science, by Hadley Wickham and Garrett Grolemund, 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

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

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)			
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			
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 Counc	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

1. To explain the dual nature of radiation and matter.
2. To apply Schrödinger's equation to solve finite and infinite potential problems and apply quantum ideas at the nanoscale.
3. 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

1. Comprehend the phenomenon of waves and electromagnetic waves.
2. Understand the principles of quantum mechanics.
3. Apply quantum mechanical ideas to subatomic domain.
4. Appreciate the fundamental principles of a laser and its types.
5. 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 CO2 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, 15th Edition, Pearson, USA.
2.	D. K. Mynbaev and Lowell L. Scheiner, Fiber Optic Communication Technology, 2011, 1st Edition, Pearson, USA
Reference Books	
1.	H. J. Pain, The Physics of vibrations and waves, 2013, 6th Edition, Wiley Publications, India.
2.	R. A. Serway, J. W. Jewett, Jr, Physics for Scientists and Engineers with Modern Physics, 2019, 10th Edition, Cengage Learning, USA.
3.	K. Krane, Modern Physics, 2020, 4th Edition, Wiley Edition, India.
4.	M.N.O. Sadiku, Principles of Electromagnetics, 2015, 6th Edition, Oxford University Press, India.
5.	W. Silfvast, Laser Fundamentals, 2012, 2nd 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:

1. To enhance the logical reasoning skills of the students and help them improve problem-solving abilities
2. To acquire skills required to solve quantitative aptitude problems
3. To boost the verbal ability of the students for academic and professional purposes

Course Outcomes:

1. Exhibit sound knowledge to solve problems of Quantitative Aptitude
2. Demonstrate ability to solve problems of Logical Reasoning
3. 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
Cryptarithmetic

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**

- 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). *Place Mentor* 1st (Ed.). Chennai: Oxford University Press.
2. Aggarwal R.S. (2017). *Quantitative Aptitude for Competitive Examinations* 3rd (Ed.). New Delhi: S. Chand Publishing.

3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.		
4.	ETHNUS. (2016). *Aptimithra,*1st (Ed.) Bangalore: McGraw-Hill Education Pvt. Ltd.		
Reference Books			
1.	Sharma Arun. (2016). *Quantitative Aptitude*, 7th(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:

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:

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:

- 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

- 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). *Place Mentor* 1st (Ed.). Chennai: Oxford University Press.
2.	Aggarwal R.S. (2017). *Quantitative Aptitude for Competitive Examinations* 3rd (Ed.). New Delhi: S. Chand Publishing.
3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.
4.	ETHNUS. (2016). *Aptimithra,*1st (Ed.) Bangalore: McGraw-Hill Education Pvt.Ltd.

Reference Books

1.	Sharma Arun. (2016). *Quantitative Aptitude*, 7th(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

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

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, 2nd Edition, 2016, PHI Learning, New Delhi, India.	
2.	Fluid Mechanics and Hydraulic Machines by Bansal R K, 10th Edition, 2018, Laxmi Publications, India.	
Reference Books		
1.	Bioprocess Engineering Principles by Pauline M Doran, 2nd Edition, 2012, Academic Press, USA.	
2.	Unit Operations of Chemical Engineering by Warren McCabe, Julian Smith. 7th Edition, 2017, McGraw Hill Education, UK.	
3.	Basic Principles and Calculations in Chemical Engineering by Himmelblau, D H, 8th Edition, 2015, Pearson Education, India.	
4	Stoichiometry by Bhatt B I and Thakore S B, 5th 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

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

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 *in silico.*
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, 5th 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, 2nd 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 *in silico* 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, 5th Edition, 2019, Oxford University Press, UK.
2. Bioinformatics: Concepts, Skills and Applications, by Rastogi S C, Namita Mendiratta, Parag Rastogi, 2nd 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

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

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 kla, 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, 3rd Edition, 2017, Prentice Hall International Series. USA.
2	Principles of Fermentation Technology, by Stanbury P, Whitaker A. & Hall, SJ. 3rd

	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

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

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, 8th Edition, 2019, W.H. Freeman & Co Ltd., USA.

