B. TECH ELECTRONICS & COMMUNICATION ENGINEERING 2011-15

1ST SEMESTER						
S. No.	**Subject Code**	**Name of the Subjects**	**Contact Hours**			**Credits**
			L	**T**	**P**	
1	10B11PD111	Presentation & Communication Skill	3	0	0	3
2	10B11MA111	Mathematics-I	3	1	0	4
3	10B11PH111	Physics-I	3	1	0	4
4	10B11EC111	Electrical Circuit Analysis	3	1	0	4
5	10B11CI111	Introduction to Computer and Programming	3	1	0	4
6	10B17PH171	Physics Lab-I	0	0	2	1
7	10B17EC171	Electrical Circuits Lab	0	0	2	1
8	10B17CI171	Computer Programming Lab	0	0	4	2
9	10B19GE199	Institutional Orientation	0	0	0	0
					Total	**23**
2ND SEMESTER						
S. No.	**Subject Code**	**Subject Names**	**Contact Hours**			**Credits**
			L	**T**	**P**	
1	10B11EC211	Basic Electronics & Device Circuits	3	1	0	4
2	10B11PD211	Group and Cooperative Processes	3	0	0	3
3	10B11MA211	Discrete Mathematics	3	1	0	4
4	10B11PH211	Physics-II	3	1	0	4
5	10B11CI211	Data Structures	3	1	0	4
6	10B17EC271	Basic Electronics Lab	0	0	2	1
7	10B17PH271	Physics Lab-II	0	0	2	1
8	10B17CI271	Data Structures and Computer Prog. Lab	0	0	4	2
9	10B19EC299	Departmental Orientation	0	0	0	0
					Total	**23**
3RD SEMESTER						
S. No.	**Subject Code**	**Name of the Subjects**	**Contact Hours**			**Credits**
			L	**T**	**P**	
1	10B11PD311	Managerial Economics	3	0	0	3
2	10B11MA201	Mathematics-II	3	1	0	4
3	10B11EC311	Electrical Machines and Instruments	3	1	0	4
4	10B11EC301	Signals & Systems	3	1	0	4
5	10B11EC312	Analogue Electronics	3	1	0	4
6	10B17EC371	Electrical Machines and Instruments Lab	0	0	2	1
7	10B17EC307	Signals and Systems Lab	0	0	2	1
8	10B17EC372	Analogues Electronics Lab	0	0	2	1
9	10B28CI408	Multimedia Development Lab-I	0	0	2	1
					Total	**23**
4TH SEMESTER						
S. No.	**Subject Code**	**Subject Names**	**Contact Hours**			**Credits**

2	10B11MA411	Probability Theory and Random Processes	3	1	0	4
3	10B11EC411	Semiconductor Devices	3	1	0	4
4	10B11EC401	Digital Electronics	3	1	0	4
5	10B11EC413	Analogue Communications	3	1	0	4
6	10B11GE411	Environmental Studies	3	0	0	3
7	10B17EC471	Devices and Circuit simulation Lab	0	0	2	1
8	10B17EC407	Digital Electronics Lab	0	0	2	1
9	10B17EC473	Analogue Communications Lab	0	0	2	1
10	10B17CI307	Unix Programming Lab	0	0	2	1
					Total	**26**

5TH SEMESTER

S. No.	Subject Code	Name of the Subjects	Contact Hours			Credits
			L	T	P	
1	10B11PD511	Social and Legal Issues	3	0	0	3
2	10B11EC511	Digital Communications	3	1	0	4
3	10B11EC512	Digital Signal Processing	3	1	0	4
4	10B11CI401	Microprocessor and Controllers	3	1	0	4
5	10B11EC513	Electromagnetic Engineering	3	1	0	4
6	10B17EC571	Digital Communications Lab	0	0	2	1
7	10B17EC572	Digital Signal Processing Lab	0	0	2	1
8	10B17CI407	Microprocessor and Controllers Lab	0	0	2	1
9	10B17EC573	Electromagnetics Lab	0	0	2	1
10	10B1WEC515	Theory and Applications of Control System	3	1	0	4
11	10B1WEC575	Theory and App. Of Control Systems Lab	0	0	2	1
					Total	**28**

6TH SEMESTER

S. No.	Subject Code	Subject Names	Contact Hours			Credits
			L	T	P	
1	10B11PD611	Project Management	3	0	0	3
2	10B11EC611	Telecommunication Networks	3	1	0	4
3	10B11EC612	VLSI Technology and Applications	3	1	0	4
4	10B11PH611	Material Sciences	3	1	0	4
5	10B11CI614	Object Oriented Systems and Programming	3	1	0	4
6	11B1WEC611	Power Electronics	3	1	0	4
7	10B17EC671	Telecommunication Networks Lab	0	0	2	1
8	10B17EC672	VLSI Lab	0	0	2	1
9	10B17CI674	Object Oriented Systems and Programming Lab	0	0	4	2
10	11B1WEC671	Power Electronics Lab	0	0	2	1
11	10B19GE698	Industrial Training	0	0	0	0
					Total	**28**

7TH SEMESTER

S. No.	Subject Code	Name of the Subjects	Contact Hours			Credits

2	10B19EC791	Project Part-I	0	0	10	10
3	E1	DE-I [Choose Any one]	3	0	0	3
4	E2	DE-II [Choose Any one]	3	0	0	3
5	E3	DE-VI [Choose Any one/ Open departmental]	3	0	0	3
					Total	**22**

8TH SEMESTER						
S.No.	**Subject Code**	**Subject Names**	**Contact Hours**			**Credits**
			L	**T**	**P**	
1		HSS Elective-II	3	0	0	3
2	E1	DE-IV [Choose Any one]	3	0	0	3
3	E2	DE-V [Choose Any one]	3	0	0	3
4	E3	DE-VI [Choose Any one/ Open departmental]	3	0	0	3
5	10B19EC891	Project Part II	0	0	10	10
					Total	**22**

LIST OF ELECTIVES

7TH SEMESTER

1.	10B1WEC731	Mobile Communication
2.	10B1WEC734	Fundamentals of Digital Image Processing
3.	12B1WEC732	Digital System Design
4.	13B1WEC731	CMOS Analog Circuit Design
5.	14B1WEC731	Sound Processing and its Applications
6.	14B1WEC733	Cognitive Radio Networks
7.	14B1WEC734	Non-linear and digital conrol systems
8.	14B1WEC735	Fundamentals of embedded systems
9.	18B1WEC732	Design of Dependable Systems
10.	15B1WEC732	RF and Microwave
11.	17B1WEC731	Time Frequency analysis and its applications
12.	18B1WEC735	Embedded system design
13.	17B1WEC733	Robotic Systems and Control
14.	18B1WEC734	Medical Image Processing
15.	10M11EC111	Advanced Communication System
16.	10M11EC112	Advanced Satellite and Fiber Optic Communication
17.	10M11EC113	Advanced Telecommunication Network
18.	10M11EC114	VLSI Circuits and System Design

8TH SEMESTER		
1.	11B1WEC832	Digital Signal Processing for VLSI
2.	11B1WEC834	Optical Comm. Systems
3.	13B1WEC831	Soft Computing Techniques
4.	13B1WEC832	Modern Antennas
5.	13B1WEC833	Bio-Electronic Sensors
6.	13B1WEC834	Qunatum Effects in Semiconductor Physics
7.	16B1WEC831	Antenna and Wave Propagation
8.	10M11EC211	Advanced Digital Signal Processing
9.	10M11EC212	Advance Wireless & Mobile Communication
10.	10M11EC213	Information & Coding Theory
11.	14M1WEC231	Advanced CMOS Digital Design Techniques
12.	12M1WEC232	Real Time Embedded System
13.	16M1WEC231	Advanced Digital Image processing
14.	13M1WEC231	Advanced Neural Networks
15.	16B1WEC832	Spectral Analysis for Signal Processing

B.TECH. ELECTRONICS & COMMUNICATION ENGINEERING

COURSE STRUCTURE

Approved in Academic Council held on 25.10.2018

Department of Electronics & Communication Engineering

PROGRAM OUTCOMES

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Approved in Academic Council held on 25.10.2018

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 1st SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS111	English and Technical Communication	2	0	0	2	2
2	HSS	18B17HS171	English and Technical Communication Lab	0	0	2	1	2
3	Basic Sciences	18B11MA111	Engineering Mathematics-I	3	1	0	4	4
4	Basic Sciences	18B11PH111	Engineering Physics-I	3	1	0	4	4
5	Basic Sciences	18B17PH171	Engineering Physics Lab-I	0	0	2	1	2
6	Engg Science	19B11CI111	Programming for Problem Solving-II	2	0	0	2	2
7	Engg Science	18B17GE173	Engineering Graphics **OR**	0	0	3	1.5	3
		18B17GE171	Workshop Practices					
8	Engg Science	19B17CI171	Programming for Problem Solving Lab-II	0	0	4	2	4
9		18B17GE172	Mandatory Induction Program	-	-	-	-	-
							17.5	23

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 2nd SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Basic Sciences	18B11MA211	Engineering Mathematics-II	3	1	0	4	4
2	Basic Sciences	18B11PH211	Engineering Physics-II	3	0	0	3	3
3	Basic Sciences	18B11PH271	Engineering Physics Lab-II	0	0	2	1	2
4	Engg Science	18B11EC211	Electrical Science	3	1	0	4	4
5	Engg Science	18B17EC271	Electrical Science Lab	0	0	2	1	2
6	Engg Science	18B17GE171	Workshop Practices **OR**	0	0	3	1.5	3
		18B17GE173	Engineering Graphics					
7	Engg Science	18B17CI211	Data Structures and Algorithms	3	1	0	4	4
8	Engg Science	18B17CI271	Data Structures and Algorithms Lab	0	0	4	2	4
							20.5	26

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 3rd SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS311	Interpersonal Dynamics, Values and Ethics	3	0	0	3	3
2	Basic Sciences	18B11MA314	Probability Theory and Random Processes	3	1	0	4	4
3	Engg Science	18B11EC313	Electronic Devices & Circuits	3	1	0	4	4
4	Engg Science	18B17EC373	Electronic Devices & Circuits Lab	0	0	2	1	2
5	Professional Core	18B11EC311	Automatic Control Systems	3	0	0	3	3
6	Professional Core	18B17EC371	Automatic Control Systems Lab	0	0	2	1	2
7	Professional Core	18B11EC312	Digital Electronics & Logic Design	3	1	0	4	4
8	Professional Core	18B17EC372	Digital Electronics & Logic Design Lab	0	0	2	1	2
							21	24

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 4th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS411	Finance and Accounts	3	0	0	3	3
2	Basic Sciences	18B11MA413	Discrete Mathematics	3	0	0	3	3
3	Engg Science	18B17EC474	Python Lab	0	0	2	1	2
4	Professional Core	18B11EC411	Analog Integrated Circuits	3	0	0	3	3
5	Professional Core	18B17EC471	Analog Integrated Circuits Lab	0	0	2	1	2
6	Professional Core	18B11EC412	Fundamentals of Signals & Systems	3	1	0	4	4
7	Professional Core	18B17EC472	Fundamentals of Signals & Systems Lab	0	0	2	1	2
8	Professional Core	18B11EC413	Modern Analog and Digital Communication	3	1	0	4	4
9	Professional Core	18B17EC473	Modern Analog and Digital Communication Lab	0	0	2	1	2
10			Environmental Studies	2	0	0	0	2
							21	27

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 5th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS511	Project Management and Entrepreneurship	3	0	0	3	3
2	Professional Core	18B11EC511	Principles of Digital Signal Processing	3	1	0	4	4
3	Professional Core	18B17EC571	Principles of Digital Signal Processing Lab	0	0	2	1	2
4	Professional Core	18B11EC512	Microprocessor and Interfacing	3	0	0	3	3
5	Professional Core	18B17EC572	Microprocessor and Interfacing Lab	0	0	2	1	2
6	Professional Core	18B11EC513	Electromagnetic Waves	3	1	0	4	4
7	Engg. Science		Science Elective	3	0	0	3	3
8	Professional Elective		Professional Elective-I	3	0	0	3	3
							22	24

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 6th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11EC611	Wireless and Data Communication	3	0	0	3	3
2	Professional Core	18B11EC612	VLSI Technology	3	1	0	4	4
3	Professional Core	18B11EC671	Mini Project	0	0	2	1	2
4	Professional Core	18B17EC672	VLSI Technology Lab	0	0	2	1	2
5	Professional Core	18B17EC673	Advance Communication Lab	0	0	2	1	2
6	Open Elective		Open Elective-I/MOOCs (**HSS Elective**)	3	0	0	3	3
7	Open Elective		Open Elective-II / MOOCs	3	0	0	3	3
8	Open Elective		Open Elective-III / MOOCs	3	0	0	3	3
9	Professional Elective		Professional Elective-II	3	0	0	3	3
10			Industrial Training				0	0
							22	25

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 7th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Project	18B19EC791	Project Part-I				7	7
2	HSS		Indian Constitution	1	0	0	0	1
3	Open Elective		Open Elective-IV/ MOOCs	3	0	0	3	3
4	Professional Elective		Professional Elective-III	3	0	0	3	3
5	Professional Elective		Professional Elective-IV	3	0	0	3	3
							16	17

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 8th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective		Open Elective V/ MOOCs	3	0	0	3	3
2	Professional Elective		Professional Elective-V	3	0	0	3	3
3	Professional Elective		Professional Elective-VI	3	0	0	3	3
4	Professional Elective		Professional Elective-VII	3	0	0	3	3
5	Project	18B19EC891	Project Part-II				8	8
							20	20

TOTAL CREDITS	160
TOTAL HOURS	186
HSS	12
Basic Science	24
Engg. Science	27
Professional Core	46
Professional Elective	21
Open Elective	15
Project	15

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFESSIONAL ELECTIVE-I

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC534	Network Analysis and Synthesis	3	0	0	3	3
2	Professional Elective	18B1WEC535	Communication Engineering	3	0	0	3	3
3	Professional Elective	18B1WEC536	Fundamentals of Digital Image Processing	3	0	0	3	3
4	Professional Elective	20B1WEC534	AVR Based Embedded System Design	2	0	0	2	2
5	Professional Elective	20B1WEC571	AVR Based Embedded System Design Lab	0	0	2	1	2

PROFESSIONAL ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC631	Digital Filter Design and Applications	3	0	0	3	3
2	Professional Elective	18B1WEC632	Intelligent Control Systems	3	0	0	3	3
3	Professional Elective	18B1WEC633	Optical Communication Systems	3	0	0	3	3
						Total	3	3

PROFESSIONAL ELECTIVE-III

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC746	Microwave Theory and Techniques	3	0	0	3	3
2	Professional Elective	18B1WEC745	Next Generation Communication Systems	3	0	0	3	3
3	Professional Elective	18B1WEC744	FPGA based Instrumentation System Design	3	0	0	3	3
4	Professional Elective	18B1WEC743	Optimum Array Processing	3	0	0	3	3
						Total	3	3

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFESSIONAL ELECTIVE-IV

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC742	Antenna and Wave Propagation	3	0	0	3	3
2	Professional Elective	18B1WEC736	OFDM and Applications	3	0	0	3	3
3	Professional Elective	18B1WEC737	Robotic Systems and Control	3	0	0	3	3
4	Professional Elective	18B1WEC738	Time Frequency Analysis and Applications	3	0	0	3	3
						Total	3	3

PROFESSIONAL ELECTIVE-V

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC852	Design of Modern Antennas	3	0	0	3	3
2	Professional Elective	18B1WEC851	Soft Computing Techniques	3	0	0	3	3
3	Professional Elective	18B1WEC850	Fault Tolerant Communication Systems	3	0	0	3	3
4	Professional Elective	18B1WEC849	Cognitive Radio Networks	3	0	0	3	3
						Total	3	3

PROFESSIONAL ELECTIVE-VI

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC848	RF Engineering	0	0	3	3	3
2	Professional Elective	18B1WEC847	Medical Image Processing	3	0	0	3	3
3	Professional Elective	18B1WEC846	Design of Dependable Systems	3	0	0	3	3
4	Professional Elective	18B1WEC838	Artificial Intelligence Techniques	3	0	0	3	3
						Total	3	3

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFESSIONAL ELECTIVE-VII

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC839	Radar Principles and Applications	3	0	0	3	3
2	Professional Elective	18B1WEC840	Industrial Automation and Control	3	0	0	3	3
3	Professional Elective	18B1WEC841	Bio Electronic Sensors	3	0	0	3	3
4	Professional Elective	18B1WEC842	Optical Networks	0	0	3	3	3
						Total	3	3

OPEN ELECTIVE-I (HSS)

OPEN ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC635	Principles of Communication Systems	2	0	0	2	2
2	Open Elective	18B1WEC672	Principles of Communication Systems Lab	0	0	2	1	2
3	Open Elective	18B1WEC636	Fundamentals of Digital Signal Processing and Applications	2	0	0	2	2
4	Open Elective	18B1WEC673	Fundamentals of Digital Signal Processing Lab	0	0	2	1	2
5	Open Elective	20B1WEC731	Automation and Robotics	3	0	0	3	3
6	Open Elective	20B1WEC732	Machine Learning for Wireless Communications	3	0	0	3	3
7	Open Elective	20B1WEC733	Signal Processing for Machine Learning	3	0	0	3	3

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B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

OPEN ELECTIVE-III

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC637	Principles of Wireless Communication	2	0	0	2	2
2	Open Elective	18B1WEC674	Principles of Wireless Communication Lab	0	0	2	1	2
3	Open Elective	18B1WEC639	Software Defined Radio and Applications	2	0	0	2	2
4	Open Elective	18B1WEC676	Software Defined Radio Lab	0	0	2	1	2
5	Open Elective	20B1WEC734	Digital Systems	3	0	0	3	3
6	Open Elective	20B1WEC735	Artificial Intelligence Techniques for Genomic Signal Processing	3	0	0	3	3
7	Open Elective	20B1WEC736	Image Sensing and Reconstruction	3	0	0	3	3

OPEN ELECTIVE-IV

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC739	Optimization Techniques in Engineering	3	0	0	3	3
2	Open Elective	18B1WEC740	Electrical Machines	3	0	0	3	3
3	Open Elective	18B1WEC741	Biomedical Signal Processing	3	0	0	3	3
4	Open Elective	20B1WEC731	Automation and Robotics	3	0	0	3	3

OPEN ELECTIVE-V

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC843	Industrial Internet of Things	3	0	0	3	3
2	Open Elective	18B1WEC844	Wireless Ad Hoc and Sensor Networks	3	0	0	3	3
3	Open Elective	18B1WEC845	Satellite Communication	3	0	0	3	3
						Total	3	3

B.TECH. ELECTRONICS & COMMUNICATION ENGINEERING

COURSE STRUCTURE

Approved in Academic Council held on 28 July 2021

Department of Electronics & Communication Engineering

PROGRAM OUTCOMES

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Approved in Academic Council held on 28 July 2021

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2021 Batch (160 CREDITS)

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 1st SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	21B11HS111	English	2	0	0	2	2
2	HSS	21B17HS171	English Lab	0	0	2	1	2
3	Basic Sciences	18B11MA111	Engineering Mathematics-I	3	1	0	4	4
4	Basic Sciences	18B11PH111	Engineering Physics-I	3	1	0	4	4
5	Basic Sciences	18B17PH171	Engineering Physics Lab-I	0	0	2	1	2
6	Engg Science	19B11CI111	Programming for Problem Solving-II	2	0	0	2	2
7	Engg Science	18B17GE173	Engineering Graphics **OR**	0	0	3	1.5	3
		18B17GE171	Workshop Practices					
8	Engg Science	19B17CI171	Programming for Problem Solving Lab-II	0	0	4	2	4
9		18B17GE172	Mandatory Induction Program	-	-	-	-	-
							17.5	**23**

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 2nd SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Basic Sciences	18B11MA211	Engineering Mathematics-II	3	1	0	4	4
2	Basic Sciences	18B11PH211	Engineering Physics-II	3	0	0	3	3
3	Basic Sciences	18B11PH271	Engineering Physics Lab-II	0	0	2	1	2
4	Engg Science	18B11EC211	Electrical Science	3	1	0	4	4
5	Engg Science	18B17EC271	Electrical Science Lab	0	0	2	1	2
6	Engg Science	18B17GE171	Workshop Practices **OR**	0	0	3	1.5	3
		18B17GE173	Engineering Graphics					
7	Engg Science	18B17CI211	Data Structures and Algorithms	3	1	0	4	4
8	Engg Science	18B17CI271	Data Structures and Algorithms Lab	0	0	4	2	4
9	HSS	21B11HS211	Life Skills & Effective Communication	1	0	0	1	1
10	HSS	21B17HS271	Life Skills & Effective Communication	0	0	2	1	2
							22.5	**29**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOG WAKNAGHAT

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2021 Batch (160 CREDITS)