Reference Books

1. Biochemistry, by U Satyanarayan and U Chakrapani, 6th 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, 2nd 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

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

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**
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, 4th 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, 9th Edition, 2019, McGraw Hill, Newyork. USA.
2.	Microbiology: Principles and Explorations, Jacquelyn G Black and Laura J Black, 10th 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, 12th 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

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, it's deviations and role of population genetics.

Course Outcomes

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+, Ca2+ - 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, IP3, DAG and Ca2+ 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 *Drosophila melanogaster* 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, 8th Edition. 2019, Oxford University Press, New York.	
2.	Genetics, by Monroe W. Strickberger, 3rd 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

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

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**	

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, 8th 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, 1st 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

BBIT209L	Molecular Biology	L	T	P	C
		3	0	0	3
Pre-requisite	**BBIT202L, BBIT202P, BBIT204L, BBIT204P**	**Syllabus version**			
		1.0			

Course Objectives

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

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 andRibosomes; 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; Reversetranscription – 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, 2nd Edition, Reprint 2020, Narosa Publishers,New Delhi, India.	
2.	Lehninger Principles of Biochemistry, by David L Nelson and Michael M Cox, 8th 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, 9th Edition, 2020, WH Freeman Publisher, New York, USA.	
2.	Molecular Biology, by Michael M Cox, Jennifer Doudna and Michael O'Donnell, 2nd Edition, 2015, WH Freeman publisher, USA.	
3.	Molecular Biology of the Cell, by Bruce Alberts, Alexander Johnson, Julian Lewis, MartinRaff, Keith Roberts and Peter Walter,7th 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

BBIT209P	Molecular Biology Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**BBIT202L, BBIT202P, BBIT204L, BBIT204P**	**Syllabus version**			
		1.0			

Course Objectivess

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, 4th 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

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

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 *E. coli* 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 *E coli* cells, transfection *in-vitro* 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, *in situ* 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, 8th Edition, 2020, Wiley-Blackwell, UK,

Reference Books

1.	Principles of Gene Manipulation and Genomics, Primrose S B and Twyman R M, 8th 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,4th 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

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

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, Blobal 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**

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, 2nd Edition, 2017, Oxford University press, United Kingdom.	
Reference Books		
1.	Discovering genomics, proteomics and bioinformatics, by Malcolm Campbell A and Laurie J Heyer, Ist Edition 2002, Cold Spring Harbor Laboratory Press, United States.	
2.	Principles of genome analysis and genomics, by SB Primrose and RM Twyman, 3rd Edition, 2003, Blackwell publishing, USA.	
3.	Introduction to proteomics: Tools for the new biology, by Daniel C Liebler, Ist 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

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

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, 3rd 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

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

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, 10th 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, 13th Edition, 2016, Wiley Blackwell, USA.
2.	Immunology, by Judy Owen, Jenni Punt, Sharon Stranford, Patricia Jones Kuby, 8th 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, 8th 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

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

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 (*Agrobacterium*, hairy root and *in planta* 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 (*Cry* 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, 2nd 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, 1st 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, 1st 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

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

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, 3rd Edition, 2016, Butterworth- Heinemann, USA.		
2.	Biotechnology, by Satyanarayana U, 1st Edition, 2020, Books & Allied Pvt, Ltd, India.		
Reference Books			
1.	A Textbook of Industrial Microbiology, by Cruger Wulf and Anneliese Crueger, 3rd Edition, 2017, Medtech, India.		
2.	Bioprocess Engineering, by Michael Shuler, Fikret Kargi, Matthew DeLisa, 3rd 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

BBIT328L	Downstream Processing	L	T	P	C
		3	0	0	3
Pre-requisite	**BBIT201L, BBIT201P**	**Syllabus version**			
		1.0			

Course Objectives

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

1. Appraise the fundamentals and understand the market demand of bio products andbio separation.
2. Choose appropriate unit operations for the separation of insoluble from fermentationbroth.
3. Examine traditional, modern and emerging technologies to apply mass transferoperation 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 abead 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 ofseparation.		
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, andPetrides DI, 2nd 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

BBIT328P	Downstream Processing Lab	L	T	P	C
		0	0	4	2
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 usingsalt	
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 twophase	
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, 1st 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

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

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 Géron, 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	
		3	0	0	
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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:

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

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

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, Dentrimers.