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 3rd SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	21B11HS312	Interpersonal Dynamics, Values and Ethics	1	0	0	1	1
2	Basic Sciences	18B11MA314	Probability Theory and Random Processes	3	1	0	4	4
3	Engg Science	18B11EC313	Electronic Devices & Circuits	3	1	0	4	4
4	Engg Science	18B17EC373	Electronic Devices & Circuits Lab	0	0	2	1	2
5	Professional Core	18B11EC412	Fundamentals of Signals & Systems	3	1	0	4	4
6	Professional Core	18B17EC472	Fundamentals of Signals & Systems Lab	0	0	2	1	2
7	Professional Core	18B11EC312	Digital Electronics & Logic Design	3	1	0	4	4
8	Professional Core	18B17EC372	Digital Electronics & Logic Design Lab	0	0	2	1	2
9	HSS	21B11HS311	Professional Communication Practice	0	0	0	Audit	2
							20	**25**

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 4th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS411	Finance and Accounts	3	0	0	3	3
2	Basic Sciences	18B11MA413	Discrete Mathematics	3	0	0	3	3
3	Engg Science	18B17EC474	Python Lab	0	0	2	1	2
4	Professional Core	18B11EC411	Analog Integrated Circuits	3	0	0	3	3
5	Professional Core	18B17EC471	Analog Integrated Circuits Lab	0	0	2	1	2
6	Professional Core	18B11EC311	Automatic Control Systems	3	0	0	3	3
7	Professional Core	18B17EC371	Automatic Control Systems Lab	0	0	2	1	2
8	Professional Core	18B11EC413	Modern Analog and Digital Communication	3	1	0	4	4
9	Professional Core	18B17EC473	Modern Analog and Digital Communication Lab	0	0	2	1	2
10			Environmental Studies	2	0	0	0	2
							20	**26**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2021 Batch (160 CREDITS)

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 5th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS511	Project Management and Entrepreneurship	3	0	0	3	3
2	Professional Core	18B11EC511	Principles of Digital Signal Processing	3	1	0	4	4
3	Professional Core	18B17EC571	Principles of Digital Signal Processing Lab	0	0	2	1	2
4	Professional Core	18B11EC512	Microprocessor and Interfacing	3	0	0	3	3
5	Professional Core	18B17EC572	Microprocessor and Interfacing Lab	0	0	2	1	2
6	Professional Core	18B11EC513	Electromagnetic Waves	3	1	0	4	4
7	Engg. Science		Science Elective	3	0	0	3	3
8	Professional Elective		Professional Elective-I	3	0	0	3	3
							22	**24**

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 6th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11EC611	Wireless and Data Communication	3	0	0	3	3
2	Professional Core	18B11EC612	VLSI Technology	3	1	0	4	4
3	Professional Core	18B11EC671	Mini Project	0	0	2	1	2
4	Professional Core	18B17EC672	VLSI Technology Lab	0	0	2	1	2
5	Professional Core	18B17EC673	Advance Communication Lab	0	0	2	1	2
6	Open Elective		Open Elective-I/MOOCs (**HSS Elective**)	3	0	0	3	3
7	Professional Elective		Professional Elective-II	3	0	0	3	3
8	Professional Elective		Professional Elective-III	3	0	0	3	3
9	Professional Elective		Professional Elective-IV	3	0	0	3	3
10			Industrial Training				0	0
							22	**25**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2021 Batch (160 CREDITS)

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 7th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Project	18B19EC791	Project Part-I				7	7
2	HSS		Indian Constitution	1	0	0	0	1
3	Open Elective		Open Elective-II / MOOCs	3	0	0	3	3
4	Open Elective		Open Elective-III / MOOCs	3	0	0	3	3
5	Professional Elective		Professional Elective-V	3	0	0	3	3
6	Professional Elective		Professional Elective-VI	3	0	0	3	3
							19	**20**

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING) 8th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective		Open Elective-IV/ MOOCs	3	0	0	3	3
2	Open Elective		Open Elective V/ MOOCs	3	0	0	3	3
3	Professional Elective		Professional Elective-VII	3	0	0	3	3
4	Project	18B19EC891	Project Part-II				8	8
							17	**17**

TOTAL CREDITS	160
TOTAL HOURS	186
HSS	12
Basic Science	24
Engg. Science	27
Professional Core	46
Professional Elective	21
Open Elective	15
Project	15

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2021 Batch (160 CREDITS)

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFESSIONAL ELECTIVE-I

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC534	Network Analysis and Synthesis	3	0	0	3	3
2	Professional Elective	18B1WEC535	Communication Engineering	3	0	0	3	3
3	Professional Elective	18B1WEC536	Fundamentals of Digital Image Processing	3	0	0	3	3
4	Professional Elective	20B1WEC534	AVR Based Embedded System Design	2	0	0	2	2
5	Professional Elective	20B1WEC571	AVR Based Embedded System Design Lab	0	0	2	1	2

PROFESSIONAL ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC631	Digital Filter Design and Applications	3	0	0	3	3
2	Professional Elective	18B1WEC632	Intelligent Control Systems	3	0	0	3	3
3	Professional Elective	18B1WEC633	Optical Communication Systems	3	0	0	3	3
						Total	3	3

PROFESSIONAL ELECTIVE-III

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC746	Microwave Theory and Techniques	3	0	0	3	3
2	Professional Elective	18B1WEC745	Next Generation Communication Systems	3	0	0	3	3
3	Professional Elective	18B1WEC744	FPGA based Instrumentation System Design	3	0	0	3	3
4	Professional Elective	18B1WEC743	Optimum Array Processing	3	0	0	3	3
						Total	3	3

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2021 Batch (160 CREDITS)

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFESSIONAL ELECTIVE-IV

S. No	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC742	Antenna and Wave Propagation	3	0	0	3	3
2	Professional Elective	18B1WEC736	OFDM and Applications	3	0	0	3	3
3	Professional Elective	18B1WEC737	Robotic Systems and Control	3	0	0	3	3
4	Professional Elective	18B1WEC738	Time Frequency Analysis and Applications	3	0	0	3	3
						Total	3	3

PROFESSIONAL ELECTIVE-V

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC852	Design of Modern Antennas	3	0	0	3	3
2	Professional Elective	18B1WEC851	Soft Computing Techniques	3	0	0	3	3
3	Professional Elective	18B1WEC850	Fault Tolerant Communication Systems	3	0	0	3	3
4	Professional Elective	18B1WEC849	Cognitive Radio Networks	3	0	0	3	3
						Total	3	3

PROFESSIONAL ELECTIVE-VI

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC848	RF Engineering	0	0	3	3	3
2	Professional Elective	18B1WEC847	Medical Image Processing	3	0	0	3	3
3	Professional Elective	18B1WEC846	Design of Dependable Systems	3	0	0	3	3
4	Professional Elective	18B1WEC838	Artificial Intelligence Techniques	3	0	0	3	3
						Total	3	3

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2021 Batch (160 CREDITS)

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

PROFESSIONAL ELECTIVE-VII

S. No	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WEC839	Radar Principles and Applications	3	0	0	3	3
2	Professional Elective	18B1WEC840	Industrial Automation and Control	3	0	0	3	3
3	Professional Elective	18B1WEC841	Bio Electronic Sensors	3	0	0	3	3
4	Professional Elective	18B1WEC842	Optical Networks	0	0	3	3	3
						Total	3	3

OPEN ELECTIVE-I (HSS)

OPEN ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC635	Principles of Communication Systems	2	0	0	2	2
2	Open Elective	18B1WEC672	Principles of Communication Systems Lab	0	0	2	1	2
3	Open Elective	18B1WEC636	Fundamentals of Digital Signal Processing and Applications	2	0	0	2	2
4	Open Elective	18B1WEC673	Fundamentals of Digital Signal Processing Lab	0	0	2	1	2
5	Open Elective	20B1WEC731	Automation and Robotics	3	0	0	3	3
6	Open Elective	20B1WEC732	Machine Learning for Wireless Communications	3	0	0	3	3
7	Open Elective	20B1WEC733	Signal Processing for Machine Learning	3	0	0	3	3

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

COURSE CURRICULUM OF ELECTRONICS & COMMUNICATION ENGINEERING DEPARTMENT- 2021 Batch (160 CREDITS)

B. TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

OPEN ELECTIVE-III

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC637	Principles of Wireless Communication	2	0	0	2	2
2	Open Elective	18B1WEC674	Principles of Wireless Communication Lab	0	0	2	1	2
3	Open Elective	18B1WEC639	Software Defined Radio and Applications	2	0	0	2	2
4	Open Elective	18B1WEC676	Software Defined Radio Lab	0	0	2	1	2
5	Open Elective	20B1WEC734	Digital Systems	3	0	0	3	3
6	Open Elective	20B1WEC735	Artificial Intelligence Techniques for Genomic Signal Processing	3	0	0	3	3
7	Open Elective	20B1WEC736	Image Sensing and Reconstruction	3	0	0	3	3

OPEN ELECTIVE-IV

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC739	Optimization Techniques in Engineering	3	0	0	3	3
2	Open Elective	18B1WEC740	Electrical Machines	3	0	0	3	3
3	Open Elective	18B1WEC741	Biomedical Signal Processing	3	0	0	3	3
4	Open Elective	20B1WEC731	Automation and Robotics	3	0	0	3	3

OPEN ELECTIVE-V

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WEC839	Industrial Internet of Things	3	0	0	3	3
2	Open Elective	18B1WEC840	Wireless Ad Hoc and Sensor Networks	3	0	0	3	3
3	Open Elective	18B1WEC841	Satellite Communication	3	0	0	3	3
						Total	3	3

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Master of Technology in Electronics & Communication Engineering
Effective from Academic Session – 2021-22

Detailed Course Structure & Curriculum

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

Approved in Academic Council Meeting held on 28 July, 2021

SEMESTER - I								
S. No.	**Course Code**	**Name of the Subjects**		**Course Hours**			**Total**	**Credits**
			C/E	L	T	P		
1	21M11EC112	Embedded Systems and Applications	C	3	0	0	3	3
2	21M11EC111	Sensor and Smart Instrumentation	C	3	0	0	3	3
3	21M11EC113	Object Oriented Programming	C	3	0	0	3	3
4		Departmental Elective - I	E	3	0	0	3	3
5		Departmental Elective - II	E	3	0	0	3	3
6		Departmental Elective - III	E	3	0	0	3	3
7	21M11EC172	Advanced Communication Lab	C	0	0	6	6	3
						Total	**24**	**21**
SEMESTER - II								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M11EC211	Digital System design using verilog HDL	C	3	0	0	3	3
2	21M11EC212	Artificial Intelligence and Expert Systems	C	3	0	0	3	3
3	21M11EC213	Network Security Protocols	C	3	0	0	3	3
4		Departmental Elective - IV	E	3	0	0	3	3
5		Departmental Elective - V	E	3	0	0	3	3
6		Open Elective	E	3	0	0	3	3
7	21M11EC272	Advanced Signal Processing Lab	C	0	0	6	6	3
						Total	**24**	**21**
SEMESTER - III								
S. No.	**Course Code**	**Name of the Subjects**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M19EC391	Literature Review / Seminar	C	0	0	6	6	3
2	21M19EC392	Dissertation Part - I	C	0	0	28	28	14
						Total	**34**	**17**
SEMESTER - IV								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M19EC491	Seminar	C	0	0	6	6	3
2	21M19EC492	Dissertation Part - II	C	0	0	28	28	14
						Total	**34**	**17**

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Master of Technology in Electronics & Communication with specialization in Internet of Things

Effective from Academic Session – 2021-22

Detailed Course Structure & Curriculum

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

Approved in Academic Council Meeting held on 28 July, 2021

SEMESTER - I								
S. No.	**Course Code**	**Name of the Subjects**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M11EC112	Embedded Systems and Applications	C	3	0	0	3	3
2	21M11EC111	Sensor and Smart Instrumentation	C	3	0	0	3	3
3	21M11EC113	Object Oriented Programming	C	3	0	0	3	3
4		Departmental Elective - I	E	3	0	0	3	3
5		Departmental Elective - II	E	3	0	0	3	3
6		Departmental Elective - III	E	3	0	0	3	3
7	21M11EC171	Advanced IoT Lab - I	C	0	0	6	6	3
						Total	**24**	**21**
SEMESTER - II								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M11EC211	Digital System design using verilog HDL	C	3	0	0	3	3
2	21M11EC212	Artificial Intelligence and Expert Systems	C	3	0	0	3	3
3	21M11EC213	Network Security Protocols	C	3	0	0	3	3
4		Departmental Elective - IV	E	3	0	0	3	3
5		Departmental Elective - V	E	3	0	0	3	3
6		Open Elective	E	3	0	0	3	3
7	21M11EC271	Advanced IoT Lab - II	C	0	0	6	6	3
						Total	**24**	**21**
SEMESTER - III								
S. No.	**Course Code**	**Name of the Subjects**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M19EC391	Literature Review / Seminar	C	0	0	6	6	3
2	21M19EC392	Dissertation Part - I	C	0	0	28	28	14
						Total	**34**	**17**
SEMESTER - IV								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M19EC491	Seminar	C	0	0	6	6	3
2	21M19EC492	Dissertation Part - II	C	0	0	28	28	14
						Total	**34**	**17**

LIST OF ELECTIVES								
ELECTIVE - I								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC132	IoT Architecture and Protocols	E	3	0	0	3	3
2	21M1WEC131	Wireless Technologies for IoT	E	3	0	0	3	3
ELECTIVE – II								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC133	Industrial Automation and IIoT	E	3	0	0	3	3
2	21M1WEC134	Intelligent Robotics and Shared Autonomy	E	3	0	0	3	3
ELECTIVE – III								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC135	Signal Processing for IoT	E	3	0	0	3	3
2	21M1WEC136	Intelligent signal Processing	E	3	0	0	3	3
ELECTIVE – IV								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC231	Image Sensing and Realtime Processing	E	3	0	0	3	3
2	21M1WEC232	Medical Image Processing and Applications	E	3	0	0	3	3
3	21M1WEC233	Applied Machine Learning for IoT	E	3	0	0	3	3
ELECTIVE – V								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC234	Antennas for IoT	E	3	0	0	3	3
2	21M1WEC235	RF technology for 5G and IoT	E	3	0	0	3	3
3	21M1WEC236	Smart Internet of Things	E	3	0	0	3	3

B.TECH. BIOINFORMATICS

COURSE STRUCTURE

Approved in Academic Council held on 25.10.2018

Department of Biotechnology & Bioinformatics

PROGRAM OUTCOMES

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Approved in Academic Council held on 25.10.2018

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOINFORMATICS) 1st SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS111	English and Technical Communication	2	0	0	**2**	**2**
2	HSS	18B17HS171	English and Technical Communication	0	0	2	**1**	**2**
3		18B11MA112	Basic Mathematics -1 OR	3	1	0	**4**	**4**
4	Basic Sciences	18B11BT111	Fundamental Biology	3	0	0	**3**	**3**
5		18B17BT171	Fundamental Biology lab	0	0	2	**1**	**2**
6	Basic Sciences	18B11PH112	Basic Engineering Physics-I	3	1	0	**4**	**4**
7	Engg Science	19B11CI111	Programming for Problem Solving-II	2	0	0	**2**	**2**
8	Engg Science	18B17GE173	Engineering Graphics	0	0	3	**1.5**	**3**
9	Basic Sciences	18B17PH172	Basic Engineering Physics Lab-I	0	0	2	**1**	**2**
10	Engg Science	19B17CI171	Programming for Problem Solving Lab-II	0	0	4	**2**	**4**
						Total	**17.5**	**23**

B. TECH (BIOINFORMATICS) 2nd SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Basic Sciences	18B11MA212	Basic Mathematics-II	3	1	0	**4**	**4**
2	Basic Sciences	18B11PH212	Bioinstrumentation Techniques	3	1	0	**4**	**4**
3	Engg Science	18B11EC212	Basic Electrical Sciences	3	1	0	**4**	**4**
4	Engg Science	18B17EC272	Basic Electrical Sciences lab	0	0	2	**1**	**2**
5	Engg Science	18B11CI211	Data Structure & Algorithms	3	1	0	**4**	**4**
6	Engg Science	18B17CI271	Data Structure & Algorithms Lab	0	0	4	**2**	**4**
7	Engg Science	18BI7GE171	Workshop Practices	0	0	3	**1.5**	**3**
						Total	**20.5**	**25**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOINFORMATICS) 3rd SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS311	Interpersonal Dynamics Values and Ethics	3	0	0	**3**	**3**
2	Basic Sciences	18B11BI311	Cell and Molecular Biology	3	0	0	**3**	**3**
3	Engg Science	20B11BI311	Bioinformatics Data Management	3	1	0	**4**	**4**
4	Professional Core	18B11BI312	Microbiology & Immune System	3	1	0	**4**	**4**
5	Professional Core	18B11BI313	Biological Computation	3	1	0	**4**	**4**
6	Engg Science	20b17BI371	Bioinformatics Data Management Lab	0	0	2	**1**	**2**
7	Basic Sciences	18B17BI371	Cell and Molecular Biology Lab	0	0	2	**1**	**2**
8	Professional Core	18B17BI372	Microbiology & Immune System Lab	0	0	2	**1**	**2**
9	Professional Core	18B17BI373	Biological Computation Lab	0	0	2	**1**	**2**
10	Professional Core	18B17BI374	Linux Lab	0	0	2	**1**	**2**
						Total	**23**	**28**

B. TECH (BIOINFORMATICS) 4th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS411	Finance and Accounts	3	0	0	**3**	**3**
2	Basic Sciences	18B11MA411	Bio-Statistics	3	0	0	**3**	**3**
3	Professional Core	18B11BI412	Genetic Engineering and Genomics	3	0	0	**3**	**3**
4	Engg Science	18B11CI415	Object Oriented Programming	3	1	0	**4**	**4**
5	Professional Core	18B11BI413	Structural Biology	3	0	0	**3**	**3**
6	Professional Core	18B11BI414	Programming Languages for Bioinformatics	3	0	0	**3**	**3**
7	Engg Science	18B11CI474	Object Oriented Programming Lab	0	0	2	**1**	**2**
8	Basic Sciences	18B11MA412	Bio-Statistics Lab	0	0	2	**1**	**2**
9	Professional Core	18B17BI472	Genetic Engineering and Genomics Lab	0	0	2	**1**	**2**
10	Professional Core	18B17BI473	Structural Biology Lab	0	0	2	**1**	**2**
11	Professional Core	18B17BI474	Programming Languages for Bioinformatics Lab	0	0	2	**1**	**2**
12	Mandatory Course	18B11GE411	Environmental Studies	2	0	0	Audit	2
						Total	**24**	**31**

Approved in Academic Council held on 25.10.2018

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOINFORMATICS) 5th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS511	Project Management and Entrepreneurship	3	0	0	**3**	**3**
2	Professional Core	18B11BI511	Design and Analysis of Algorithms	3	0	0	**3**	**3**
3	Professional Core	18B11BT511	Bioprocess Engineering	3	1	0	**4**	**4**
4	Professional Core	18B11BI512	Scripting Languages for Bioinformatics	3	0	0	**3**	**3**
5	Professional Core	18B17BI571	Design and Analysis of Algorithms Lab	0	0	2	**1**	**2**
6	Professional Core	18B17BT571	Bioprocess Engineering Lab	0	0	2	**1**	**2**
7	Professional Core	18B17BI572	Scripting Languages for Bioinformatics Lab	0	0	2	**1**	**2**
8	Professional Core	18B17BI573	Structural Bioinformatics Lab	0	0	2	**1**	**2**
9	Professional Elective		Departmental Elective-I	3	0	0	**3**	**3**
10	Open Elective		Open Elective-I	3	0	0	**3**	**3**
11	Project	18B19BI591	Minor Project Part-I	0	0	2	**1**	**2**
						Total	**24**	**29**

B. TECH (BIOINFORMATICS) 6th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11BI611	Machine Learning for Bioinformatics	3	0	0	**3**	**3**
2	Professional Core	18B11BI612	Computer Aided Drug Design	3	0	0	**3**	**3**
3	Professional Core	18B17BI671	Machine Learning for Bioinformatics lab	0	0	2	**1**	**2**
4	Professional Core	18B17BI672	Computer Aided Drug Design Lab	0	0	2	**1**	**2**
5	Professional Core	18B17BI673	Advanced Algorithms for Bioinformatics Lab	0	0	2	**1**	**2**
6	Professional Core	18B17BI674	R Language Lab	0	0	2	**1**	**2**
7	Professional Elective		Departmental Elective-II	3	0	0	**3**	**3**
8	Professional Elective		Departmental Elective-III	3	0	0	**3**	**3**
9	Open Elective		Open Elective-II (HSS)	3	0	0	**3**	**3**
10	Project	18B19BI691	Minor Project Part-II	0	0	4	**2**	**4**
11	Mandatory Course		Industrial Training				**Audit**	
						Total	**21**	**27**