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, 26th Edition, 2020, Elsevier, New Delhi.
2. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, by Allen V Loyd, Howard C Ansel, 11th 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, 13th 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

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

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, 12th 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

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

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, 1st Edition, 2020, Routledge, USA.		
Reference Book(s)			
1.	Stem Cells: A Short Course, by Burgess R. 1st 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

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

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**
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

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

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, Hydrazide 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, 1st 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, 1st Edition 2015, A John Wiley & Sons, INC., Publication, UK.
2.	Bioconjugate Techniques, by Greg Hermanson, 3rd 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

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

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,1st Edition, 2017, Cambridge University Press, Cambridge, United Kingdom.
Reference Book	
1.	Principles of Tissue Engineering, by Robert Lanza, Anthony Atala Joseph Vacanti, Robert Langer, 5th 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

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

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 Splatter-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,12th 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, 6th 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

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

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, 4th Edition, 2017, Woodhead publishing limited, USA.		
2.	Fundamentals of Food Process Engineering, by Romeo T Toledo, 3rd 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, 5th Edition, 2018, Academic Press, London.		
3	Food Process Engineering and Technology, by Zeki Berk, 3rd Edition, 2018, Academic Press, Elsevier, ISBN: 9780128120187 eBook		
4	Advances in Agri-Food Biotechnology, by Tilak Raj Sharma, Rupesh Deshmukh, Humira Soanah, 1st 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

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

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, lgG, lgA, lgM and lgE 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), 10th 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, 6th Edition, 2018, Elsevier Health Science, USA.
2.	Clinical Diagnosis and Management by Laboratory Methods, by Richard A. McPherson, Matthew R. Pincus, Henry's 2017. 23rd 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

1. Analyse the various dimensions of food biotechnology.
2. Integrate the biotechnological principles applied to food production.
3. Apply the modern food biotechnological aspects involved in processing of food.

Course Outcomes

1. Illustrate the concepts of biotechnology to the science of food.
2. Appraise the sources and substitutes of foods.
3. Identify the role of biotechnology in primary food produce.
4. Combine the knowledge about adulterants, allergens with the production of food.
5. Interpret the principles of novel food biotechnology aspects related to process of food.
6. 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., 2nd Edition, 2021, Wiley- Blackwell Publishers, USA.
2.	Food Biotechnology, by Foster G.N, 5th 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, 1st Edition 2020, Springer Nature, Singapore.
2.	Advances in Biotechnology for Food Industry, Hand Book of Food Engineering, by Alina Mariaholban, Alexandrumihai Grumezescu, 5th Edition, 2018, Academic Press, London.
3	Fundamentals of Food Process Engineering, by Romeo T. Toledo, 3rd 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

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

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, 2nd Edition, 2014, Blackwell Ltd, USA
Reference Books	
1.	The Molecular Basis of Cancer by Mendelsohn, Howley, Israel, Gray, Thompson, 2015, 4th Edition, Elsevier Inc., USA
2	Cancer Biology by Roger J.B. King, Mike W. Robins, 3rd 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

1. Understand and anlyse 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

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 *de novo* 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:

1. To gain an understanding of real-life issues faced by society.
2. To study appropriate technologies in order to find a solution to real life issues.
3. Students will design system components intended to solve a real-life issue.

Course Outcome:

1. Identify real life issue(s) faced by society.
2. Apply appropriate technologies to suggest a solution to the identified issue(s).
3. Design the related system components/processes intended to provide a solution to the identified issue(s).

Module Content

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.

Subsequently the student should design the related system components or processes which is intended to provide the solution to the identified real-life issues.

General Guidelines:

1. Identification of real-life problems
2. Field visits can be arranged by the faculty concerned
3. Maximum of 3 students can form a team (within the same/different discipline)
4. Minimum of eight hours on self-managed team activity
5. Appropriate scientific methodologies to be utilized to solve the identified issue
6. Solution should be in the form of fabrication/coding/modelling/product design/process design/relevant scientific methodology(ies)
7. Consolidated report to be submitted for assessment
8. 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
9. Project outcome to be evaluated in terms of technical, economical, social, environmental, political and demographic feasibility
10. 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:

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:

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:

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:

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

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.