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COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOINFORMATICS) 7th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professiona l Elective		Departmental Elective- IV	3	0	0	**3**	**3**
2	Open Elective		Open Elective - III	3	0	0	**3**	**3**
3	Open Elective		Open Elective - IV	3	0	0	**3**	**3**
4	Project	18B19BI791	Major Project Part I	0	0	10	**5**	**10**
5	HSS		Indian Constitution	1	0	0	**Audit**	**1**
						Total	**14**	**20**

B. TECH (BIOINFORMATICS) 8th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective		Departmental Elective- V	3	0	0	**3**	**3**
2	Professional Elective		Departmental Elective- VI	3	0	0	**3**	**3**
3	Open Elective		Open Elective-V	3	0	0	**3**	**3**
4	Project	18B19BI891	Major Project Part II	0	0	14	**7**	**14**
						Total	**16**	**23**
			TOTAL CREDITS				**160**	
			TOTAL HOURS				**205**	
			HSS				**12**	
			Basic Science				**25**	
			Engg Science				**28**	
			Professional CORE				**47**	
			Professional Elective				**18**	
			OE				**15**	
			PROJECT				**15**	
			TOTAL CREDITS				**160**	**160**

Approved in Academic Council held on 25.10.2018

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOINFORMATICS)

PROFESSIONAL ELECTIVE-I

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBI531	Structural Bioinformatics	3	0	0	**3**	**3**
2	Professional Elective	18B1WBT532	Comparative & Functional Genomics	3	0	0	**3**	**3**
						Total	**3**	**3**

PROFESSIONAL ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBI631	Advanced Algorithms for Bioinformatics	3	0	0	**3**	**3**
2	Professional Elective	18B1WBT632	Infectious Diseases	3	0	0	**3**	**3**
						Total	**3**	**3**

PROFESSIONAL ELECTIVE-III

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBI632	Dataware housing and Mining for Bioinformatics	3	0	0	**3**	**3**
	Professional Elective	18B1WBT634	Bioenergy & Biofuels	3	0	0	**3**	**3**
						Total	**3**	**3**

PROFESSIONAL ELECTIVE-IV

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBI731	Computational Systems Biology	3	0	0	**3**	**3**
	Professional Elective	18B1WBT734	Intellectual Property Rights & Commercialization	3	0	0	**3**	**3**
						Total	**3**	**3**

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PROFESSIONAL ELECTIVE-V

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBT831	Genetic Counselling	3	0	0	**3**	**3**
2	Professional Elective	18B1WBI831	Computational Molecular Evolution	3	0	0	**3**	**3**
						Total	**3**	**3**

PROFESSIONAL ELECTIVE-VI

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBT833	Diagnostics & Vaccine Manufacture	3	0	0	**3**	**3**
2	Professional Elective	18B1WBI834	NGS Data Analysis & Applications	3	0	0	**3**	**3**
						Total	**3**	**3**

Jaypee University of Information Technology

B.Tech Bioinformatics

FOUR YEAR B.TECH COURSE CURRICULUM FOR BIOINFORMATICS

SEMESTER I (B1)

S.No	Course Code	Course Name	Contact Hours	Credits
1	10B11PD111	Presentation and Communication Skill	3	3
2	10B11MA112	*Basic Math-I OR	4	4
3	13B11BT111	*Fundamental Biology	3	3
4	10B11PH111	Physics-I	4	4
5	13B11BI112	Cell and Molecular Biology	4	4
6	10B11CI111	Introduction to Computers and Programming	4	4
7	10B17PH171	Physics Lab-I	2	1
8	13B17BI173	Introduction to Biocomputing Lab	2	1
9	10B17CI171	Introduction to Computers and Programming Lab	4	2
10	13B17BI174	Biological Databases Lab	2	1
11	13B17BI172	Cell and Molecular Biology Lab	2	1
12	13B17BT171	*Fundamanetal Biology Lab	2	1
		Total	**31/32**	**25**

* Basic Math-I **OR** Fundamental Biology (**Theory**) and Fundamental Biology Lab (**Practical**)

SEMESTER II (B2)

S.No	Course Code	Course Name	Contact Hours	Credits
1	10B11PD211	Group and Cooperative Processes	3	3
2	10B11MA212	Basic Math-II	4	4
3	10B11BI411	Molecular Genetics	4	4
4	10B11BI211	Structural Biology	4	4
5	10B11CI211	Data Structures	4	4
6	10B17BI472	Molecular Modeling Lab	4	2
7	10B17BI271	Structural Biology Lab	2	1
8	10B17CI271	Data Structures and Computer Programming Lab	4	2
9	10B17BI471	Molecular Genetics Lab	2	1
		Total	**31**	**25**

FOUR YEAR B.TECH COURSE CURRICULUM FOR BIOINFORMATICS

SEMESTER III (B3)

S.No	Course Code	Course Name	Contact Hours	Credits
1	10B11PD311	Managerial Economics	3	3
2	10B11MA311	Probability and Statistics	4	4
3	10B11CI312	Database Systems	4	4
4	10B11BI311	Biological Computation	4	4
5	14B11BI311	Microbiology and Immune System	4	4
6	10B17CI372	Database System Lab	2	1
7	10B17BI371	Biological Computation Lab	4	2
8	14B17BI371	Microbiology and Immune System Lab	2	1
9	14B17BI372	Linux Lab	4	2
		Total	**31**	**25**

SEMESTER IV (B4)

S.No	Course Code	Course Name	Contact Hours	Credits
1	10B11PD411	Financial Management	3	3
2	10B12MA421	Biostatistics	4	4
3	15B11BI411	Genetic Engineering and Genomics	4	4
4	10B11CI311	Object Oriented Programming	4	4
5	15B11BI421	Programming Languages for Bioinformatics	4	4
6	10B11GE411	Environmental Studies	3	3
7	15B11BI471	Genetic Engineering and Genomics Lab	2	1
8	10B17CI371	Object Oriented Programming Lab	2	1
9	15B12MA481	Biostatistics	2	1
10	15B11BI472	Programming Languages for Bioinformatics Lab	2	1
		Total	**30**	**25**

FOUR YEAR B.TECH COURSE CURRICULUM FOR BIOINFORMATICS

SEMESTER V (B5)

S.No	Course Code	Course Name	Contact Hours	Credits
1	10B11PD511	Introduction to Psychology	3	3
2	10B11C1412	Fundamentals of Algorithms	4	4
3	15B11BI511	Structural Bioinformatics	4	4
4	15B11BI512	Computational Genomics	4	4
5	10B11BI512	Scripting Languages for Bioinformatics	4	4
6	10B17C1472	Fundamentals of Algorithms Lab	2	1
7	15B17BI571	Structural Bioinformatics Lab	2	1
8	15B17BT671	Computational Genomics Lab	2	1
9	15B17BI572	Advanced Database System Lab	2	1
10	10B17BI572	Scripting Languages for Binformatics Lab	2	1
11	15B17BI574	Biomedical Informatics Lab	2	1
		Total	**31**	**25**

SEMESTER VI (B6)

S.No	Course Code	Course Name	Contact Hours	Credits
1	10B11PD611	Project Management	3	3
2	10B11BI612	Machine Learning for Bioinformatics	4	4
3	16B11BI611	Computer Aided Drug Design	4	4
4	16B11BI612	Data Warehousing and Mining for Bioinformatics	4	4
5	10B11BI614	Advanced Algorithms for Bioinformatics	4	4
6	10B17BI672	Machine Learning for Bioinformatics lab	2	1
7	16B17BI671	Computer Aided Drug Design Lab	4	2
8	16B17BI672	Data Warehousing and Mining for Bioinformatics Lab	2	1
9	10B17BI674	Advanced Algorithms for Bioinformatics Lab	2	1
10	16B17BI673	R Language Lab	2	1
		Total	**31**	**25**

FOUR YEAR B.TECH COURSE CURRICULUM FOR BIOINFORMATICS

SEMESTER VII (B7)

S.No	Course Code	Course Name	Contact Hours	Credits
1		Professional Dev – VII	3	3
2		DE-I	3	3
3		DE-II	3	3
4		DE-III	3	3
5	10B19B1791	Project Part-I	20	10
		Total	**32**	**22**

SEMESTER VIII (B8)

S.No	Course Code	Course Name	Contact Hours	Credits
1		Professional Dev – VIII	3	3
2		DE-V	3	3
3		DE-VI	3	3
4		DE-VII	3	3
5	10B19B1891	Project Part-II	20	10
		Total	**32**	**22**

LIST OF ELECTIVES

BIOINFORMATICS

S.No	Course code	Course Name
1	14B1WBI732	Computational Systems Biology
2	15B1WBI832	NGS Data Analysis and Applications
3	14B1WBI733	Clinical Data Management Systems
4	10B13BI732	Microbial Genomics
5	10B13BI736	High Throughput Screening Techniques
6	11B1WBT831	Protein Modelling
7	15B1WBT834	Cancer Biomarkers
8	15B1WBT838	Synthetic Biology
9	11B1WBT837	Clinical Trials and Database Management
10	14B1WBT734	Traditional Foods
11	11B1WBT838	Genetic Counselling
12	10B13BI737	Human Genome & Therapeutics
13	15B1WBT839	Infectious Diseases
14	10B13BI839	Pathogen Genomes
15	10B13BT834	Pharmacogenomics
16	14B1WBT737	Population Genomics
17	10B13BI831	Tool Design in Bioinformatics
18	11B1WBT832	Biosafety, Bioethics, IPR & Patents
19	15B1WPH832	Biophysics of Single Molecules
20	11B1WMA832	Linear programming and Applications
21	15B1WBT832	Chemical Biology
22	10B1WMA731	Optimization Techniques
23	11B2WBT853	Immunoinformatics
24	11B1WPY736	Natural products in Drug Leads

LIST OF ELECTIVES

MEDICAL

S.No	Course code	Course Name
1	10B1WBT733	Bioterrorism
2	14M1WBT332	Clinical Diagnostics
3	10I1WBT433	Gene Therapy
4	14B1WBT736	Antibody Engineering Technologies
5	14B1WBT733	Human Pathogens
6	10B13B1839	Pathogen Genomes
7	14B1WBT739	Stem Cells & Regenerative Medicine
8	10B1WBT731	Stem Cells and Healthcare
9	15M1BT432	Translational Genomics
10	1111WBT531	Vaccines
11	10B1WBT419	Cancer Biology
12	08B71BT432	Molecular Aspects of Life Style Diseases
13	14M1WBT333	Vaccine Production

FOOD AND AGRICULTURE

S.No	Course code	Course Name
1	11B1WBT834	Fermented Food Products Technology
2	14M1WBT331	Food Processing & Engineering
3	10B1WBT738	Functional Food Technology
4	15B1WBT841	Industrial Crops & Products
5	10B1WBT735	Industrial Plant Tissue Culture
6	15B1WBT837	Nutritional Security
7	1111WBT433	Plant Biotechnology
8	15B1WBT831	Plant-Microbe Interactions
9	15M1BT431	Traditional Bioprocesses

LIST OF ELECTIVES

INDUSTRIAL

S.No	Course code	Course Name
1	14B1WBT731	Bioenergy and Biofuels
2	11B1WBT841	Bioprocess Modelling and Simulation
3	15B1WBT836	Bioprocess Optimization & Upscaling
4	14B1WBT741	Bio-resources & Industrial Products
5	10B1WBT737	Environmental Biotechnology
6	11B1WBT833	Industrial Enzymes
7	11B1WBT836	Manufacturing Processes & QC
8	11B1WBT840	Nano Biotechnology
9	15B1WBT835	Product Manufacturing & Production
10	10B1WBT736	Protein Engineering and Applications
11	14M1WBT334	QC Analysis & Management
12	10I1WBT432	Antibody Engineering and Manufacturing Techniques
13	08B71BT435	Bio-energy Technology

OTHERS

S.No	Course code	Course Name
1	11B1WPH834	Biosensors
2	10B1WPH731	Nanoscience & Nanotechnology
3	11B1WBT832	IPR and Bioethics

B Tech Course Structure 2017-18 Biotechnology

Department of Biotechnology and Bioinformatics				
4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch				
		BTech I semester (B1)		
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**
1	PD	Presentation and Communication Skills	3	3
2	MA	Basic Math-I/ **OR**	4	4
	BT	Fundamental Biology	3	3
3	PH	Basic Engineering & Applied Physics	4	4
4	BT	Cell Biology	4	4
5	CI	Introduction to Computers and Basic Programing	4	4
6	PH	Physics Lab-1	2	1
7	BT	Cell Biology Lab	2	1
8	BT	GLP and Instrumentation Lab	4	2
9	CI	Basic Computer Programming Lab	4	2
	BT	Fundamental Biology Lab	2	1
		Total	**31**	**25**
	PD	English* (*This subject will be offered as an audit course for students with less than 60% marks)		
4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch				
		BTech II semester (B2)		
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**
1	PD	Group and Cooperative Processes	3	3
2	MA	Basic Math-II	4	4
3	BT	Genetics	4	4
4	BT	General Chemistry	4	4
5	CI	Basic Data Structures	4	4
6	BT	Genetics Lab	4	2
7	BT	Chemistry Lab	2	1

8	CI	Basic Data Structures & Computer Programming Lab	4	2
		Total	**29**	**24**

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

BTech III semester (B3)

SN	Sub Code	Subject	Contact hours	Credits
1	PD	Managerial Economics	3	3
2	MA	Probability & Statistics	4	4
3	BT	Thermodynamics & Chemical Processes	4	4
4	BT	Biochemistry	4	4
5	BT	Microbiology	4	4
		Thermodynamics & Chemical Processes Lab	2	1
7	BT	Biochemistry Lab	4	2
8	BT	Microbiology Lab	4	2
		Total	**29**	**24**

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

BTech IV semester (B4)

SN	Sub Code	Subject	Contact hours	Credits
1	PD	Financial Management	3	3
2	BT	Cell Culture Technology	4	4
3	EC	Basic Electronics	4	4
4	PH	Biophysical Techniques	4	4
5	BT	Molecular Biology	4	4
7	GE	Environmental Studies	3	3
8	BT	Molecular Biology Lab	4	2
9	BT	Animal Tissue Culture Lab	2	1
10	BT	Plant Tissue Culture Lab	2	1
11	EC	Basic Electronics Lab	2	1
		Total	**32**	27

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

BTech V semester (B5)

SN	Sub Code	Subject	Contact hours	Credits
1	PD	Social & Legal Issues	3	3
2	BI	Elective course from Bioinformatics	4	4
3	BT	Bioprocess Engineering	4	4
4	BT	Genetic Engineering	4	4
5	BT	Immunology	4	4
6	BT	Bioinformatics Lab	2	1
7	BT	Bioprocess Engineering Lab	4	2
8	BT	Genetic Engineering Lab	4	2
9	BT	Immunology Lab	2	1
10.		Minor Project-I		2
		Total	**31**	**27**

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

BTech VI semester (B6)

SN	Sub Code	Subject	Contact hours	Credits
1	PD	Project Management/Open Elective	3	3
2	BT	Comparative and Functional genomics	4	4
3	BT	Food and Agricultural Biotechnology	4	4
4	BT	Downstream Processing	4	4
5	BT	Diagnostics & Vaccine Manufacture Technologies	4	4
6	BT	Comparative and Functional Genomics Lab	4	2
7	BT	Food and Agricultural Biotechnology Lab	4	2
8	BT	Downstream Processing Lab.	4	2
9	BT	Diagnostics & Vaccine Manufacture Technologies Lab	2	1
10	GE	Industrial Training		0
		Minor Project-II		2
		Total	**33**	**28**

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

		BTech VII semester (B7)		
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**
1		Professional Dev – VII/Open Elective/Moocs	3	3
2		DE-I	3	3
3		DE-II	3	3
4		DE-III	3	3
5	BT	Project Part I	16	8
		Total	**28**	**20**

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

		BTech VIII semester (B8)		
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**
1.		Professional Dev – VIII Open Elective/Moocs	3	3
2.		DE-IV	3	3
3.		DE-V	3	3
4.		DE-VI	3	3
		Project Part-II	16	8
		Total	**28**	**20**
		Total Credits		**195**
		Credit Summary	**Credits**	
		Sem1	25	
		Sem2	24	
		Sem3	24	
		Sem4	27	
		Sem5	27	
		Sem6	28	
		Sem7	20	
		Sem8	20	
		Total	**195**	

B.TECH. BIOTECHNOLOGY

COURSE STRUCTURE

Approved in Academic Council held on 25.10.2018

Department of Biotechnology & Bioinformatics

PROGRAM OUTCOMES

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Approved in Academic Council held on 25.10.2018

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOTECHNOLOGY) 1st SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS111	English and Technical Communication	2	0	0	**2**	**2**
2		18B1HS171	English and Technical Communication Lab	0	0	2	**1**	**2**
3		18B11MA112	Basic Mathematics -1 OR	3	1	0	**4**	**4**
4	Basic Sciences	18B11BT111	Fundamental Biology	3	0	0	**3**	**3**
5		18B17BT171	Fundamental Biology lab	0	0	2	**1**	**2**
6	Basic Sciences	18B11PH112	Basic Engineering Physics-I	3	1	0	**4**	**4**
7	Engg Science	19B11CI111	Programming for Problem Solving-II	2	0	0	**2**	**2**
8	Engg Science	18B17GE173	Engineering Graphics	0	0	3	**1.5**	**3**
9	Basic Sciences	18B17PH172	Basic Engineering Physics Lab-I	0	0	2	**1**	**2**
10	Engg Science	19B17CI171	Programming for Problem Solving Lab-II	0	0	4	**2**	**4**
						Total	**17.5**	**23**

B. TECH (BIOTECHNOLOGY) 2nd SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Basic Sciences	18B11MA212	Basic Mathematics-II	3	1	0	**4**	**4**
2	Basic Sciences	18B11PH212	Bioinstrumentation Techniques	3	1	0	**4**	**4**
3	Engg Science	18B11EC212	Basic Electrical Sciences	3	1	0	**4**	**4**
4	Engg Science	18B17EC272	Basic Electrical Sciences lab	0	0	2	**1**	**2**
5	Engg Science	18B11CI211	Data Structure & Algorithms	3	1	0	**4**	**4**
6	Engg Science	18B17CI271	Data Structure & Algorithms Lab	0	0	4	**2**	**4**
7	Engg Science	18BI7GE171	Workshop Practices	0	0	3	**1.5**	**3**
						Total	**20.5**	**25**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOTECHNOLOGY) 3rd SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS311	Interpersonal Dynamics Values and Ethics	3	0	0	**3**	**3**
2	Basic Sciences	18B11MA312	Probability & Statistical Techniques	3	1	0	**4**	**4**
3	Professional Core	18B11BT311	Genetics	3	1	0	**4**	**4**
4	Professional Core	18B11BT312	Biochemistry	3	0	0	**3**	**3**
5	Engg Science	18B11BT313	Thermodynamics & Chemical Processes	3	1	0	**4**	**4**
6	Basic Sciences	18B11BT314	General Chemistry	3	0	0	**3**	**3**
7	Professional Core	18B17BT371	Genetics Lab.	0	0	2	**1**	**2**
8	Basic Sciences	18B17BT372	Biochemistry Lab	0	0	2	**1**	**2**
9	Engg Science	18B17BT373	Thermodynamics & Chemical Processes lab	0	0	2	**1**	**2**
10	Basic Sciences	18B17BT374	General Chemistry Lab	0	0	2	**1**	**2**
						Total	**25**	**29**

B. TECH (BIOTECHNOLOGY) 4th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS411	Finance and Accounts	3	0	0	**3**	**3**
2	Professional Core	18B11BT411	Cell Biology and Culture Technologies	3	1	0	**4**	**4**
3	Professional Core	18B11BT412	Molecular Biology	3	0	0	**3**	**3**
4	Professional Core	18B11BT413	Introduction to Bioinformatics	3	1	0	**4**	**4**
5	Professional Core	18B11BT414	Microbiology	3	1	0	**4**	**4**
6	Professional Core	18B17BT471	Cell Biology and Culture Technologies lab	0	0	2	**1**	**2**
7	Professional Core	18B17BT472	Molecular Biology Lab	0	0	2	**1**	**2**
8	Professional Core	18B17BT473	Introduction to Bioinformatics lab	0	0	2	**1**	**2**
9	Professional Core	18B17BT474	Microbiology Lab	0	0	2	**1**	**2**
10	Mandatory Course	18B11GE411	Environmental Studies	2	0	0	Audit	2
						Total	**22**	**28**

Approved in Academic Council held on 25.10.2018

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOTECHNOLOGY) 5th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS511	Project Management and Entrepreneurship	3	0	0	**3**	**3**
2	Engg Science	18B11BT511	Bioprocess Engineering	3	1	0	**4**	**4**
3	Professional Core	18B11BT512	Genetic Engineering	3	1	0	**4**	**4**
4	Professional Core	18B11BT513	Immunology	3	1	0	**4**	**4**
5	Engg Science	18B17BT571	Bioprocess Engineering Lab	0	0	2	**1**	**2**
6	Professional Core	18B17BT572	Genetic Engineering Lab	0	0	2	**1**	**2**
7	Professional Core	18B17BT573	Immunology Lab	0	0	2	**1**	**2**
8	Professional Elective		Departmental Elective-I	3	0	0	**3**	**3**
9	Project	18B19BT591	Minor Project Part-I	0	0	2	**1**	**2**
						Total	**22**	**26**

B. TECH (BIOTECHNOLOGY) 6th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11BT611	Downstream Processing	3	1	0	**4**	**4**
2	Professional Core	18B11BT612	Food and Agricultural Biotechnology	3	0	0	**3**	**3**
3	Professional Core	18B17BT671	Downstream Processing Lab.	0	0	2	**1**	**2**
4	Professional Core	18B17BT672	Food and Agricultural Biotechnology Lab	0	0	2	**1**	**2**
5	Professional Elective		Departmental Elective- II	3	0	0	**3**	**3**
6	Professional Elective		Departmental Elective-III	3	0	0	**3**	**3**
7	Open Elective		Open Elective-I (HSS)	3	0	0	**3**	**3**
8	Open Elective		Open Elective-II	3	0	0	**3**	**3**
9	Project	18B19BT691	Minor Project Part-II	0	0	4	**2**	**4**
10	Mandatory Course		Industrial Training				**Audit**	
						Total	**23**	**27**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOTECHNOLOGY) 7th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective		Departmental Elective- IV	3	0	0	**3**	**3**
2	Open Elective		Open Elective - III	3	0	0	**3**	**3**
3	Open Elective		Open Elective - IV	3	0	0	**3**	**3**
4	Project	18B19BT791	Major Project Part I	0	0	10	**5**	**10**
5	HSS		Indian Constitution	1	0	0	**Audit**	**1**
						Total	**14**	**20**

B. TECH (BIOTECHNOLOGY) 8th SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective		Departmental Elective- V	3	0	0	**3**	**3**
2	Professional Elective		Departmental Elective- VI	3	0	0	**3**	**3**
3	Open Elective		Open Elective-V	3	0	0	**3**	**3**
4	Project	18B19BT891	Major Project Part II	0	0	14	**7**	**14**
						Total	**16**	**23**
			TOTAL CREDITS				**160**	
			TOTAL HOURS				**200**	
			HSS				**12**	
			Basic Science				**25**	
			Engg Science				**28**	
			Professional CORE				**47**	
			Professional Elective				**18**	
			OE				**15**	
			PROJECT				**15**	
			TOTAL CREDITS				**160**	**160**

Approved in Academic Council held on 25.10.2018

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF BT & BI DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (BIOTECHNOLOGY)

PROFESSIONAL ELECTIVE-I

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBT531	Phytopharmaceuticals and Biologicals	3	0	0	**3**	**3**
2	Professional Elective	18B1WBT532	Comparative & Functional Genomics	3	0	0	**3**	**3**
						Total	**3**	**3**

PROFESSIONAL ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBT631	Peptide Therapeutics	3	0	0	**3**	**3**
2	Professional Elective	18B1WBT632	Infectious Diseases	3	0	0	**3**	**3**
						Total	**3**	**3**

PROFESSIONAL ELECTIVE-III

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBT633	Nano-Biotechnology	3	0	0	**3**	**3**
	Professional Elective	18B1WBT634	Bioenergy & Biofuels	3	0	0	**3**	**3**
						Total	**3**	**3**

PROFESSIONAL ELECTIVE-IV

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBT733	Industrial Enzymes Technologies	3	0	0	**3**	**3**
	Professional Elective	18B1WBT734	Intellectual Property Rights & Commercialization	3	0	0	**3**	**3**
						Total	**3**	**3**

PROFESSIONAL ELECTIVE-V								
S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBT831	Genetic Counselling	3	0	0	**3**	**3**
2	Professional Elective	18B1WBT832	Traditional Bioprocessing & Their Up Scaling	3	0	0	**3**	**3**
						Total	**3**	**3**
PROFESSIONAL ELECTIVE-VI								
S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WBT833	Diagnostics & Vaccine Manufacture	3	0	0	**3**	**3**
2	Professional Elective	18B1WBI834	NGS Data Analysis & Applications	3	0	0	**3**	**3**
						Total	**3**	**3**
OPEN ELECTIVE-I								
S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WBT635	Biology for Engineers	3	0	0	**3**	**3**
						Total	**3**	**3**
OPEN ELECTIVE-II								
S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WBT636	Industrial Chemistry	3	0	0	**3**	**3**
						Total	**3**	**3**
OPEN ELECTIVE-III								
S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	19B1WBT731	Sustainable Technologies for Waste Management	3	0	0	**3**	**3**
						Total	**3**	**3**
OPEN ELECTIVE-IV								
S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	19B1WBT732	Food Nutrition & Health Care	3	0	0	**3**	**3**
						Total	**3**	**3**

M. Tech. Biotechnology – 2021 Batch onwards

Program Educational Objectives (PEOs)

PEO-1: To impart basic and advance knowledge in the emerging areas biotechnologies
PEO-2: To inculcate the laboratory skills to cater the needs of industries and high end research
PEO-3: To inculcate team work with ethics to solve problems using multidisciplinary approaches

M.Tech. Biotechnology Course Curriculum

FIRST SEMESTER

Sr.No.	Code	Subject	L-T-P	Credits
1	13M11BT111	Advances in Molecular Cell Biology	3-0-0	3
2	13M17BT171	Advances in Molecular Cell Biology Lab	0-0-2	1
3	18M11BT113	Research Methodology and Ethics	3-0-0	3
4	18M11BT114	Patenting in Biotechnology	3-0-0	3
5	13M11BT112	Advanced Bioinformatics	3-0-0	3
6	13M17BT172	Advanced Bioinformatics Lab	0-0-2	1
7	13M11BT114	High Throughput Technologies	3-0-0	3
8	Elective	DE-1	3-0-0	3
9	Elective	DE-II	3-0-0	3
		Total	**25**	**23**

SECOND SEMESTER

Sr.No.	Code	Subject	L-T-P	Credits
1	14M11BT211	Industrial Biotechnology	3-0-0	3
2	14M17BT271	Industrial Biotechnology Lab	0-0-2	1
3	14M11BT212	Immunotechnology	3-0-0	3
4	14M17BT272	Immunotechnology Lab	0-0-2	1
5	14M11BT214	Bioenterpreunership Management	2-0-0	2
6	14M11BT213	Functional Genomics	3-0-0	3
7	14M17BT273	Functional Genomics Lab	0-0-2	1
8	14M11BT215	Metabolic Engineering	3-0-0	3
9	Elective	DE-III	3-0-0	3
10	Elective	DE-1V	3-0-0	3
		Total	**26**	**23**

THIRD SEMESTER

Sr.No.	Code	Subject	L-T-P	Credits
1.		Seminar	0-0-4	2
4.		Project- Thesis Part I		12
		Total	**04**	**14**

FOURTH SEMESTER

Sr. No.	Code	Subject	L-T-P	Credits
1.		Seminar	0-0-4	2
3.		Project- Thesis Part II		14
		Total	**04**	**16**

Total Credit Hours: 76

Approved in Academic Council Meeting held on 28 July, 2021

M. Tech. Biotechnology Electives courses

ODD SEMESTER			
	Course Code	Credits	Elective Courses
1	20M1WBT131	03	Food Processing & Engineering
2	20M1WBT132	03	Plant Tissue Culture Technologies
3	18M1WBT134	03	Microbial Ecology
4	20M1WBT134	03	Advances in Gene manipulations
5	20M1WBT133	03	Vaccine Production
6	18M1WBT133	03	Advances in Computational System Biology

EVEN SEMESTER			
	Course Code	Credits	Elective Courses
1	20M1WBT232	03	Industrial Enzyme Technology
2	20M1WBT231	03	QC Analysis and Management
3	20M1WBT234	03	Clinical Diagnostics
4	11IIWBT433	03	Plant Biotechnology
5	11BIWBT840	03	Nano Biotechnology

M. Tech. Biotechnology Course Curriculum (modified 2018 & 2019)

1st SEMESTER

Sr. No.	Code	Subject	L-T-P	Credits
1		Advances in Molecular Cell Biology	3-0-0	3
2		Advances in Molecular Cell Biology Lab	0-0-2	1
3		Research Methodology and Ethics	3-0-0	3
4		Patenting in Biotechnology	3-0-0	3
5		Advanced Bioinformatics	3-0-0	3
6		Advanced Bioinformatics Lab	0-0-2	1
7		High Throughput Technologies	3-0-0	3
8	Elective	DE-1	3-0-0	3
9	Elective	DE-II	3-0-0	3
		Total	**25**	**23**

2nd SEMESTER

Sr. No.	Code	Subject	L-T-P	Credits
1		Industrial Biotechnology	3-0-0	3
2		Industrial Biotechnology Lab	0-0-2	1
3		Immunotechnology	3-0-0	3
4		Immunotechnology Lab	0-0-2	1
5		Bioenterpreunership Management	2-0-0	2
6		Functional Genomics	3-0-0	3
7		Functional Genomics Lab	0-0-2	1
8		Metabolic Engineering	3-0-0	3
9	Elective	DE-III	3-0-0	3
10	Elective	DE-1V	3-0-0	3
		Total	**26**	**23**

3rd SEMESTER

Sr. No.	Code	Subject	L-T-P	Credits
1.		Seminar	0-0-4	2
4.		Project- Thesis Part I		12
		Total	**04**	**14**

4th SEMESTER

Sr. No.	Code	Subject	L-T-P	Credits
1.		Seminar	0-0-4	2
3.		Project- Thesis Part II		14
		Total	**04**	**16**

Total Credit Hours: 76

M. Tech. Biotechnology Electives courses;

	Code	Credits	Electives in Odd Semester
1		03	Food Processing & Engineering
2			Plant Tissue Culture Technologies
3		03	Advances in Computational System Biology
4		03	Microbial Ecology

	Code	Credits	Electives in Even semester
1		03	Vaccine Production
2		03	QC Analysis and Management
3		03	Clinical Diagnostics
4.		03	Plant Biotechnology
5.		03	Advances in Gene manipulations

Jaypee University of Information Technology

M.TECH (Biotechnology) Course Curriculum

M.Tech. Programme

The M.Tech. programme has been designed with the following objectives and goals:

To promote specialized or inter-disciplinary project/ dissertation work of an advanced nature,

To attract the best talent for higher studies and,

To build requisite academic flexibility for a student-centric program in which students can learn at their own pace and which enables interaction with the professional world

The M. Tech. program provides compulsory core courses, elective subjects and intensive project work in the respective area of specialization. Through compulsory core subjects the students acquire a state-of-the-art advanced knowledge. The elective courses provide an opportunity to further specialize in the field depending on his/her interest and future career plans. For project work, students are required to take up problems on a particular topic in the field to focus their study and work. They are required to submit a dissertation/ report at the end of the project work compiling their study. M.Tech. project and dissertation work usually enables students to publish their results. Project work prepares students to take up challenging research and development tasks. Seminars are part of the M.Tech. curriculum for which students collect material on specific current topics and make presentations.

M.Tech. in Biotechnology

The M.Tech in Biotechnology program is designed to offer diverse and extensive aspects of biotechnology and life sciences with strong emphasis on research. It encompasses streams such as Metabolic Engineering, Bioprocess Engineering, Molecular Biology of Infectious Diseases, Microbial Technology, Industrial Enzymes and Protein Engineering; Plant Cell Culture Technologies, Bioremediation, Food Technology & Probiotics, Biosynthetic Pathway Discovery and Gene Function, Genomic, Proteomic and Metabolomic Technologies, etc. Curriculum is enriched to help students to fulfill their research aspirations and current industrial demands. Working along with a blend of Ph.D. students and research fellows involved in intense research enhances the quality of research experience for M.Tech. students.

M.TECH (Biotechnology) Course Curriculum

TWO YEAR M.TECH COURSE CURRICULUM FOR BIOTECHNOLOGY

SEMESTER I (M1)

S.No	Course Code	Course Name	Contact Hours	Credits
1	13M11BT111	Advances in Molecular Cell Biology	3	3
2	13M11BT171	Advances in Molecular Cell Biology Lab	2	1
3	13M11BT115	Research Methodology	3	3
4	13M11BT113	IPR, Biosafety and Bioethics	3	3
5	13M11BT112	Advanced Bioinformatics	3	3
6	13M11BT172	Advanced Bioinformatics Lab	2	1
7	13M11BT114	High Throughput Technologies	3	3
		Total	**19**	**17**

SEMESTER II (M2)

S.No	Course Code	Course Name	Contact Hours	Credits
1	14M11BT211	Industrial Biotechnology	3	3
2	14M17BT271	Industrial Biotechnology Lab	2	1
3	14M11BT212	Immunotechnology	3	3
4	14M17BT272	Immunotechnology Lab	2	1
5	14M11BT214	Bioenterpreunership and Management	2	2
6	14M11BT213	Functional Genomics	3	3
7	14M17BT273	Functional Genomics Lab	2	1
8	14M11BT215	Metabolic Engineering	3	3
		Total	**20**	**17**

TWO YEAR M.TECH COURSE CURRICULUM FOR BIOTECHNOLOGY

SEMESTER III (M3)

S.No	Course Code	Course Name	Contact Hours	Credits
1		DE-I	3	3
2		DE-II	3	3
3		DE-III	3	3
4	14M19BT391	Project-Thesis Part I	24	12
5	14M19BT392	Seminar	2	1
		Total	**35**	**22**

SEMESTER IV (M4)

S.No	Course Code	Course Name	Contact Hours	Credits
1		DE-IV	3	3
2		DE-V	3	3
4	15M19BT 491	Project-Thesis Part II	28	14
		Total	**34**	**20**

LIST OF ELECTIVES

MEDICAL

S.No	Course code	Course Name
1	10B1WBT733	Bioterrorism
2	14M1WBT332	Clinical Diagnostics
3	10I1WBT433	Gene Therapy
4	14B1WBT736	Antibody Engineering Technologies
5	14B1WBT733	Human Pathogens
6	10B13B1839	Pathogen Genomes
7	14B1WBT739	Stem Cells & Regenerative Medicine
8	10B1WBT731	Stem Cells and Healthcare
9	15M1BT432	Translational Genomics
10	1111WBT531	Vaccines
11	10B1WBT419	Cancer Biology
12	08B71BT432	Molecular Aspects of Life Style Diseases
13	14M1WBT333	Vaccine Production

FOOD AND AGRICULTURE

S.No	Course code	Course Name
1	11B1WBT834	Fermented Food Products Technology
2	14M1WBT331	Food Processing & Engineering
3	10B1WBT738	Functional Food Technology
4	15B1WBT841	Industrial Crops & Products
5	10B1WBT735	Industrial Plant Tissue Culture
6	15B1WBT837	Nutritional Security
7	1111WBT433	Plant Biotechnology
8	15B1WBT831	Plant-Microbe Interactions
9	15M1BT431	Traditional Bioprocesses

INDUSTRIAL

S.No	Course code	Course Name
1	14B1WBT731	Bioenergy and Biofuels
2	11B1WBT841	Bioprocess Modelling and Simulation
3	15B1WBT836	Bioprocess Optimization & Upscaling
4	14B1WBT741	Bio-resources & Industrial Products
5	10B1WBT737	Environmental Biotechnology
6	11B1WBT833	Industrial Enzymes
7	11B1WBT836	Manufacturing Processes & QC
8	11B1WBT840	Nano Biotechnology
9	15B1WBT835	Product Manufacturing & Production
10	10B1WBT736	Protein Engineering and Applications
11	14M1WBT334	QC Analysis & Management
12	1011WBT432	Antibody Engineering and Manufacturing Techniques
13	08B71BT435	Bio-energy Technology

OTHERS

S.No	Course code	Course Name
1	11B1WPH834	Biosensors
2	10B1WPH731	Nanoscience & Nanotechnology
3	11B1WBT832	IPR and Bioethics

BIOINFORMATICS

S.No	Course code	Course Name
1	14B1WBI732	Computational Systems Biology
2	15B1WBI832	NGS Data Analysis and Applications
3	14B1WBI733	Clinical Data Management Systems
4	10B13BI732	Microbial Genomics
5	10B13BI736	High Throughput Screening Techniques
6	11B1WBT831	Protein Modelling
7	15B1WBT834	Cancer Biomarkers
8	15B1WBT838	Synthetic Biology
9	11B1WBT837	Clinical Trials and Database Management
10	14B1WBT734	Traditional Foods
11	11B1WBT838	Genetic Counselling
12	10B13BI737	Human Genome & Therapeutics
13	15B1WBT839	Infectious Diseases
14	10B13BI839	Pathogen Genomes
15	10B13BT834	Pharmacogenomics
16	14B1WBT737	Population Genomics
17	10B13BI831	Tool Design in Bioinformatics
18	11B1WBT832	Biosafety, Bioethics, IPR & Patents
19	15B1WPH832	Biophysics of Single Molecules
20	11B1WMA832	Linear programming and Applications
21	15B1WBT832	Chemical Biology
22	10B1WMA731	Optimization Techniques
23	11B2WBT853	Immunoinformatics
24	11B1WPY736	Natural products in Drug Leads

B.TECH. CIVIL ENGINEERING

COURSE STRUCTURE

Approved in Academic Council held on 25.10.2018

B.TECH. CIVIL ENGINEERING

PROGRAM OBJECTIVES

PO 1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engg. specialization to the solution of complex engineering problems.

PO-2 Problem analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO-3 Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

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

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

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

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

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

PO-10 Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO-11 Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

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

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF CIVIL ENGINEERING DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (CIVIL ENGINEERING) 1st SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Humanities & Social Science	18B11HS111	English and Technical Communication	2	0	0	**2**	**2**
2	Humanities & Social Science	18B17HS171	English and Technical Communication Lab	0	0	2	**1**	**2**
3	Basic Science Courses	18B11MA111	Engineering Mathematics -I	3	1	0	**4**	**4**
4	Basic Science Courses	18B11PH111	Engineering Physics-I	3	1	0	**4**	**4**
5	Basic Science Courses	18B17PH171	Engineering Physics Lab - I	0	0	2	**1**	**2**
6	Engineering Science Course	19B11CI111	Programming for Problem Solving-II	2	0	0	**2**	**2**
7	Engineering Science Course	19B17CI171	Programming for problem solving Lab-II	0	0	4	**2**	**4**
8	Engineering Science Courses	18B17GE173	Engineering Graphics **OR**	0	0	3	**1.5**	**3**
		18B17GE171	Workshop Practice					
9		18B17GE172	Mandatory Induction Program	-	-	-	-	-
				Total			**17.5**	**23**

B. TECH (CIVIL ENGINEERING) 2nd SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Engineering Science Courses	18B11EC211	Electrical Science	3	1	0	**4**	**4**
2	Engineering Science Courses	18B17CI211	Data Structure & Algorithms	3	1	0	**4**	**4**
3	Basic Science Courses	18B11MA211	Engineering Mathematics -II	3	1	0	**4**	**4**
4	Basic Science Courses	18B11PH211	Engineering Physics-II	3	0	0	**3**	**3**
5	Basic Science Courses	18B17PH271	Engineering Physics Lab -II	0	0	2	**1**	**2**
6	Engineering Science Courses	18B17EC271	Electrical Science Lab	0	0	2	**1**	**2**
7	Engineering Science Courses	18B17CI271	Data Structure & Algorithms Lab	0	0	4	**2**	**4**
8	Engineering Science Courses	18B17GE171	Workshop Practice **OR**	0	0	3	**1.5**	**3**
		18B17GE173	Engineering Graphics					
				Total			**20.5**	**26**

Approved in Academic Council held on 25.10.2018

B. TECH (CIVIL ENGINEERING) 3rd SEMESTER								
S. No.	**Category Code**	**Subject Code**	**Name of the Subjects**	**Course Hours**			**Credits**	**Total Hours**
				L	**T**	**P**		
1	Engineering Science Courses	18B11CE315	Engineering Mechanics	3	0	0	**3**	**3**
2	Professional Core Courses	18B17CE373	Concrete Technology Lab	0	0	2	**1**	**2**
3	Professional Core Courses	18B11CE313	Building Materials & Construction	3	0	0	**3**	**3**
4	Professional Core Courses	18B11CE312	Surveying	3	0	0	**3**	**3**
5	Professional Core Courses	18B11CE314	Water Supply Engineering	3	0	0	**3**	**3**
6	Professional Core Courses	18B17CE372	Surveying Lab	0	0	2	**1**	**2**
7	Basic Science Courses	18B11CE311	Chemistry	3	0	0	**3**	**3**
8	Basic Science Courses	18B17CE371	Chemistry Lab	0	0	2	**1**	**2**
9	Basic Science Courses	18B11MA311	Numerical Methods	3	0	0	**3**	**3**
10	Humanities & Social Science	18B11HS311	Interpersonal Dynamics, Values and Ethics	3	0	0	**3**	**3**
				Total			**24**	**27**