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 1st Edition, 2017, Springer Nature, Singapore.		
Reference Books			
1.	Peptide and Protein Engineering: From Concepts to Biotechnological Applications, by Olga I and Roque A C, 1st Edition, 2020, Springer-Verlac New York Inc. USA.		
2.	Proteins: Biochemistry and Biotechnology, by Walsh, G, 2nd 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:

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:

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:

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:

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:

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:

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:

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:

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:

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:

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

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

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, *De novo* 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, 1st 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, 2nd 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, 1st Edition, 2020, Academic Press Inc, USA.
3.	The Organic Chemistry of Drug Design and Drug Action By Richard B. Silverman, Mark W. Holladay, 3rd 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

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

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, 2nd Edition, 2018, Wolters Kluwer, China.
2. Principles of Neural Science, by Eric R. Kandel, John D. Koester, Sarah H. Mack, Steven A. Siegelbaum, 6th Edition, 2021, McGraw Hill, USA.

Reference Books

1. Neuroscience – Exploring the Brain, by Mark F Bear, Barry W Connors, Michael A Paradiso, 4th 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, 6th

	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

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

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**

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, 1st 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, 1st Edition, 2020, Academic Press, United States.
2.	Microbial Fermentation and Enzyme Technology, by Hrudayanath Thatoi, Pradeep K Das Mohapatra, Sonali Mohapatra, Keshab C Mondal, 1st Edition, 2020, CRC Press. Boca Raton.
3.	Industrial enzyme application, by Andreas Vogel and Oliver May, 1st 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

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

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 diptheriae, 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, 11th Edition, 2020, University Press (India) Pvt. Ltd., India.
2	Textbook of Medical Parasitology, by Paniker, 9th 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, 28th 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

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

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**

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.

Module:2	**Data Preprocessing**	**6 hours**

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.

Module:3	**NGS Data Analysis**	**6 hours**

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 Omes; 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.

Module:4	***De novo* Assembly**	**6 hours**

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.

Module:5	**Big Data and R Language in NGS Analysis**	**6 hours**

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).

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, 1st Edition, 2017, CRC Press, USA.
Reference Books	
1.	Microarray Bioinformatics, by DovStekel, Ist Edition, 2003, Cambridge University Press, USA.
2.	Data Analysis tools for DNA Microarray, by Draghic S, Chapman, 2nd Edition, 2002, CRC Press, USA.
3.	Biological Data Mining, by Jake Y Chen, Stefano Lonardi, 2nd Edition, 2017, CRC Press, USA.
4.	Bioinformatics for Omics Data, Methods and Protocols, by Bernd Mayer (Editor) Ist 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

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

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 Aslgorithms**	**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 Lerning Approach, by Phillip Compeau, Pavel Pevzner, 2018, Active Learning Publishers, NY, USA.	
2.	Bioinformatics and Functional Genomics, by Jonathan Pevsner, 2015, 3rd 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

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

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 *in vitro* and *in vivo* 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, *In vitro* and *in vivo* 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, 4th 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

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

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, 3rd 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 , 13th Edition, 2018, Edinburgh: Churchill Livingstone, New York.		
2.	Principles of Anatomy & Physiology, by Gerard J. Tortora and Bryan Derrickson, 15th 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

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:

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, 3rd Edition, 2016, CRC Press, Taylor & Francis, USA	
2.	Management of Data in Clinical Trials, by Mcfadden E, 2nd Edition, 2015, Wiley, USA	
Reference Books		
1.	Clinical Data Management, by Richard K. Rondel, Sheila A. Varley, Colin F. Webb, 2nd 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

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

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**
In silico 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, 4th 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

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

1. Recall the knowledge on the sources of drugs and their screening processes.
2. Apply *in silico* 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, 2nd Edition, 2017, CRC press, Taylor & Francis, USA.
2. Handbook on Laboratory Animals, by Desai PV, Saravanan P, 2nd Edition, 2015, Jaypee Brothers Medical Publishers, India.

Reference Books

1.	Drug Discovery and Development, Technology in Transition, by Raymond G Hill, Duncan Richards, 3rd Edition 2021, Elsevier, UK.		
2.	Hayes' Principles and Methods of Toxicology, by A Wallace Hayes, Claire L Kruger, 6th 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

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

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, 32nd Edition, 2016, Nirali Publication, India.

2.	Heat and Mass Transfer, by Rajput, R K, 7th Edition, 2019, S Chand Publishing, India.		
Reference Books			
1.	Heat and Mass Transfer, by Nag P, 3rd Edition, 2011, McGraw Hill Education, India.		
2.	Fundamentals of Heat & Mass Transfer, by Roy G K, 6th 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:

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

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.

Can be individual work or a group project, with a maximum of 3 students.

In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.

Carried out inside or outside the university, in any relevant industry or research institution. 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

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:

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

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:

- 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:

- 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

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

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.

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:

1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity.
2. To understand the negative health impacts of certain unhealthy behavior.
3. To appreciate the need and importance of physical, emotional health and social health.

Expected Course Outcomes:

1. Students will be able to:
2. Follow sound morals and ethical values scrupulously to prove as good citizens.
3. Understand various social problems and learn to act ethically.
4. Understand the concept of addiction and how it will affect the physical and mental health.
5. 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.
6. 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

BBIT413P	Applied Biology Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objective

1. Understand and gain practical training on biological concepts and basic applications.

Course Outcomes

1. Classify various living organisms based on structure and function.
2. Apply the knowledge to plan and conduct simple biological experiments.

Indicative Experiments

1.	Study and differentiate the diversity of cells using permanent slides (morphology of bacteria, fungi and algae) and understanding of cellular length scales in biology.
2.	Permanent histological slides for localization of important biomolecules or organelles eg. epithelial and endothelial cells.
3.	Identification of bacteria by Gram's staining and DNA sequencing of 16S rRNA (virtual lab)
4.	Qualitative and quantitative assays in biology, eg. Estimation of proteins.
5.	Examining Cyanobacteria and comparison with bacteria and plant cell (permanent slides)
6.	Responses of single-celled organisms to environmental stimuli
7.	Demonstration of diffusion and osmosis in biological systems
8.	Rate of photosynthesis in plants
9.	Bioelectricity experiment
10.	Use of lateral flow strip for detection of glucose
11.	Human genetic variation study in facial feature in the class group
	Total Laboratory hours: **30 hours**

Mode of assessment: Continuous assessment, FAT and Oral examination

Text Books:

1. Exploring Biology in the Laboratory, b yMurray P Pendarvis, John L Crawley, 3rd Edition, 2018, Morton Publishing, Colorado, USA.
2. Biology Laboratory Manual, by Darrell Vodopich and Randy Moore, 11th Edition, 2017, McGrawHill Education, New York, USA.

Reference Books:

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, edited by Andreas Hofmann and Samuel Clokie, 8th Edition, 2018, Cambridge University Press, Cambridge, UK.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BBIT414L	Bioinspired Design	L	T	P	C
		3	0	0	3
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives:

1. Relate the complexities and various aspects of the real-world engineering problems.
2. Realize the biological world has answers to most of the engineering and industrial problems.
3. Explain that bioinspired solutions are simple, sustainable and environmentally friendly.

Course Outcome:

1. Recall and define various bioinspired technologies.
2. Interpret and explain bioinspired design approaches being used in energy and mobility industries.
3. Select and apply various biomimetic lighting and coloring mechanisms.
4. Categorize and analyze various biomimetic solutions for environment friendly constructions and buildings.
5. Explain the importance of bioinspired design for development of smart materials.
6. Adapt and combine bioinspired designs and heuristics to create cutting edge intelligent technologies.