B. TECH (CIVIL ENGINEERING) 4th SEMESTER								
S. No.	**Category Code**	**Subject Code**	**Name of the Subjects**	**Course Hours**			**Credits**	**Total Hours**
				L	**T**	**P**		
1	Professional Core Courses	18B11CE415	Mechanics of Solids	3	0	0	**3**	**3**
2	Engineering Science Courses	18B11CE413	Computer Aided Civil Engineering Drawing	0	0	2	**1**	**2**
3	Professional Core Courses	18B11CE412	Fluid Mechanics	3	0	0	**3**	**3**
4	Professional Core Courses	18B11CE414	Water Resources Engineering	3	0	0	**3**	**3**
5	Professional Core Courses	18B11CE411	Geotechnical Engineering	3	0	0	**3**	**3**
6	Professional Core Courses	18B17CE471	Geotechnical Engineering Lab	0	0	2	**1**	**2**
7	Professional Core Courses	18B17CE472	Fluid Mechanics Lab	0	0	2	**1**	**2**
8	Humanities & Social Science	18B11HS411	Finance and Accounts	3	0	0	**3**	**3**
9	Mandatory Courses	18B11GE411	Environmental Studies	2	0	0	**0**	**2**
				Total			**18**	**23**

B. TECH (CIVIL ENGINEERING) 5th SEMESTER								
S. No.	**Category Code**	**Subject Code**	**Name of the Subjects**	**Course Hours**			**Credits**	**Total Hours**
				L	**T**	**P**		
1	Professional Core Courses	18B11CE513	Structural Analysis	3	0	0	**3**	**3**
2	Professional Core Courses	18B11CE512	Sewage Treatment and Disposal	3	0	0	**3**	**3**
3	Professional Elective Courses		Elective -1	3	0	0	**3**	**3**
4	Professional Core Courses	18B17CE572	Environmental Engineering Lab	0	0	2	**1**	**2**
5	Professional Core Courses	18B11CE515	Design of Concrete Structures	3	1	0	**4**	**4**
6	Professional Core Courses	18B11CE511	Highway Engineering	3	0	0	**3**	**3**
7	Professional Core Courses	18B17CE571	Highway Engineering Lab	0	0	2	**1**	**2**
8	Humanities & Social Science	18B11HS511	Project Management and Entrepreneurship	3	0	0	**3**	**3**
9	Professional Core Courses	18B11CE514	Foundation Engineering	3	0	0	**3**	**3**
				Total			**24**	**26**

B. TECH (CIVIL ENGINEERING) 6 th SEMESTER								
S. No.	**Category Code**	**Subject Code**	**Name of the Subjects**	**Course Hours**			**Credits**	**Total Hours**
				L	**T**	**P**		
1	Professional Core Courses	18B11CE611	Concrete Technology	3	0	0	**3**	**3**
2	Professional Elective Courses		Elective -2	3	0	0	**3**	**3**
3	Professional Core Courses	18B11CE612	Design of Steel Structures	3	0	0	**3**	**3**
4	Professional Elective Courses		Elective -3	3	0	0	**3**	**3**
5	Professional Elective Courses		Elective -4	3	0	0	**3**	**3**
6	Open Elective		Open Elective 1 (HSS)	3	0	0	**3**	**3**
7	Professional Core Courses	18B17CE671	Computer Aided Planning and Costing	0	0	4	**2**	**4**
8	Project	18B19CE691	Minor Project	0	0	6	**3**	**6**
				Total			**23**	**28**

B. TECH (CIVIL ENGINEERING) 7 th SEMESTER								
S. No.	**Category Code**	**Subject Code**	**Name of the Subjects**	**Course Hours**			**Credits**	**Total Hours**
				L	**T**	**Project Hours**		
1	Open Elective		Open Elective 2	3	0	0	**3**	**3**
2	Open Elective		Open Elective 3	3	0	0	**3**	**3**
3	Project	18B19CE791	Major Project-I	0	0	12	**6**	**12**
4	Professional Elective Courses		Elective - 5	3	0	0	**3**	**3**
5	Professional Elective Courses		Elective - 6	3	0	0	**3**	**3**
6	Mandatory Courses	18B11GE111	Indian Constitution (HSS Audit)	1	0	0	**0**	**1**
				Total			**18**	**25**

B. TECH (CIVIL ENGINEERING) 8 th SEMESTER								
S. No.	**Category Code**	**Subject Code**	**Name of the Subjects**	**Course Hours**			**Credits**	**Total Hours**
				L	**T**	**Project Hours**		
1	Project	18B19CE891	Major Project-II	0	0	12	**6**	**12**
2	Professional Elective Courses		Elective - 7	3	0	0	**3**	**3**
3	Open Elective		Open Elective 4	3	0	0	**3**	**3**
4	Open Elective		Open Elective 5	3	0	0	**3**	**3**
				Total			**15**	**21**

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B. TECH (CIVIL ENGINEERING)

ELECTIVE-I

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCE531	Construction Technology and Management	3	0	0	3	3
2	Professional Elective	18B1WCE532	Solid Waste Management	3	0	0	3	3
3	Professional Elective	18B1WCE533	Air and Noise Pollution and Control	3	0	0	3	3
						Total	3	3

ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCE631	Advanced Structural Analysis	3	0	0	3	3
2	Professional Elective	18B1WCE632	Pavement Analysis and Design	3	0	0	3	3
3	Professional Elective	18B1WCE633	Industrial Waste Treatment	3	0	0	3	3
						Total	3	3

ELECTIVE-III

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCE634	Transportation Engineering	3	0	0	3	3
2	Professional Elective	18B1WCE635	Traffic Engineering	3	0	0	3	3
3	Professional Elective	18B1WCE636	Highway Construction, Maintenance and Management	3	0	0	3	3
						Total	3	3

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B. TECH (CIVIL ENGINEERING)

ELECTIVE-IV

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCE637	Advanced Concrete Technology	3	0	0	3	3
2	Professional Elective	18B1WCE638	Underground Technology	3	0	0	3	3
3	Professional Elective	18B1WCE639	Open Channel Flow and Hydraulic Machine	3	0	0	3	3
						Total	3	3

ELECTIVE-V

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCE731	FEM and its Applications in Civil Engineering	3	0	0	3	3
2	Professional Elective	18B1WCE732	Environmental Management and Impact Assessment	3	0	0	3	3
3	Professional Elective	18B1WCE733	Advanced Foundation Engineering	3	0	0	3	3
						Total	3	3

ELECTIVE-VI

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCE734	Earthquake Engineering	0	0	3	3	3
2	Professional Elective	18B1WCE735	Design of Prestressed Concrete Structures	3	0	0	3	3
3	Professional Elective	18B1WCE736	Dam and Reservoir Design	3	0	0	3	3
						Total	3	3

Approved in Academic Council held on 25.10.2018

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B. TECH (CIVIL ENGINEERING)

ELECTIVE-VII

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCE831	Advanced Reinforced Concrete Design	3	0	0	3	3
2	Professional Elective	18B1WCE832	Advanced Highway Material and construction	3	0	0	3	3
3	Professional Elective	18B1WCE833	Hydropower Engineering	3	0	0	3	3
						Total	3	3

OPEN ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WCE640	Optimization Techniques	3	0	0	3	3

OPEN ELECTIVE-III

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WCE737	Finite Element Method	0	0	3	3	3

OPEN ELECTIVE-IV

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WCE738	Financial Management	0	0	3	3	3

OPEN ELECTIVE-V

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Open Elective	18B1WCE834	Sustainable Development	0	0	3	3	3

TWO YEAR MTECH PROGRAMME COURSE STRUCTURE
(Effective from Academic Session 2018-19)

STRUCTURAL ENGINEERING			
SEMESTER I			
Subject Code	**Subject Title**	**Credits**	**Contact Hours**
11M1WCE111	Advanced Structural Analysis	3	3
11M1WCE112	Structural Dynamics	3	3
11M1WCE113	Design of Reinforced Concrete Structures	3	3
	Elective I	3	3
13M1WCE131	Finite Element Methods	3	3
11M1WCE713	Concrete Structures Laboratory	2	4
	Total	**17**	**19**
SEMESTER II			
11M1WCE211	Solid Mechanics in Structural Engineering	3	3
	Elective II	3	3
11M1WCE213	Earthquake Resistant Design of Structures	3	3
11M1WCE214	Theory of Plates and Shells	3	3
12M1WCE231	Prestress Concrete Structures	3	3
12M1WCE271	CAD Laboratory	2	4
	Total	**17**	**19**
SEMESTER III			
12M19CE391	Seminar	02	-
12M19CE392	Project Part-I	18	36
	Total	**20**	**36**
SEMESTER IV			
12M19CE492	Project Part II	22	44
	Total	**22**	**44**

LIST OF ELECTIVES

	Course Code	**Course Name**
Elective I	11M1WCE114	Modelling, Simulation and Computer Applications
	11M1WCE332	Advances in Construction Materials
	12M1WCE332	Repair and Retrofitting of Structures
Elective II	11M1WCE212	Design of Steel Structures
	11M1WCE133	Bridge Engineering
	10M13CE432	Construction Methods Improvement

TWO YEAR MTECH PROGRAMME COURSE STRUCTURE
(Effective from Academic Session 2018-19)

CONSTRUCTION MANAGEMENT			
SEMESTER I			
Subject Code	**Subject Title**	**Total Credits**	**Contact Hours**
10M11CE111	Construction Techniques	3	3
10M11CE112	Estimating & Costing	3	3
10M11CE113	Construction Planning and Control	3	3
	Elective I	3	3
10M11CE115	Mechanical and Electrical Systems in Building	3	3
10M19CE191	Construction Capstone Project	2	4
	Total	**17**	**19**
SEMESTER II			
10M11CE211	Construction Contracts and Laws	3	3
	Elective II	3	3
10M11CE213	Construction Cost Analysis	3	3
10M11CE214	Construction Financial Management	3	3
10M11CE215	Sustainable Design and Construction	3	3
10M19CE291	Construction Capstone Project	2	4
	Total	**17**	**19**
SEMESTER III			
12M19CE391	Seminar	02	-
12M19CE392	Project Part-I	18	36
	Total	**20**	**36**
SEMESTER IV			
12M19CE492	Project Part II	22	44
	Total	**22**	**44**

LIST OF ELECTIVES

	Course Code	**Course Name**
Elective I	10M11CE114	Construction Safety and Health
	12M1WCE332	Repair and Retrofitting of Structures
	11M1WCE332	Advances in Construction Materials
Elective II	10M11CE212	Heavy/Civil Construction Equipment, Methods, and Management
	10M13CE334	Principles of Affordable Housing
	10M13CE432	Construction Methods Improvement

B.TECH. COMPUTER SCIENCE AND ENGINEERING

COURSE STRUCTURE

Approved in Academic Council held on 25.10.2018

B.TECH. COMPUTER SCIENCE AND ENGINEERING

PROGRAM OBJECTIVES

PO 1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engg. specialization to the solution of complex engineering problems.

PO-2 Problem analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO-3 Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

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

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

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

PO-10 Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO-11 Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

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

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B. TECH (COMPUTER SCIENCE AND ENGINEERING) 1st SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS111	English and Technical Communication	2	0	0	**2**	**2**
2	Basic Sciences	18B11MA111	Engineering Mathematics -1	3	1	0	**4**	**4**
3	Basic Sciences	18B11PH111	Engineering Physics-I	3	1	0	**4**	**4**
4	Engg Science	19B11CI111	Programming for Problem Solving-II	2	0	0	**2**	**2**
5	Engg Science	18B17GE171	Workshop Practices **OR**	0	0	3	**1.5**	**3**
6		18B17GE173	Engineering Graphics	0	0	3		**3**
7	Basic Sciences	18B17PH171	Engineering Physics Lab-I	0	0	2	**1**	**2**
8	Engg Science	19B17CI171	Programming for Problem Solving Lab-II	0	0	4	**2**	**4**
9	HSS	18B17HS171	English and Technical Communication Lab	0	0	2	**1**	**2**
10		18B17GE172	Mandatory Induction Programm	-	-	-	-	-
						Total	**17.5**	**23**

B. TECH (COMPUTER SCIENCE AND ENGINEERING) 2nd SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Basic Sciences	18B11MA211	Engineering Mathematics -2 (Differential Calculas)	3	1	0	**4**	**4**
2	Basic Sciences	18B11PH211	Engineering Physics-II	3	0	0	**3**	**3**
3	Basic Sciences	18B11PH271	Engineering Physics Lab - II	0	0	2	**1**	**2**
4	Engg Science	18B11EC211	Electrical Sciences	3	1	0	**4**	**4**
5	Engg Science	18B17EC271	Electrical Sciences Lab	0	0	2	**1**	**2**
6	Engg Science	18B17GE173	Engineering Graphics **OR**	0	0	3	**1.5**	**3**
7		18B17GE171	Workshop Practices	0	0	3		**3**
8	Engg Science	18B11CI211	Data Structures and Algorithms	3	1	0	4	4
9	Engg Science	18B17CI271	Data Structures and Algorithms Lab	0	0	4	**2**	**4**
						Total	**20.5**	**26**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF CSE&IT DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (COMPUTER SCIENCE AND ENGINEERING) 3rd SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11CI314	Python Programming Essentials	3	0	0	**3**	**3**
2	Engg Science	18B11CI311	Object Oriented Systems and Programming	3	0	0	**3**	**3**
3	Professional Core	18B11CI313	Database Management systems	3	0	0	**3**	**3**
4	Basic Sciences		Mathematics-III (Probability & Statistics)	3	0	0	**3**	**3**
5	HSS		Humanities-I (Interpersonal Dynamics, Values and Ethics)	3	0	0	**3**	**3**
6	Professional Core	18B17CI374	Python programming Lab	0	0	4	**2**	**4**
7	Engg Science	18B17CI371	Object Oriented Systems and rogramming Lab	0	0	4	**2**	**4**
8	Professional Core	18B17CI373	Database Management Systems Lab	0	0	4	**2**	**4**
9	Engg Science	18B17CI372	IT Workshop (SciLab/MATLAB) Lab	0	0	4	**2**	**4**
						Total	**23**	**31**

B. TECH (COMPUTER SCIENCE AND ENGINEERING) 4th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11CI414	Discrete Computational Mathematics	3	0	0	**3**	**3**
2	Professional Core	18B11CI413	Modeling and Simulation Techniques	2	0	0	**2**	**2**
3	Professional Core	18B11CI411	Operating Systems	3	0	0	**3**	**3**
4	Professional Core	18B11CI412	Design & Analysis of Algorithms	3	0	0	**3**	**3**
5	Mandatory Course		Environmental Sciences	2	-	-	**-**	**2**
6	HSS		Management 1 (Finance & Accounting)	3	0	0	**3**	**3**
7	Professional Core	18B17CI473	Data Simulation Lab	0	0	4	**2**	**4**
8	Professional Core	18B17CI471	Operating System Lab	0	0	4	**2**	**4**
9	Professional Core	18B17CI472	Design and Analysis of Algorithms Lab	0	0	4	**2**	**4**
10	Professional Core	18B17CI474	Web Tech Lab	0	0	4	2	4
						Total	**22**	**32**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF CSE&IT DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (COMPUTER SCIENCE AND ENGINEERING) 5th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11CI515	Computer Graphics	3	0	0	3	3
2	Basic Sciences		Science Elective	3	0	0	3	3
3	Professional Core	18B11CI513	Formal Language & Automata Theory	3	0	0	3	3
4	Professional Core	18B11CI514	Computer Organization and Architecture	3	0	0	3	3
5	HSS		Humanities II (Project Management and Entrepreneurship)	3	0	0	3	3
6	Professional Core	18B17CI575	Computer Graphics Lab	0	0	4	2	4
7	Professional Core	18B17CI574	Computer Organization and Architecture Lab	0	0	2	1	2
8	Engg Science	18B1WCI575	Multimedia Lab	0	0	2	1	2
9	Professional Elective		Elective -I	2	0	0	2	2
10	Professional Elective		Elective -I Lab	0	0	2	1	2
						Total	22	27

B. TECH (COMPUTER SCIENCE AND ENGINEERING) 6 th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11CI612	Compiler Design	3	0	0	3	3
2	Professional Core	18B11CI611	Computer Networks	3	0	0	3	3
3	Professional Core	18B17CI672	Compiler Design Lab	0	0	4	2	4
4	Professional Core	18B17CI671	Computer Networks lab	0	0	4	2	4
5	Professional Elective		Elective II	2	0	0	2	2
6	Professional Elective		Elective - II Lab	0	0	2	1	2
7	Professional Elective		Elective III	2	0	0	2	2
8	Professional Elective		Elective - III Lab	0	0	2	1	2
9	Open Elective		Open Elective -I (Humanities)	3	0	0	3	3
10	Project	18B19CI691	Minor Project	0	0	6	3	6
						Total	22	31

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF CSE&IT DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (COMPUTER SCIENCE AND ENGINEERING) 7 th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective		Elective IV	2	0	0	2	2
2	Professional Elective		Elective IV Lab	0	0	2	1	2
3	Professional Elective		Elective V	3	0	0	3	3
4	Open Elective		Open Elective II / MOOC Course*	3	0	0	3	3
5	Open Elective		Open Elective III / MOOC Course*	3	1	0	3	3
6	Mandatory Course		Indian Constitution/Essence of Indian Traditional Knowledge	1	-	-	-	1
7	Project	18B19CI791	Major Project - I	0	0	12	6	12
						Total	18	26

B. TECH (COMPUTER SCIENCE AND ENGINEERING) 8 th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective		Elective VI	3	0	0	3	3
2	Open Elective		Open Elective IV / MOOC Course*	3	0	0	3	3
3	Open Elective		Open Elective V / MOOC Course*	3	0	0	3	3
4	Project	18B19CI891	Major Project - II	0	0	12	6	12
						Total	15	21

TOTAL CREDITS					160	
TOTAL HOURS					216	
HSS					12	
Basic Science					23	
Engg Science					24.5	
Professional Core					51	
Professional Elective					18	
OE					15	
PROJECT					15	158.5

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF CSE&IT DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (COMPUTER SCIENCE AND ENGINEERING)

ELECTIVE-I

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI532	Data Compression	2	0	0	**2**	**2**
2	Professional Elective	18B1WCI533	Principal of Programming Languages	2	0	0	**2**	**2**
3	Professional Elective	18B1WCI534	Java Programming	2	0	0	**2**	**2**
4	Professional Elective	18B1WCI531	Information Theory & Coding	2	0	0	**2**	**2**
5	Professional Elective	18B1WCI572	Data Compression Lab	0	0	2	**1**	**2**
6	Professional Elective	18B1WCI573	Principal of Programming Languages Lab	0	0	2	**1**	**2**
7	Professional Elective	18B1WCI574	Java Programming Lab	0	0	2	**1**	**2**
8	Professional Elective	18B1WCI571	Information Theory & Coding Lab	0	0	2	**1**	**2**
9	**Professional Elective**	**20B1WCI531**	**Foundation for Data Science and Visualization**	**2**	**0**	**0**	**2**	**2**
10	**Professional Elective**	**20B1WCI571**	**Data Science and Visualization Lab**	**0**	**0**	**2**	**1**	**2**
11	**Professional Elective**	**19B1WCI531**	**Big Data using Hadoop**	**2**	**0**	**0**	**2**	**2**
12	**Professional Elective**	**19B1WCI571**	**Big Data using Hadoop Lab**	**0**	**0**	**2**	**1**	**2**
13	**Professional Elective**	**19B1WCI532**	**Image Analysis and Pattern Recognition**	**2**	**0**	**0**	**2**	**2**
14	**Professional Elective**	**19B1WCI572**	**Image Analysis and Pattern Recognition Lab**	**0**	**0**	**2**	**1**	**2**
15	**Professional Elective**	**20B1WCI532**	**Cloud Computing: Concepts, Technology & Architecture**	**2**	**0**	**0**	**2**	**2**
16	**Professional Elective**	**20B1WCI572**	**Cloud Computing: Concepts, Technology & Architecture Lab**	**0**	**0**	**2**	**1**	**2**
17	**Professional Elective**	**19B1WCI533**	**Human-Computer Interaction**	**2**	**0**	**0**	**2**	**2**
18	**Professional Elective**	**19B1WCI573**	**Human-Computer Interaction Lab**	**0**	**0**	**2**	**1**	**2**
19	**Professional Elective**	**19B1WCI534**	**Social Media**	**2**	**0**	**0**	**2**	**2**
20	**Professional Elective**	**19B1WCI574**	**Social Media Lab (Node XL)**	**0**	**0**	**2**	**1**	**2**

ELECTIVE-II

S.No.		Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI633	Software Testing Fundamentals	2	0	0	**2**	**2**
2	Professional Elective	18B1WCI634	Machine Learning	2	0	0	**2**	**2**
3	Professional Elective	18B1WCI637	C# and VB.NET	2	0	0	**2**	**2**
4	Professional Elective	18B1WCI631	Data Structure and Software Design	2	0	0	**2**	**2**
5	Professional Elective	18B1WCI673	Software Testing Fundamentals Lab	0	0	2	**1**	**2**
6	Professional Elective	18B1WCI674	Machine Learning Lab	0	0	2	**1**	**2**
7	Professional Elective	18B1WCI677	C# and VB.NET Lab	0	0	2	1	2
8	Professional Elective	18B1WCI671	Data Structure and Software Design Lab	0	0	2	**1**	**2**
9	**Professional Elective**	**19B1WCI631**	**Digital Forensics**	**2**	**0**	**0**	**2**	**2**
10	**Professional Elective**	**19B1WCI671**	**Digital Forensics lab**	**0**	**0**	**2**	**1**	**2**
11	**Professional Elective**	**19B1WCI633**	**Computer Animation**	**2**	**0**	**0**	**2**	**2**
12	**Professional Elective**	**19B1WCI673**	**Computer Animation Lab**	**0**	**0**	**2**	**1**	**2**
13	**Professional Elective**	**19B1WCI634**	**Computer and Robot Vision**	**2**	**0**	**0**	**2**	**2**
14	**Professional Elective**	**19B1WCI674**	**Computer and Robot Vision lab**	**0**	**0**	**2**	**1**	**2**
15	**Professional Elective**	**19B1WCI636**	**Computability, Complexity & Algorithms**	**2**	**0**	**0**	**2**	**2**
16	**Professional Elective**	**19B1WCI676**	**Computability, Complexity & Algorithms Lab**	**0**	**0**	**2**	**1**	**2**
17	**Professional Elective**	**19B1WCI638**	**Statistics and Data Science**	**2**	**0**	**0**	**2**	**2**
18	**Professional Elective**	**19B1WCI678**	**Statistics and Data Science Lab**	**0**	**0**	**2**	**1**	**2**

ELECTIVE-III

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI638	Pattern Recognition	2	0	0	2	2
2	Professional Elective	18B1WCI635	Data Mining & Data Warehousing	2	0	0	2	2
3	Professional Elective	18B1WCI632	Parallel and Distributed Algorithms	2	0	0	2	2
4	Professional Elective	18B1WCI636	Digital Image processing	2	0	0	2	2
5	Professional Elective	18B1WCI678	Pattern Recognition Lab	0	0	2	1	2
6	Professional Elective	18B1WCI675	Data Mining & Data Warehousing Lab	0	0	2	1	2
7	Professional Elective	18B1WCI672	Parallel and Distributed Algorithms Lab	0	0	2	1	2
8	Professional Elective	18B1WCI676	Digital Image processing Lab	0	0	2	1	2
9	**Professional Elective**	**19B1WCI632**	**Information Security**	**2**	**0**	**0**	2	2
10	**Professional Elective**	**19B1WCI672**	**Information Security Lab**	**0**	**0**	**2**	1	2
11	**Professional Elective**	**20B1WCI732**	**From Graph to Knowledge Graph**	**2**	**0**	**0**	2	2
12	**Professional Elective**	**20B1WCI772**	**From Graph to Knowledge Graph Lab**	**0**	**0**	**2**	1	2
13	**Professional Elective**	**19B1WCI635**	**Architecting Distributed Cloud Applications**	**2**	**0**	**0**	2	2
14	**Professional Elective**	**19B1WCI675**	**Architecting Distributed Cloud Applications Lab**	**0**	**0**	**2**	1	2
15	**Professional Elective**	**19B1WCI637**	**Statistics and Exploratory Data Analytics**	**2**	**0**	**0**	2	2
16	**Professional Elective**	**19B1WCI677**	**Statistics and Exploratory Data Analytics Lab**	**0**	**0**	**2**	1	2

ELECTIVE-IV

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI734	Cryptography& network security	2	0	0	2	2
2	Professional Elective	18B1WCI743	Advanced Algorithms	2	0	0	2	2
3	Professional Elective	18B1WCI741	R-Programming	2	0	0	2	2
4	Professional Elective	18B1WCI742	Artificial Intelligence	2	0	0	2	2
5	Professional Elective	18B1WCI774	Cryptography& network security Lab	0	0	2	1	2
6	Professional Elective	18B1WCI773	Advanced Algorithms Lab	0	0	2	1	2
7	Professional Elective	18B1WCI771	R-Programming Lab	0	0	2	1	2
8	Professional Elective	18B1WCI772	Artificial Intelligence Lab	0	0	2	1	2
9	**Professional Elective**	**19B1WCI731**	**Computational Data Analysis**	**2**	**0**	**0**	2	2
10	**Professional Elective**	**19B1WCI771**	**Computational Data Analysis lab**	**0**	**0**	**2**	1	2
11	**Professional Elective**	**19B1WCI732**	**Game Development and Design**	**2**	**0**	**0**	2	2
12	**Professional Elective**	**19B1WCI772**	**Game Development Lab**	**0**	**0**	**2**	1	2

ELECTIVE-V

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI736	Storage Networks	3	0	0	**3**	**3**
2	Professional Elective	18B1WCI738	Internet of Things	3	0	0	**3**	**3**
3	Professional Elective	18B1WCI735	Mobile Computing	3	0	0	**3**	**3**
4	Professional Elective	18B1WCI737	Cloud Computing	3	0	0	**3**	**3**
5	Professional Elective	18B1WCI740	Computational Techniques and Algorithms in Engineering	3	0	0	**3**	**3**
6	**Professional Elective**	**19B1WCI736**	**Information Auditing & Risk Management**	**3**	**0**	**0**	**3**	**3**
7	**Professional Elective**	**19B1WCI737**	**Optimization Methods in Business Analytics**	**3**	**0**	**0**	**3**	**3**
8	**Professional Elective**	**18B1WCI840**	**Computer Vision**	**3**	**0**	**0**	**3**	**3**
9	**Professional Elective**	**19B1WCI738**	**Introduction to Deep Learning**	**3**	**0**	**0**	**3**	**3**

ELECTIVE-VI

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI843	Data Analytics	3	0	0	**3**	**3**
2	Professional Elective	18B1WCI844	BIG DATA	3	0	0	**3**	**3**
3	Professional Elective	18B1WCI845	Network Management	3	0	0	**3**	**3**
4	Professional Elective	18B1WCI846	Graph Theory	3	0	0	**3**	**3**
5	**Professional Elective**	**19B1WCI831**	**Ethics and Information Technology**	**3**	**0**	**0**	**3**	**3**
6	**Professional Elective**	**18B1WCI832**	**Social and Information Network Analysis**	**3**	**0**	**0**	**3**	**3**
7	**Professional Elective**	**19B1WCI832**	**Probabilistic Graphical Models**	**3**	**0**	**0**	**3**	**3**
8	**Professional Elective**	**19B1WCI833**	**Information Modeling**	**3**	**0**	**0**	**3**	**3**
9	**Professional Elective**	**19B1WCI834**	**Information Visualization**	**3**	**0**	**0**	**3**	**3**
10	**Professional Elective**	**19B1WCI835**	**Cloud Computing Security**	**3**	**0**	**0**	**3**	**3**
11	**Professional Elective**	**19B1WCI836**	**Knowledge-Based AI: Cognitive Systems**	**3**	**0**	**0**	**3**	**3**
12	**Professional Elective**	**19B1WCI837**	**Reinforcement Learning**	**3**	**0**	**0**	**3**	**3**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN								
COURSE CURRICULUM OF DEPARTMENT CSE&IT - 2018 Batch (160 CREDITS)								
LIST OF OPEN ELECTIVES								
S. No.	Category Code	Semester	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
OPEN ELECTIVE II (7th Semester)								
1	19B1WCI733	7	Introduction to C++ Programming	2	0	0	2	2
2	19B1WCI734	7	Object-Oriented Technologies using Java	2	0	0	2	2
3	19B1WCI735	7	Software Testing Methodologies	2	0	0	2	2
4	19B1WCI773	7	Introduction to C++ Programming Lab	0	0	2	1	2
5	19B1WCI774	7	Object-Oriented Technologies using Java Lab	0	0	2	1	2
6	19B1WCI775	7	Software Testing Methodologies Lab	0	0	2	1	2
OPEN ELECTIVE III (7th Semester)								
1	13B1WCI731	7	ARM based Embedded System Design	3	0	0	3	3
2	19B1WCI739	7	Software Defined Network	3	0	0	3	3
3	19B1WCI740	7	Introduction to Statistical learning	3	0	0	3	3
OPEN ELECTIVE IV (8th Semester)								
1	19B1WCI838	8	Principles of Distributed Database Systems	3	0	0	3	3
2	19B1WCI839	8	Foundations of Blockchain	3	0	0	3	3
3	19B1WCI840	8	Computational Biology	3	0	0	3	3
OPEN ELECTIVE V (8th Semester)								
1	19B1WCI841	8	Wireless Sensor Networks: Protocols and Applications	3	0	0	3	3
2	19B1WCI842	8	Service Oriented Architecture	3	0	0	3	3
3	19B1WCI843	8	Multimedia Systems and Applications	3	0	0	3	3

JES

4 year BTech New Approved Curricula for Computer Science Engineering wef 2017-18 batch

BTech I semester (B1)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Professional Dev – I	3	3	
2	MA	Mathematics-I	4	4	
3	PH	Physics-I	4	4	
4	EC	Electrical Circuit Analysis	4	4	
5	CS	Introduction to Computers and Programming	4	4	
6	PH	Physics Lab-I	2	1	
7	EC	Electrical Circuits Lab	2	1	
8	CS	Computer Programming Lab	4	2	
9		Institutional Orientation	2	0	
		Total	**29**	**23**	

JES

4 year BTech New Approved Curricula for Computer Science Engineering wef 2017-18 batch

BTech II semester (B2)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Professional Dev – II	3	3	
2	MA	Mathematics-II	4	4	
3	PH	Physics-II	4	4	
4	EC	Basic Electronic Devices and Circuits	4	4	
5	CS	Data Structures	4	4	
6	PH	Physics Lab-II	2	1	
7	EC	Basic Electronics Lab	2	1	
8	CS	Data Structures and Computer Programming Lab	4	2	
9	CS	Departmental Orientation	2	0	
		Total	**29**	**23**	

JES

4 year BTech New Approved Curricula for Computer Science Engineering wef 2017-18 batch

BTech III semester (B3)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Professional Dev – III	3	3	
2	MA	Mathematics-III	4	4	
3	EC	Digital Electronics	4	4	
4	CS	Object Oriented Programming	4	4	
5	CS	Database Systems	4	4	
6	EC	Digital Electronics Lab	2	1	
7	CS	Object Oriented Programming Lab	2	1	
8	CS	Database Systems Lab	2	1	
9	CS	Unix Programming Lab	2	1	

		Total	**27**	**23**	
JES					
4 year BTech New Approved Curricula for Computer Science Engineering wef 2017-18 batch					
		BTech IV semester (B4)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1	PD	Professional Dev – IV	3	3	
2	MA	Mathematics-IV	4	4	
3	EC	Signals and Systems	4	4	
4	CS	Microprocessors and Controllers	4	4	
5	CS	Fundamentals of Algorithms	4	4	
6	EC	Signals and Systems Lab	2	1	
7	CS	Microprocessors and Controllers Lab	2	1	
8	CS	Algorithms Lab	2	1	
9	IT	Multimedia Development Lab I	2	1	
		Environmental Studies	3	3	
		Total	**30**	**26**	
JES					
4 year BTech New Approved Curricula for Computer Science Engineering wef 2017-18 batch					
		BTech V semester (B5)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1	PD	Professional Dev – V	3	3	
2	EC	Communication Systems	4	4	
3	CS	Operating Systems	4	4	
4	CS	Software Engineering	4	4	
5	EC	Communication Systems Lab	2	1	
6	CS	Operating Systems Lab	2	1	
7	CS	Software Engineering Lab	2	1	
8	IT	Web Technology Lab	2	1	
9		DE-I	3	3	
10	**CS**	**Project Part-I**	**6**	**3**	
			32	**25**	
JES					
4 year BTech New Approved Curricula for Computer Science Engineering wef 2017-18 batch					
		BTech VI semester (B6)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1	PD	Professional Dev – VI	3	3	
2	CS	Computer Networks	4	4	
3	CS	Computer Organisation and Architecture	4	4	
4	CS	Computer Networks Lab	2	1	
5	CS	System and Network Programming Lab	4	2	

6	IT	Computer Graphics	4	4	
7	IT	Computer Graphics Lab	2	1	
8	CS	Project Part II	6	3	
9	CS	DE-II	3	3	
		Total	**32**	**25**	

JES					
4 year BTech New Approved Curricula for Computer Science Engineering wef 2017-18 batch					
		BTech VII semester (B7)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1	PD	Professional Dev – VII	3	3	
2	CS	Software Testing and Debugging	4	4	
3	CS	Software Testing and Debugging La	2	1	
4	CS	Theory of Computation	4	4	
5		DE-III	3	3	
6		DE-IV	3	3	
7	CS	Project Part III	14	7	
		Total	**33**	**25**	

JES					
4 year BTech New Approved Curricula for Computer Science Engineering wef 2007-11 batch					
		BTech VIII semester (B8)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1	PD	Professional Dev – VIII	3	3	
2	CS	Compiler Design	4	4	
3	CS	Compiler Design Lab	2	1	
5		DE-V	3	3	
6		DE-VI	3	3	
7	CS	Project Part IV	17	7	
3	PH	Material Science	4	4	
		Total	**36**	**25**	
		List of Electives			
		(To be updated from time to time)			
1	MA	Algebraic Number Theory			
2	BT	Bio-informatics			
3	IT	Computer Games			
4	IT	Cryptography and Network Security			
5	CS	Design of Algorithms			
6	CS	Embedded Systems			
7	IT	Human Aspects for Information Technology			
8	CS	Image Processing			
9	IT	Information Retrieval and Data Mining			
10	MA	Integral Transforms			
11	EC	Mobile Communications			
12	IT	Network Management			
13	MA	Operation Research			
14	CS	Parallel Processing			
15	MA	Partial Differential Equations			
16	PH	Quantum Computing			

17	PH	Special Theory of Relativity			
18	CS	Systems Programming			
19	MA	Abstract Algebra			
20	CS	Artificial Intellegence			
21	PH	Astrophysics			
22	BT	Biosciences			
23	CS	Computer Graphics			
24	CS	Design of Database Sytems			
25	EC	Digital Signal Processing			
26	MA	Game Theory			
27	PH	General Theory of Relativity			
28	CS	Graph Algorithms and Applications			
29	MA	Graph Theory			
30	EC	Information Theory and Applications			
31	IT	Learning Sciences and Technology			
32	CS	Multi-Dimensional Data Structures			
33	PH	Nano Science and Technology			
34	CS	Network Programming			
35	MA	Numerical Analysis			
36	CS	Principles of Programming Languages			
37	IT	Research Methodology			
38	CS	Soft Computing			
39	CS	Software Engineering Management			
		Credit Summary	Credits		
		Sem1	23		
		Sem2	23		
		Sem3	23		
		Sem4	26		
		Sem5	25		
		Sem6	25		
		Sem7	25		
		Sem8	**25**		
		Total	195		

Jaypee University of IT Waknaghat

Curricula for 2 year MTech Computer Science Engineering

Batch 2018-20 onwards Mtech CSE: I Semester (M1)

SN	Sub Code	Subject	C/E	Contact hours				Cr
				L	T	P	Hr	
1	10M11CI111	Advanced Data Structures	C	3	0	0	3	3
2	10M11CI112	Advanced Computer Networks	C	3	0	0	3	3
3	10M11CI113	Advanced Database Systems	C	3	0	0	3	3
4	10M11CI114	High performance Computer Architecture	C	3	0	0	3	3
5	CS	DE-I	E	3	0	0	3	3
6	CS	DE-II	E	3	0	0	3	3
7	CS	DE-III	E	3	0	0	3	3
8	10M17CI171	Software Systems Lab - I	C	0	0	4	4	2
		TOTAL CREDITS					25	23

Curricula for 2 year MTech Computer Science Engineering

Batch 2017-19 onwards Mtech CSE: II Semester (M2)

SN	Sub Code	Subject	C/E	Contact hours				Cr
				L	T	P	Hr	
1	10M11CI211	Advanced Algorithms	C	3	0	0	3	3
2	10M11CI212	Advanced Operating Systems	C	3	0	0	3	3
3	10M11CI213	Advanced Software Engineering	C	3	0	0	3	3
4	10M11CI214	Multimedia Systems	C	3	0	0	3	3
5	CS	DE-IV	E	3	0	0	3	3
6	CS	DE-V	E	3	0	0	3	3
7	CS	DE-VI	E	3	0	0	3	3
8	10M17CI271	Software Systems Lab - II	C	4	0	2	6	2
		TOTAL CREDITS					27	23

Curricula for 2 year MTech Computer Science Engineering

Batch 2017-19 onwards Mtech CSE: III Semester (M3)

SN	Sub Code	Subject	C/E	Contact hours				Cr
				L	T	P	Hr	
1	10M19CI393	Seminar	C	0	0	4	4	2
2	10M19CI391	Project, Part -I	C	0	0	24	24	12
		TOTAL CREDITS					28	14

Curricula for 2 year MTech Computer Science Engineering								
Batch 2017-19 onwards Mtech CSE: IV Semester (M4)								
SN	Sub Code	Subject	C/E	Contact hours				Cr
				L	T	P	Hr	
1	10M19CI493	Project Seminar	C	0	0	4	4	2
2	10M19CI491	Project, Part -II	C	0	0	28	28	14
		TOTAL CREDITS					32	16

List of Electives for DE-I, DE-II, DE-III, DE-IV,DE-V and,DE-VI		
To be updated from time to time		
1	10M1WCI131	System and Network Security Techniques
2	14M1WCI333	Natural Language Processing
3	14M1WCI431	Parallel Programming Techniques
4	11M1WCI432	Performance Evaluation of Networks
5	13M1WCI331	Machine Learning
6	15M1WCI331	Advanced Theory of Computation
7	11M1WCI431	Advanced Web Mining
8	15M1WCI431	Advanced AI
9	15M1WCI432	Advanced Computational Techniques in Engineering
10	CS	Algorithmic Graph Theory
11	CS	Analysis of Algorithms
12	CS	Cognitive Sciences
13	CS	Computation Theory and Applications
14	CS	Computer Vision
15	CS	Control Systems Security
16	18M1WCI113	Cyber Warfare & Cyber Crime
17	CS	Embedded System Design
18	CS	Fault Tolerant Computing
19	CS	Grid Computing
20	CS	Incident Response & Event Management
21	CS	Information and Network Security
22	CS	Intelligent Systems
23	CS	Knowledge Discovery
24	CS	Machine Learning
25	CS	Mobile Computing
26	CS	Parallel Computing
27	CS	Pattern Recognition
28	CS	Penetration Testing
29	CS	Performance Evaluation of Computer Networks
30	CS	Quantum Algorithms

31	CS	Real Time Operating Systems
32	CS	Theory of Programming Languages
33	CS	Threat & Vulnerability Analysis
34	CS	VLSI Algorithms
35	CS	Advanced Wireless and Mobile Communications
36	CS	Digital CMOS design
37	CS	Digital Signal Processors and Applications
38	CS	Information and Coding Theory
39	CS	VLSI Circuit and System Design
40	CS	VLSI Modelling and Simulation
41	CS	VLSI Testing
42	18M1WCI332	Deep Learning

Summary	Cr
Sem1	23
Sem2	23
Sem3	14
Sem4	16
Total	76

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

Course Structure

Master of Technology Computer Sc & Engineering specialization in Data Science

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Semester I

Sr. No.	Course Code	Course Name	C/E	L	T	P	Hr	Cr
1		Advanced Data Structures	C	3	0	0	3	3
2		Elective -Mathematical Foundations for Data Science	E	3	0	0	3	3
3		Introduction to Data Science	C	3	0	0	3	3
4		DE-I	E	3	0	0	3	3
5		DE-II	E	3	0	0	3	3
6		DE-III	E	3	0	0	3	3
7		Advanced Data Structures Lab	C	0	0	1	2	1
8		Data Science Lab	C	0	0	2	4	2
9		Elective - Mathematical Foundations for Data Science Lab	E	0	0	2	4	2
		Total Credits						23

Semester II

Sr. No.	Course Code	Course Name	C/E	L	T	P	Hr	Cr
		Soft computing	C	3	0	0	3	3
		Deep Learning Techniques	C	3	0	0	3	3
		Big Data Analytics	C	3	0	0	3	3
		DE-IV	E	3	0	0	3	3
		DE-V	E	3	0	0	3	3
		DE-VI	E	3	0	0	3	3
		Soft Computing Lab	C	0	0	1	2	1
		Deep Learning Techniques Lab	C	0	0	2	4	2
		Big Data using Hadoop Lab	C	0	0	2	4	2
		Total Credits						23