Module:1	**Overview**	**5 hours**
Overview of biomimetics, Definitions, Scope and approach; Bird inspired aircrafts and Velcro.		
Module:2	**Transport, Motion, and Energy**	**7 hours**
Birds and bullet trains, Owl-inspired noise reduction, Humpback whales and wind turbines, Fluid movement in nature; The importance of spirals, Tree-inspired wind turbine, Boxfish inspired bionic car, Fuel efficiency inspired by sharks, The new generation of ornithopters.		
Module:3	**Colour and Light**	**7 hours**
Photonic biomimicry, Structure and light output, Cephalopods and camouflage, Photonic cooling, Biomimetic antireflective coatings, Novel glass inspired by spiders, Other relevant inventions.		
Module:4	**The Built Environment**	**7 hours**
Cooling buildings the termite, Functional structures inspired by nature, Self-cleaning surfaces, Self-healing concrete, New building materials, Sunshades modelled on trees, Solar ivy, Fully Responsive buildings.		
Module:5	**Bioinspired Smart Materials**	**7 hours**
Self-cleaning materials, Antifouling surfaces, SLIPS inspired from pitcher plants, Novel adhesives- Glue from clam shells, terrestrial slugs, byssal threads, Gecko-inspired dry adhesion, Self-healing materials, Smart textiles-environment responsive, Polar bear inspired heat insulation textile, Woodpeckers inspired safety helmets.		
Module:6	**Bioinspired Smart Devices**	**7 hours**
Burrowing Robots Based on Razor Clams, Novel sensors - Bioinspired underwater pressure sensors, Crack-based strain sensors, Ice plants and Actuators; Passive water collection-inspiration from the Namib desert beetle, Collecting water with spiders' webs, Cactus-inspired water collection; Insects and origami; Mosquito bites and injection needles; Butterfly drones; Swarm of drones.		
Module:7	**Bioinspired Algorithms**	**3 hours**
Genetic algorithms, Swarm intelligence, Human swarming.		
Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Biomimetics: Nature Inspired Design and Innovation, by Sandy B Primrose, 2020 Wiley, USA.	
Reference Books		
1.	Biomimetics: Nature-Based Innovation, by Yoseph Bar-Cohen, 2nd Edition, 2016, CRC Press, USA.	
2.	A Practical Guide to Bio-inspired Design, by Helena Hashemi Farzaneh and Udo Lindemann, 2019, Springer-Verlag, USA.	
3.	Adapt: How Humans Are Tapping into Nature's Secrets to Design and Build a Better Future: How Humans Are Tapping into Nature's Secrets to Design and Build a Better Future, by Anima Khan, 2017, St. Martin Press New York, 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

BBIT415L	Food, Nutrition and Health	L	T	P	C
		3	0	0	3
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. Outline an overview on general aspects of food, nutrition and health.
2. Identify the different foods sources, food composition, nutritive values and nutritional disorders.
3. Explain the importance of food hygiene and sanitation.

Course Outcomes

1. Recall the basics of food groups, food composition, nutritive value and functions of food.
2. Explain the fundamental principles of nutrition.
3. Interpret the adverse effects of inadequate intake of nutrients.
4. Analyze the importance of functional foods and nutraceuticals in health promotion and disease prevention.
5. Determine the importance of food safety and quality control for leading healthy life.

Module:1	**Nutrients in Food**	**7 hours**
Macronutrients and micronutrients - Carbohydrates, Protein, Fats, Vitamins (A, D, E, K, B complex and C) and Minerals (calcium, phosphorous, magnesium, sodium, iron, zinc and iodine), Food sources, Recommended daily allowance, Biological functions, Deficiency diseases and its symptoms.		
Module:2	**Nutritional Physiology**	**5 hours**
Digestion and absorption of nutrients - Carbohydrates, Protein, Fats; Factors affecting digestion and absorption; Utilization of nutrients in the body.		
Module:3	**Food Choices**	**6 hours**
Food groups-classification; Food composition and nutritive values of different foods; Functions of foods-physiological, Social and Psychological functions. Balanced Diet for all age groups; Importance of Food guide pyramid and food exchange list; Junk food Vs Healthy food.		
Module:4	**Basics of Food, Nutrition and Health**	**5 hours**
Relationship between food, nutrition and health; Concept of health and disease; Dimensions and spectrum of Health; Recommended Dietary Allowance (RDA) and factors affecting RDA; Body Mass Index (BMI) categories		
Module:5	**Malnutrition and Lifestyle Disorders**	**7 hours**
Malnutrition - Underweight and obesity; Micronutrient deficiencies - Iron Deficiency Anaemia (IDA) and Iodine Deficiency Disorder (IDD); Non- communicable diseases - Diabetes mellitus, Cardiovascular diseases, Hypertension and cancer - Prevalence, Causes, Symptoms and Dietary treatment.		
Module:6	**Functional Foods and Nutraceuticals in Disease Prevention**	**7 hours**
Functional foods, Nutraceuticals and “super” foods; Role of functional foods in disease prevention; Sugar, Protein and Fat substitutes.		
Module:7	**Food Safety and Quality Assurance**	**6 hours**
Food safety principles - Importance and Principles of food hygiene and sanitation; Food quality control - Indicators of food quality control, Microbiological criteria for foods, Legislation for food safety- HACCP and ISO systems; Food Standards (FSSAI, CODEX Alimentarius and other Indian standards).		
Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Foods Facts and Principles, by Shakuntala Manay N, 4th Edition, 2021, New Age International Publishers, New Delhi.	
2.	Dietetics, by Srilakshmi B, 7th Edition, 2021, New Age International Publishers, Chennai.	
Reference Books		
1.	Understanding Nutrition, by Whitney E and Rolfes SR, 11th Edition, 2018, Wadsworth Cengage Learning, USA.	
2.	Nutrition- Concepts and Controversies, by Sizer FS and Whitney E 15th Edition, 2016, Wadsworth Cengage Learning, USA.	
3.	Textbook of Preventive and Social Medicine, by Park K, 25th Edition, 2019, Banarsidas Bhanot Publishers, Madhya Pradesh.	
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