Semester III

Sr. No.	Course Code	Course Name	C/E	L	T	P	Cr
1		Seminar	C	0	0	4	2
2		Project, Part I	C	0	0	24	12
		Total Credit					14

Semester IV

Sr. No.	Course Code	Course Name	C/E	L	T	P	Cr
1		Seminar	C	0	0	4	2
2		Project, Part I	C	0	0	24	12
		Total Credit					14

Summary

Semester	Cr
I	23
I	23
III	14
IV	16
Total	76

Departmental Electives

DE-I	Data Storage Technologies	Data Warehousing and Data Mining
DE-II	Data Visualization	Artificial Intelligence Techniques
DE- III	Introduction to Statistical Leaming	Cryptography and Information System security
DE-IV	Advanced Computational Techniques	Medical Image Analysis
DE-V	Knowledge-Based AI: Cognitive Systems	Social and Information Network Analysis
DE-VI	Reinforcement Leaming	Natural Language Processing

JES

4 year BTech New Approved Curricula for Information Technology wef 2017-18 batch

BTech I semester (B1)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Professional Dev – I	3	3	
2	MA	Mathematics-I	4	4	
3	PH	Physics-I	4	4	
4	EC	Electrical Circuit Analysis	4	4	
5	CS	Introduction to Computers and Programming	4	4	
6	PH	Physics Lab-I	2	1	
7	EC	Electrical Circuits Lab	2	1	
8	CS	Computer Programming Lab	4	2	
9		Institutional Orientation	2	0	
		Total	**29**	**23**	

JES

4 year BTech New Approved Curricula for Information Technology wef 2017-18 batch

BTech II semester (B2)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Professional Dev – II	3	3	
2	MA	Mathematics-II	4	4	
3	PH	Physics-II	4	4	
4	EC	Basic Electronic Devices and Circuits	4	4	
5	CS	Data Structures	4	4	
6	PH	Physics Lab-II	2	1	
7	EC	Basic Electronics Lab	2	1	
8	CS	Data Structures and Computer Programming Lab	4	2	
9	IT	Departmental Orientation	2	0	
		Total	**29**	**23**	

JES

4 year BTech New Approved Curricula for Information Technology wef 2017-18 batch

BTech III semester (B3)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Professional Dev – III	3	3	
2	MA	Mathematics-III	4	4	
3	EC	Digital Electronics	4	4	
4	CS	Object Oriented Programming	4	4	
5	CS	Database Systems	4	4	
6	EC	Digital Electronics Lab	2	1	
7	CS	Object Oriented Programming Lab	2	1	
8	CS	Database Systems Lab	2	1	
9	CS	Unix Programming Lab	2	1	
		Total	**27**	**23**	

JES

4 year BTech New Approved Curricula for Information Technology wef 2017-18 batch

BTech IV semester (B4)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Professional Dev – IV	3	3	
2	MA	Mathematics-IV	4	4	
3	EC	Signals and Systems	4	4	
4	IT	Computer Organisation	4	4	
5	CS	Fundamentals of Algorithms	4	4	
6	EC	Signals and Systems Lab	2	1	
7	CS	Computer Organisation Lab	2	1	
8	CS	Algorithms Lab	2	1	
9	IT	Multimedia Development Lab I	2	1	
10	Civ	Environmental Studies	3	3	
		Total	**30**	**26**	

JES

4 year BTech New Approved Curricula for Information Technology wef 2017-18 batch

BTech V semester (B5)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Professional Dev – V	3	3	
2	EC	Communication Systems	4	4	
3	CS	Operating Systems	4	4	
4	CS	Software Engineering	4	4	
5	EC	Communication Systems Lab	2	1	
6	CS	Operating Systems Lab	2	1	
7	CS	Software Engineering Lab	2	1	
8	IT	Web Technology Lab	2	1	
9	IT	DE-I	3	3	
10	IT	Project Part-I	6	3	
		Total	**32**	**25**	

JES

4 year BTech New Approved Curricula for Information Technology wef 2017-18 batch

BTech VI semester (B6)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Professional Dev – VI	3	3	
2	CS	Computer Networks	4	4	
4	IT	Data Mining	4	4	
5	CS	Computer Networks Lab	2	1	
7	IT	Multimedia Development Lab II	2	1	
8	IT	Data Mining Lab	2	1	
2	IT	Computer Graphics	4	4	
3	IT	Computer Graphics Lab	2	1	
9	IT	DE-II	3	3	
10	IT	Project Part II	6	3	

		Total	**32**	**25**	
JES					
4 year BTech New Approved Curricula for Information Technology wef 2017-18 batch					
		BTech VII semester (B7)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1	PD	Professional Dev – VII	3	3	
2	CS	Software Testing and Debugging	4	4	
3	CS	Software Testing and Debugging Lab	2	1	
4	IT	Web Application Engineering	4	4	
5	IT	DE-III	3	3	
6	IT	DE-IV	3	3	
7	IT	Project Part I	14	7	
		Total	**33**	**25**	

JES					
4 year BTech New Approved Curricula for Information Technology wef 2017-18 batch					
		BTech VIII semester (B8)			
SN	**Sub Code**	**Subject**	**Contact hours**	**Credits**	**Remarks**
1	PD	Professional Dev – VIII	3	3	
2	IT	Information Systems	4	4	
3	IT	Information Systems Lab	2	1	
4	PH	Material Science	4	4	
5	IT	DE-V	3	3	
6	IT	DE-VI	3	3	
7	IT	Project Part II	14	7	
		Total	**33**	**25**	
		List of Electives			
		(To be updated from time to time)			
1	MA	Algebraic Number Theory			
2	BT	Bio-informatics			
3	IT	Computer Games			
4	IT	Cryptography and Network Security			
5	IT	E-commerce			
6	IT	Geographic Information Systems			
7	IT	Human Aspects for Information Technology			
8	CS	Image Processing			
9	MA	Integral Transforms			
10	IT	Learning Sciences and Technology			
11	EC	Mobile Communications			
12	IT	Multimedia Content Creation			
13	MA	Operation Research			
14	MA	Partial Differential Equations			
15	PH	Quantum Computing			
16	PH	Special Theory of Relativity			
17	CS	Systems Programming			
18	MA	Abstract Algebra			
19	CS	Artificial Intelligence			
20	PH	Astrophysics			
21	BT	Biosciences			
22	IT	Computer Animation			
23	CS	Computer Graphics			
24	CS	Design of Database Sytems			
25	IT	Enterprise Application Development			
26	MA	Game Theory			
27	PH	General Theory of Relativity			
28	MA	Graph Theory			
29	IT	Human Computer Interaction			
30	CS	Multi-Dimensional Data Structures			
31	PH	Nano Science and Technology			
32	CS	Network Programming			
33	MA	Numerical Analysis			
34	IT	Research Methodology			
35	CS	Software Engineering Management			

		Credit Summary	Credits		
		Sem1	23		
		Sem2	23		
		Sem3	23		
		Sem4	26		
		Sem5	25		
		Sem6	25		
		Sem7	25		
		Sem8	**25**		
		Total	195		

B.TECH. INFORMATION TECHNOLOGY
COURSE STRUCTURE

Approved in Academic Council held on 25.10.2018

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF CSE&IT DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (INFORMATION TECHNOLOGY) 1st SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	HSS	18B11HS111	English and Technical Communication	2	0	0	**2**	**2**
2	Basic Sciences	18B11MA111	Engineering Mathematics -1	3	1	0	**4**	**4**
3	Basic Sciences	18B11PH111	Engineering Physics-I	3	1	0	**4**	**4**
4	Engg Science	19B11CI111	Programming for Problem Solving-II	2	0	0	**2**	**2**
5	Engg Science	18B17GE171	Workshop Practices **OR**	0	0	3	**1.5**	**3**
6		18B17GE173	Engineering Graphics	0	0	3		**3**
7	Basic Sciences	18B17PH171	Engineering Physics Lab-I	0	0	2	**1**	**2**
8	Engg Science	19B17CI171	Programming for Problem Solving Lab-II	0	0	4	**2**	**4**
9	HSS	18B17HS171	English and Technical Communication Lab	0	0	2	**1**	**2**
10		18B17GE172	Mandatory Induction Programm	-	-	-	-	-
						Total	**17.5**	**23**

B. TECH (INFORMATION TECHNOLOGY) 2nd SEMESTER

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Basic Sciences	18B11MA211	Engineering Mathematics -2 (Differential Calculas)	3	1	0	**4**	**4**
2	Basic Sciences	18B11PH211	Engineering Physics-II	3	0	0	**3**	**3**
3	Basic Sciences	18B11PH271	Engineering Physics Lab - II	0	0	2	**1**	**2**
4	Engg Science	18B11EC211	Electrical Sciences	3	1	0	**4**	**4**
5	Engg Science	18B17EC271	Electrical Sciences Lab	0	0	2	**1**	**2**
6	Engg Science	18B17GE173	Engineering Graphics **OR**	0	0	3	**1.5**	**3**
7		18B17GE171	Workshop Practices	0	0	3		**3**
8	Engg Science	18B11CI211	Data Structures and Algorithms	3	1	0	4	4
9	Engg Science	18B17CI271	Data Structures and Algorithms Lab	0	0	4	**2**	**4**
						Total	**20.5**	**26**

JAYPEE UNIVERSIT OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF CSE&IT DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (INFORMATION TECHNOLOGY) 3rd SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11CI315	Python Programming with Raspberry Pi	3	0	0	**3**	**3**
2	Engg Science	18B11CI311	Object Oriented Systems and Programming	3	0	0	**3**	**3**
3	Professional Core	18B11CI313	Database Management systems	3	0	0	**3**	**3**
4	Basic Sciences		Mathematics-3 Probability & Statistics)	3	0	0	**3**	**3**
5	HSS		Humanities-I (Interpersonal Dynamics, Values and Ethics)	3	0	0	**3**	**3**
6	Professional Core	18B17CI375	Python programming with Raspberry Pi Lab	0	0	4	**2**	**4**
7	Engg Science	18B17CI371	Object Oriented Systems and Programming Lab	0	0	4	**2**	**4**
8	Professional Core	18B17CI373	Database Management Systems Lab	0	0	4	**2**	**4**
9	Engg Science	18B17CI372	IT Workshop (SciLab/MATLAB) Lab	0	0	4	**2**	**4**
						Total	**23**	**31**

B. TECH (INFORMATION TECHNOLOGY) 4th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11CI414	Discrete Computational Mathematics	3	0	0	**3**	**3**
2	Professional Core	18B11CI413	Modeling and Simulation Techniques	2	0	0	**2**	**2**
3	Professional Core	18B11CI411	Operating Systems	3	0	0	**3**	**3**
4	Professional Core	19B11CI411	Software Engineering Practices	3	0	0	**3**	**3**
5	Mandatory Course		Environmental Sciences	2	-	-	**-**	**2**
6	HSS		Management 1 (Finance & Accounting)	3	0	0	**3**	**3**
7	Professional Core	18B17CI473	Data Simulation Lab	0	0	4	**2**	**4**
8	Professional Core	18B17CI471	Operating System Lab	0	0	4	**2**	**4**
9	Professional Core	19B17CI471	Software Engineering Practices Lab	0	0	4	**2**	**4**
10	Professional Core	18B17CI474	Web Tech Lab	0	0	4	2	4
						Total	22	32

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN
COURSE CURRICULUM OF CSE&IT DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (INFORMATION TECHNOLOGY) 5th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11CI512	Information Systems	3	0	0	**3**	**3**
2	Basic Sciences		Science Elective	3	0	0	**3**	**3**
3	Professional Core	18B11CI511	Advanced Java	3	0	0	**3**	**3**
4	Professional Core	18B11CI514	Computer Organization and Architecture	3	0	0	**3**	**3**
5	HSS		Humanities II (Project Management and Entrepreneurship)	3	0	0	**3**	**3**
6	Professional Core	18B17CI572	Information Systems Lab	0	0	2	**1**	**2**
7	Professional Core		CO Lab	0	0	2	**1**	**2**
8	Professional Core	18B17CI571	Advanced Java Lab	0	0	4	**2**	**4**
9	Professional Elective		Elective -I	2	0	0	**2**	**2**
10	Professional Elective		Elective -I Lab	0	0	2	**1**	**2**
						Total	**22**	**27**

B. TECH (INFORMATION TECHNOLOGY) 6 th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Core	18B11CI613	Data Mining	3	0	0	**3**	**3**
2	Professional Core	18B11CI611	Computer Networks	3	0	0	**3**	**3**
3	Professional Core	18B17CI673	Data Mining Lab	0	0	4	**2**	**4**
4	Professional Core	18B17CI671	Computer Networks lab	0	0	4	**2**	**4**
5	Professional Elective		Elective II	2	0	0	**2**	**2**
6	Professional Elective		Elective - II Lab	0	0	2	**1**	**2**
7	Professional Elective		Elective III	2	0	0	**2**	**2**
8	Professional Elective		Elective - III Lab	0	0	2	**1**	**2**
9	Open Elective		Open Elective -I (Humanities)	3	0	0	**3**	**3**
10	Project	18B19CI691	Minor Project	0	0	6	**3**	**6**
						Total	**22**	**31**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF CSE&IT DEPARTMENT- 2018 batch (160 CREDITS)

B. TECH (INFORMATION TECHNOLOGY) 7 th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective		Elective IV	2	0	0	**2**	**2**
2	Professional Elective		Elective IV Lab	0	0	2	**1**	**2**
3	Professional Elective		Elective V	3	0	0	**3**	**3**
4	Open Elective		Open Elective II / MOOC Course*	3	0	0	**3**	**3**
5	Open Elective		Open Elective III / MOOC Course*	3	1	0	**3**	**3**
6	Mandatory Course		Indian Constitution /Essence of Indian Traditional Knowledge	1	-	-	**-**	**1**
7	Project	18B19CI791	Major Project - I	0	0	12	**6**	**12**
						Total	**18**	**26**

B. TECH (INFORMATION TECHNOLOGY) 8 th SEMESTER

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
1	Professional Elective		Elective VI	3	0	0	**3**	**3**
2	Open Elective		Open Elective IV / MOOC Course*	3	0	0	**3**	**3**
3	Open Elective		Open Elective V / MOOC Course*	3	0	0	**3**	**3**
4	Project	18B19CI891	Major Project - II	0	0	12	**6**	**12**
						Total	**15**	**21**
			TOTAL CREDITS				**160**	
			TOTAL HOURS				**216**	
			HSS				**11**	
			Basic Science				**22**	
			Engg Science				**21**	
			Professional Core				**52**	
			Professional Elective				**18**	
			OE				**15**	
			PROJECT				**15**	**154**

Approved in Academic Council held on 25.10.2018

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF CSE&IT DEPARTMENT- 2018 batch (160CREDIT

B. TECH (LIST OF ELECTIVES- INFORMATION TECHNOLOGY)

ELECTIVE-I

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credit	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI532	Data Compression	2	0	0	**2**	**2**
2	Professional Elective	18B1WCI533	Principal of Programming Languages	2	0	0	**2**	**2**
3	Professional Elective	20B1WCI733	Computer Graphics and its Applications	2	0	0	**2**	**2**
4	Professional Elective	18B1WCI531	Information Theory & Coding	2	0	0	**2**	**2**
5	Professional Elective	18B1WCI572	Data Compression Lab	0	0	2	**1**	**2**
6	Professional Elective	18B1WCI573	Principal of Programming Languages	0	0	2	**1**	**2**
7	Professional Elective	20B17CI773	Computer Graphics and its Applications Lab	0	0	2	**1**	**2**
8	Professional Elective	18B1WCI571	Information Theory & Coding Lab	0	0	2	**1**	**2**
9	Professional Elective	**20B1WCI531**	**Foundation for Data Science and Visualization**	**2**	**0**	**0**	**2**	**2**
10	Professional Elective	**20B1WCI571**	**Data Science and Visualization Lab**	**0**	**0**	**2**	**1**	**2**
11	Professional Elective	**19B1WCI531**	**Big Data using Hadoop**	**2**	**0**	**0**	**2**	**2**
12	Professional Elective	**19B1WCI571**	**Big Data using Hadoop Lab**	**0**	**0**	**2**	**1**	**2**
13	Professional Elective	**19B1WCI532**	**Image Analysis and Pattern Recognition**	**2**	**0**	**0**	**2**	**2**
14	Professional Elective	**19B1WCI572**	**Image Analysis and Pattern Recognition Lab**	**0**	**0**	**2**	**1**	**2**
15	Professional Elective	**20B1WCI532**	**Cloud Computing: Concepts, Technology & Architecture**	**2**	**0**	**0**	**2**	**2**
16	Professional Elective	**20B1WCI572**	**Cloud Computing: Concepts, Technology & Architecture Lab**	**0**	**0**	**2**	**1**	**2**
17	Professional Elective	**19B1WCI533**	**Human-Computer Interaction**	**2**	**0**	**0**	**2**	**2**
18	Professional Elective	**19B1WCI573**	**Human-Computer Interaction Lab**	**0**	**0**	**2**	**1**	**2**
19	Professional Elective	**19B1WCI534**	**Social Media**	**2**	**0**	**0**	**2**	**2**
20	Professional Elective	**19B1WCI574**	**Social Media Lab (Node XL)**	**0**	**0**	**2**	**1**	**2**

ELECTIVE-II

S.No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credit	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI633	Software Testing Fundamentals	2	0	0	**2**	**2**
2	Professional Elective	18B1WCI634	Machine Learning	2	0	0	**2**	**2**
3	Professional Elective	18B1WCI637	C# and VB.NET	2	0	0	**2**	**2**
4	Professional Elective	18B1WCI631	Data Structure and Software Design	2	0	0	**2**	**2**
5	Professional Elective	18B1WCI673	Software Testing Fundamentals Lab	0	0	2	**1**	**2**
6	Professional Elective	18B1WCI674	Machine Learning Lab	0	0	2	**1**	**2**
7	Professional Elective	18B1WCI677	C# and VB.NET Lab	0	0	2	1	2
8	Professional Elective	18B1WCI671	Data Structure and Software Design L	0	0	2	**1**	**2**
9	Professional Elective	**19B1WCI631**	**Digital Forensics**	**2**	**0**	**0**	**2**	**2**
10	Professional Elective	**19B1WCI671**	**Digital Forensics lab**	**0**	**0**	**2**	**1**	**2**
11	Professional Elective	**19B1WCI633**	**Computer Animation**	**2**	**0**	**0**	**2**	**2**
12	Professional Elective	**19B1WCI673**	**Computer Animation Lab**	**0**	**0**	**2**	**1**	**2**
13	Professional Elective	**19B1WCI634**	**Computer and Robot Vision**	**2**	**0**	**0**	**2**	**2**
14	Professional Elective	**19B1WCI674**	**Computer and Robot Vision lab**	**0**	**0**	**2**	**1**	**2**
15	Professional Elective	**19B1WCI636**	**Computability, Complexity & Algorithms**	**2**	**0**	**0**	**2**	**2**
16	Professional Elective	**19B1WCI676**	**Computability, Complexity & Algorithms Lab**	**0**	**0**	**2**	**1**	**2**
17	Professional Elective	**19B1WCI638**	**Statistics and Data Science**	**2**	**0**	**0**	**2**	**2**
18	Professional Elective	**19B1WCI678**	**Statistics and Data Science Lab**	**0**	**0**	**2**	**1**	**2**

ELECTIVE-III

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credit	Total Hours
				L	T	P		

Approved in Academic Council held on 25.10.2018

1	Professional Elective	18B1WCI638	Pattern Recognition	2	0	0	**2**	**2**
2	Professional Elective	18B1WCI632	Parallel and Distributed Algorithms	2	0	0	**2**	**2**
3	Professional Elective	18B1WCI636	Digital Image processing	2	0	0	**2**	**2**
4	Professional Elective	18B1WCI678	Pattern Recognition Lab	0	0	2	**1**	**2**
5	Professional Elective	18B1WCI672	Parallel and Distributed Algorithms L	0	0	2	**1**	**2**
6	Professional Elective	18B1WCI676	Digital Image Processing Lab	0	0	2	**1**	**2**
7	Professional Elective	**19B1WCI632**	**Information Security**	**2**	**0**	**0**	**2**	**2**
8	Professional Elective	**19B1WCI672**	**Information Security Lab**	**0**	**0**	**2**	**1**	**2**
9	Professional Elective	**20B1WCI732**	**From Graph to Knowledge Graph**	**2**	**0**	**0**	**2**	**2**
10	Professional Elective	**20B1WCI772**	**From Graph to Knowledge Graph Lab**	**0**	**0**	**2**	**1**	**2**
11	Professional Elective	**18B1WCI635**	**Data Mining & Data Warehousing**	**2**	**0**	**0**	**2**	**2**
12	Professional Elective	**18B1WCI675**	**Data Mining & Data Warehousing Lab**	**0**	**0**	**2**	**1**	**2**
13	Professional Elective	**19B1WCI635**	**Architecting Distributed Cloud Applications**	**2**	**0**	**0**	**2**	**2**
14	Professional Elective	**19B1WCI675**	**Architecting Distributed Cloud Applications Lab**	**0**	**0**	**2**	**1**	**2**
15	Professional Elective	**19B1WCI637**	**Statistics and Exploratory Data Analytics**	**2**	**0**	**0**	**2**	**2**
16	Professional Elective	**19B1WCI677**	**Statistics and Exploratory Data Analytics Lab**	**0**	**0**	**2**	**1**	**2**