BBIT416L	Systems Biology	L	T	P	C
		3	0	0	3
Pre-requisite	**BBIT202L, BBIT202P**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand biological systems in terms of structure and dynamics of cellular and organism function.
2. Develop knowledge on biological interaction networks and genome-level cellular metabolism.
3. Apply mathematics, statistics and computing in an integrated way to analyze biological systems.

Course Outcomes

1. Interpretation of the biological information with data analysis.
2. Evaluate and handle various bioinformatics tools.
3. Build group and compare data, to gain information about single molecules compared to similar molecules.
4. Explain how genomic, transcriptomic and proteomic techniques work, and discuss their strengths and limitations.
5. Analyze the results of biological studies by making use of bioinformatics techniques.
6. Develop basic scripts and pipelines for automating and repeating analysis.

Module: 1	**Transcription Networks: Basic Concepts**	**7 hours**
Cognitive problem of the cell, Elements of transcription networks, Separation of timescales, Activators and repressors, Dynamics and response time of simple regulation, Cell generation logic functions, Logic input functions.		
Module: 2	**Types of Network Motifs**	**6 hours**
Autoregulation, Negative autoregulation, Feed forward loops, Structure and dynamics of C1FFL, Sign sensitive delay element, AND Logic, OR Logic, I1 FFL, Structure and dynamics, SIM,Bi-Fans, DORs, Interlocked circuits, Multi output FFLs.		
Module: 3	**Positive Feedback, Bistability and Memory**	**6 hours**
Network motifs in Developmental networks, Protein-protein interaction networks, Neuronal networks, Multi-input FFLs, Building biological oscillator.		
Module: 4	**Kinetic and Conformational Proof Reading**	**6 hours**
Kinetic proof reading of genetic code, Recognition of self and non self by immune system, Diverse processes in cells, Conformational proof reading, Demand rules for gene regulation.		
Module:5	**Robustness in Bacterial Chemotaxis**	**6 hours**
Chemotaxis behavior, Response and exact adaptation, Chemotaxis protein circuit, Barkai Leibler model of exact adaption.		
Module:6	**Fold Change Detection**	**6 hours**
Universal features of sensory systems, FCD in chemotaxis, FCD and exact adaptation, Incoherent FFL and FCD, Identifying FCD from dynamic measurements, Insulin glucose feedback loop.		
Module:7	**Optimal Gene Circuit Designing**	**6 hours**
Optimal expression level of a protein under constant condition, Optimal regulation in changing environments, Environmental selection of FFL network motif, Inverse ecology.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1	An Introduction to Systems Biology: Design Principles of Biological Circuits, by Uri Alon, 2nd Edition, 2015, Chapman & Hall/CRC Press, United States.

Reference Books			
1	Computational Modeling of Genetic and Biochemical Networks, by James M. Bower, Hamid Bolouri, Ist Edition, 2003, .MIT Press, United States.		
2	Gene Regulation and Metabolism: Postgenomic Computational Approaches, Julio Collado, Ist Edition, 2002, MIT Press, United States.		
Mode of Evaluation: CAT, Application oriented assignment, Quiz, and FAT			
Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022