ELECTIVE-IV

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credit	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI734	Cryptography& network security	2	0	0	**2**	**2**
2	Professional Elective	18B1WCI733	Advanced Algorithms	2	0	0	**2**	**2**
3	Professional Elective	18B1WCI731	R-Programming	2	0	0	**2**	**2**
4	Professional Elective	20B1WCI731	Artificial Intelligence	2	0	0	2	2
5	Professional Elective	18B1WCI774	Cryptography& network security Lab	0	0	2	**1**	**2**
6	Professional Elective	18B1WCI773	Advanced Algorithms Lab	0	0	2	**1**	**2**
7	Professional Elective	18B1WCI771	R-Programming Lab	0	0	2	**1**	**2**
8	Professional Elective	20B1WCI771	Artificial Intelligence Lab	0	0	2	1	2
9	Professional Elective	**19B1WCI731**	**Computational Data Analysis**	**2**	**0**	**0**	**2**	**2**
10	Professional Elective	**19B1WCI771**	**Computational Data Analysis lab**	**0**	**0**	**2**	**1**	**2**
11	Professional Elective	**19B1WCI732**	**Game Development and Design**	**2**	**0**	**0**	**2**	**2**
12	Professional Elective	**19B1WCI772**	**Game Development Lab**	**0**	**0**	**2**	**1**	**2**

ELECTIVE-V

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credit	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI736	Storage Networks	3	0	0	**3**	**3**
2	Professional Elective	18B1WCI738	Internet of Things	3	0	0	**3**	**3**
3	Professional Elective	18B1WCI735	Mobile Computing	3	0	0	**3**	**3**
4	Professional Elective	18B1WCI737	Cloud Computing	3	0	0	**3**	**3**
5	Professional Elective	18B1WCI739	Formal Languages & Automata	3	0	0	**3**	**3**
6	Professional Elective	18B1WCI740	Computational Techniques & Algorithms in Engineering	3	0	0	**3**	**3**
7	Professional Elective	**19B1WCI736**	**Information Auditing & Risk Management**	**3**	**0**	**0**	**3**	**3**
8	Professional Elective	**19B1WCI737**	**Optimization Methods in Business Analytics**	**3**	**0**	**0**	**3**	**3**
9	Professional Elective	**18B1WCI840**	**Computer Vision**	**3**	**0**	**0**	**3**	**3**
10	Professional Elective	**19B1WCI738**	**Introduction to Deep Learning**	**3**	**0**	**0**	**3**	**3**

ELECTIVE-VI

S. No.	Category Code	Subject Code	Name of the Subjects	Course Hours			Credit	Total Hours
				L	T	P		
1	Professional Elective	18B1WCI831	Data Analytics	3	0	0	**3**	**3**
2	Professional Elective	18B1WCI832	Big Data	3	0	0	**3**	**3**
3	Professional Elective	18B1WCI834	Network Management	3	0	0	**3**	**3**
4	Professional Elective	18B1WCI833	Graph Theory	3	0	0	**3**	**3**
5	Professional Elective	18B1WCI835	Deep Learning	3	0	0	**3**	**3**

6	Professional Elective	**19B1WCI831**	**Ethics and Information Technology**	**3**	**0**	**0**	**3**	**3**
7	Professional Elective	**18B1WCI832**	**Social and Information Network Analysis**	**3**	**0**	**0**	**3**	**3**
8	Professional Elective	**19B1WCI832**	**Probabilistic Graphical Models**	**3**	**0**	**0**	**3**	**3**
9	Professional Elective	**19B1WCI833**	**Information Modeling**	**3**	**0**	**0**	**3**	**3**
10	Professional Elective	**19B1WCI834**	**Information Visualization**	**3**	**0**	**0**	**3**	**3**
11	Professional Elective	**19B1WCI835**	**Cloud Computing Security**	**3**	**0**	**0**	**3**	**3**
12	Professional Elective	**19B1WCI836**	**Knowledge-Based AI: Cognitive Systems**	**3**	**0**	**0**	**3**	**3**
13	Professional Elective	**19B1WCI837**	**Reinforcement Learning**	**3**	**0**	**0**	**3**	**3**

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, SOLAN

COURSE CURRICULUM OF DEPARTMENT CSE&IT - 2018 Batch (160 CREDITS)

LIST OF OPEN ELECTIVES

S. No.	Category Code	Semester	Name of the Subjects	Course Hours			Credits	Total Hours
				L	T	P		
			OPEN ELECTIVE II (7th Semester)					
1	19B1WCI733	7	Introduction to C++ Programming	2	0	0	2	2
2	19B1WCI734	7	Object-Oriented Technologies using Java	2	0	0	2	2
3	19B1WCI735	7	Software Testing Methodologies	2	0	0	2	2
4	19B1WCI773	7	Introduction to C++Programming Lab	0	0	2	1	2
5	19B1WCI774	7	Object-Oriented Technologies using Java Lab	0	0	2	1	2
6	19B1WCI775	7	Software Testing Methodologies Lab	0	0	2	1	2
			OPEN ELECTIVE III (7th Semester)					
1	13B1WCI731	7	ARM based Embedded System Design	3	0	0	3	3
2	19B1WCI739	7	Software Defined Network	3	0	0	3	3
3	19B1WCI740	7	Introduction to Statistical learning	3	0	0	3	3
			OPEN ELECTIVE IV (8th Semester)					
1	19B1WCI838	8	Principles of Distributed Database Systems	3	0	0	3	3
2	19B1WCI839	8	Foundations of Blockchain	3	0	0	3	3
3	19B1WCI840	8	Computational Biology	3	0	0	3	3
			OPEN ELECTIVE V (8th Semester)					
1	19B1WCI841	8	Wireless Sensor Networks: Protocols and Applications	3	0	0	3	3
2	19B1WCI842	8	Service Oriented Architecture	3	0	0	3	3
3	19B1WCI843	8	Multimedia Systems and Applications	3	0	0	3	3

M.Sc. Biotechnology (Effective w.e.f. Academic Session-2020-21)

S.No.	Title	Credits	L-T-P
	SEMESTER ONE		
1	Biochemistry (20MS1BT111)	3	3-0-0
2	Cell and Molecular Biology (20MS1BT112)	3	3-0-0
3	Plant and Animal Biotechnology (20MS1BT113)	2	2-0-0
4	Microbiology (20MS1BT114)	2	2-0-0
5	Genetics (20MS1BT115)	2	2-0-0
6	Basics of Mathematics and Statistics (20MS1MA111)	2	2-0-0
7	Basics of Chemistry and Physics (20MS1PH111)	2	2-0-0
8	Laboratory I: Biochemistry and Analytical Techniques (20MS7BT171)	4	0-0-8
9	Laboratory II: Microbiology (20MS7BT173)	2	0-0-4
10	Laboratory III: Plant and Animal Biotechnology (20MS7BT172)	2	0-0-8
	TOTAL	24	
	SEMESTER TWO		
1	Genetic Engineering (20MS1BT211)	3	3-0-0
2	Immunology (20MS1BT212)	3	3-0-0
3	Bioinformatics (20MS1BT213)	2	2-0-0
4	Genomics and Proteomics (20MS1BT214)	2	2-0-0
5	Molecular Diagnostics (20MS1BT215)	2	2-0-0
6	Research Methodology and Scientific Communication Skills (20MS1BT216)	2	2-0-0
7	Elective I Nanobiotechnology (20MSWBT231) Environmental Biotechnology (20MSWBT232) Protein Engineering (20MSWBT233)	2	2-0-0
8	Seminar (20MS9BT211)	1	-
9	Laboratory IV: Molecular Biology and Genetic Engineering (20MS7BT271)	4	0-0-8
10	Laboratory V: Immunology (20MS7BT272)	3	0-0-6
	TOTAL	24	
	SEMESTER THREE		
1	Bioprocess Engineering and Technology (20MS1BT311)	3	3-0-0
2	Emerging Technologies (20MS1BT312)	2	2-0-0
3	Critical Analysis of Classical Papers (20MS9BT312)	2	-
4	Bioentrepreneurship (20MS1BT314)	2	2-0-0
5	Intellectual Property Rights, Biosafety and Bioethics (20MS1BT315)	2	2-0-0
6	Project Proposal Preparation and Presentation (20MS9BT313)	2	-
7	Seminar (20MS9BT311)	1	-
8	Laboratory VI: Bioprocess Engineering and Technology (20MS7BT371)	4	0-0-8
9	Laboratory VII: Bioinformatics (20MS7BT372)	2	0-0-4
10	Dissertation (20MS9BT391)	4	-
	TOTAL	24	
	SEMESTER FOUR		
1	Dissertation (20MS9BT491)	20	-
2	Elective II Vaccines (20MSWBT431) Drug Discovery and Development (20MSWBT432) Computational Systems Biology (20MSWBT433)	2	2-0-0
	TOTAL	22	
	TOTAL CREDITS	94	

Approved in Academic Council Meeting held on August 06, 2020

Recommended Electives:

Elective – I (II Semester)	L-T-P	Elective – II (IV Semester)	L-T-P
Nanobiotechnology (20MSWBT231)	- 2-0-0	Vaccines (20MSWBT431)	- 2-0-0
Environmental Biotechnology (20MSWBT232)	- 2-0-0	Drug Discovery and Development (20MSWBT432)	- 2-0-0
Protein Engineering (20MSWBT233)	- 2-0-0	Computational Systems Biology (20MSWBT433)	- 2-0-0

Semester One

Biochemistry

Credits

3

Course Objectives

The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.

Student Learning Outcomes

On completion of this course, students should be able to:

- Gain fundamental knowledge in biochemistry;
- Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.

Unit I

Chemical basis of life

7 lectures

Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies.

Unit II

Protein structure

4 lectures

Structure-function relationships: amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, evolution of protein structure, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin *etc.*; basic principles of protein purification; tools to characterize expressed proteins; Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation.

Unit III

Enzyme kinetics

5 lectures

Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate enzymes; concept of catalytic antibodies; catalytic strategies with specific examples of proteases, carbonic anhydrases, restriction enzymes and nucleoside monophosphate kinase; regulatory strategies with specific example of hemoglobin; isozymes; role of covalent modification in enzymatic activity; zymogens.

Unit IV

Glycobiology

2 lectures

Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.

Unit V

Structure and functions of DNA & RNA and lipids

3 lectures

Self-assembly of lipids, micelle, biomembrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena; nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure; difference in RNA and DNA structure and their importance in evolution of DNA as the genetic material.

Unit VI

Bioenergetics

8 lectures

Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism; Introduction to GPCR, Inositol/DAG//PKC and Ca++ signaling pathways;

glycolysis and gluconeogenesis; reciprocal regulations and non-carbohydrate sources of glucose; Citric acid cycle, entry to citric acid cycle, citric acid cycle as a source of biosynthetic precursors; Oxidative phosphorylation; importance of electron transfer in oxidative phosphorylation; F1-F0 ATP Synthase; shuttles across mitochondria; regulation of oxidative phosphorylation; Photosynthesis – chloroplasts and two photosystems; proton gradient across thylakoid membrane; Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulin in glycogen metabolism; Fatty acid metabolism; protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway; elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation.

Unit VII

Role of vitamins & cofactors in metabolism

12 lectures

Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulin in glycogen metabolism; Fatty acid metabolism; protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway; elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation; target of rapamycin (TOR) & Autophagy regulation in relation to C & N metabolism, starvation responses and insulin signaling.

Recommended Textbooks and References:

1. Stryer, L. (2015). *Biochemistry*. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Dobson, C. M. (2003). *Protein Folding and Misfolding*. Nature, 426(6968), 884-890. doi:10.1038/nature02261.
5. Richards, F.M. (1991). *The Protein Folding Problem*. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54.

Cell and Molecular Biology

Credits

3

Course Objectives

The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.

Student Learning Outcomes

Student should be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?

Unit I

Dynamic organization of cell

6 lectures

Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.

Unit II

Chromatin structure and dynamics

12 lectures

Chromatin organization - histone and DNA interactome: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin-Writers,-Readers and –Erasers; Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, trancriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs), protein translation machinery, ribosomes-composition and assembly; universal genetic codes, degeneracy of codons, Wobble hypothesis; Iso-accepting tRNA; mechanism of initiation, elongation and termination; co- and post-translational modifications, mitochondrial genetic code translation product cleavage, modification and activation.

Unit III

Cellular signalling, transport and trafficking

3 lectures

Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.

Unit IV

Cellular processes

8 lectures

Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans-membrane signalling; cell motility and migration; cell death: different modes of cell death and their regulation.

Unit V

Manipulating and studying cells

3 lectures

Isolation of cells and basics of cell culture; observing cells under a microscope, different types of microscopy; analyzing and manipulating DNA, RNA and proteins.

Unit VI

Genome instability and cell transformation

8 lectures

Mutations, proto-oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and inter-genic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators.

Recommended Textbooks and References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th Ed.). New York: Garland Science.
2. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman.
3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning.
4. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM ; Sunderland.
5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W.M. (2012). *Becker's World of the Cell*. Boston (8th Ed.). Benjamin Cummings.
6. Watson, J. D. (2008). *Molecular Biology of the Gene* (5th ed.). Menlo Park, CA: Benjamin/Cummings.

Plant and Animal Biotechnology

Credits

2

Course Objectives

The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

Student Learning Outcomes

Students should be able to gain fundamental knowledge in animal and plant biotechnology and their applications.

Unit I

Plant tissue culture and animal cell culture

10 lectures

Plant tissue culture: historical perspective; totipotency; organogenesis; Somatic embryogenesis; establishment of cultures – callus culture, cell suspension culture, media preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production.
Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation and *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Unit II

Plant genetic manipulation

10 lectures

Genetic engineering: *Agrobacterium*-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - *Agrobacterium*-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.

Unit III

Animal reproductive biotechnology and vaccinology

8 lectures

Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and *in vitro* fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation for conservation endangered species; Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.

Unit IV

Plant and animal genomics

4 lectures

Overview of genomics – definition, complexity and classification; need for genomics level analysis; methods of analyzing genome at various levels – DNA, RNA, protein, metabolites and phenotype; genome projects and bioinformatics resources for genome research – databases; overview of forward and reverse genetics for assigning function for genes.

Approved in Academic Council Meeting held on August 06, 2020

Unit V

Molecular mapping and marker assisted selection

8 lectures

Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications; introduction to mapping of genes/QTLs; marker-assisted selection - strategies for Introducing genes of biotic and abiotic stress resistance in plants: genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.

Recommended Textbooks and References:

1. Chawla, H. S. (2000). *Introduction to Plant Biotechnology*. Enfield, NH: Science.
2. Razdan, M. K. (2003). *Introduction to Plant Tissue Culture*. Enfield, NH: Science.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). *Plant Biotechnology: an Introduction to Genetic Engineering*. Oxford: Oxford University Press.
4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry & Molecular Biology of Plants*. Chichester, West Sussex: John Wiley & Sons.
5. Umesha, S. (2013). *Plant Biotechnology.* The Energy And Resources.
6. Glick, B. R., & Pasternak, J. J. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, D.C.: ASM Press.
7. Brown, T. A. (2006). *Gene Cloning and DNA Analysis: an Introduction*. Oxford: Blackwell Pub.
8. Primrose, S. B., & Twyman, R. M. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
9. Slater, A., Scott, N. W., & Fowler, M. R. (2003). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford: Oxford University Press.
10. Gordon, I. (2005). *Reproductive Techniques in Farm Animals*. Oxford: CAB International.
11. Levine, M. M. (2004). *New Generation Vaccines.* New York: M. Dekker.
12. Pörtner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Totowa, NJ: Humana Press.

Microbiology

Credits

2

Course Objectives

The objectives of this course are to introduce field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host-microbe interactions.

Student Learning Outcomes

Students should be able to:

- Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity;
- Identify and demonstrate structural, physiological, genetic similarities and differences of major categories of microorganisms;
- Identify and demonstrate how to control microbial growth;
- Demonstrate and evaluate interactions between microbes, hosts and environment.

Unit I

Microbial characteristics

6 lectures

Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance.

Unit II

Microbial diversity

9 lectures

Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria,

Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilic archae, Thermoplasm; eukarya: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes.

Unit III

Control of microorganisms

3 lectures

Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms.

Unit IV

Virology

5 lectures

Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions.

Unit V

Host-microbes interaction

5 lectures

Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.

Recommended Textbooks and References:

1. Pelczar, M. J., Reid, R. D., & Chan, E. C. (2001). *Microbiology* (5th ed.). New York: McGraw-Hill.
2. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). *Prescott's Microbiology*. New York: McGraw-Hill.
3. Matthai, W., Berg, C. Y., & Black, J. G. (2005). *Microbiology, Principles and Explorations*. Boston, MA: John Wiley & Sons.

Genetics

Credits

2

Course Objectives

The objectives of this course are to take students through basics of genetics and classical genetics covering prokaryotic/ phage genetics to yeast and higher eukaryotic domains. On covering all classical concepts of Mendelian genetics across these life-forms, students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution.

Student Learning Outcomes

On successful completion of this course, student will be able :

- Describe fundamental molecular principles of genetics;
- Understand relationship between phenotype and genotype in human genetic traits;
- Describe the basics of genetic mapping;
- Understand how gene expression is regulated.

Unit I

Genetics of bacteria and bacteriophages

10 lectures

Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene.

Unit II

Yeast genetics

6 lectures

Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.

Unit III

Drosophila genetics as a model of higher eukaryotes

4 lectures

Monohybrid & dihybrid crosses, back-crosses, test-crosses, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics, genetic epistasis in context of developmental mechanism.

Unit IV

Population genetics and genetics of evolution

4 lectures

Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, balancing selection, Fishers theorem, Hardy-Weinberg equilibrium, linkage disequilibrium; in-breeding depression & mating systems; population bottlenecks, migrations, Bayesian statistics; adaptive landscape, spatial variation & genetic fitness.

Unit V

Quantitative genetics of complex traits (QTLs)

2 lectures

Complex traits, mapping QTLs, yeast genomics to understand biology of QTLs.

Unit VI

Plant genetics

2 lectures

Laws of segregation in plant crosses, inbreeding, selfing, heterosis, maintenance of genetic purity, gene pyramiding.

Recommended Textbooks and References:

1. Hartl, D. L., & Jones, E. W. (1998). *Genetics: Principles and Analysis*. Sudbury, MA: Jones and Bartlett.
2. Pierce, B. A. (2005). *Genetics: a Conceptual Approach*. New York: W.H. Freeman.
3. Tamarin, R. H., & Leavitt, R. W. (1991). *Principles of Genetics*. Dubuque, IA: Wm. C. Brown.
4. Smith, J. M. (1998). *Evolutionary Genetics*. Oxford: Oxford University Press.

Basics of Mathematics and Statistics

Credits

2

Course Objectives

The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students.

Student Learning Outcomes

On completion of this course, students should be able to :

- Gain broad understanding in mathematics and statistics;
- Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.

Unit I

Algebra

6 lectures

Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models *etc.*), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices.

Unit II

Calculus

4 lectures

Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series *etc.*).

Unit III

Mathematical models in biology

4 lectures

Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modeling chemical reaction networks and metabolic networks.

Unit IV

Statistics

5 lectures

Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.

Recommended Textbooks and References:

1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science.
3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley.
4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*. New York: Wiley.

Basics of Chemistry and Physics

Credits

2

Course Objectives

The objectives of this course are to cover all essentials required to appreciate physico-chemical principles underlying biological processes.

Student Learning Outcomes

Students should be able to have a firm foundation in fundamentals and application of current chemical and physical scientific theories.

Unit I

Basic physics for biologists

12 lectures:
10 hours teaching +
2 hours tutorials

Physical quantities and their dynamics: definitions and dimensions; vectors & scalars, displacement, velocity, acceleration, kinematic formulas, angular momentum, torque *etc.* force, power, work, energy (kinetic & potential/electric charge separation, electromagnetic spectrum, photons *etc.*); springs & Hookes laws; elastic and inelastic collisions; Newton's law of motions (centripetal and centrifugal forces *etc.*); simple harmonic motions, mechanical waves, Doppler effect, wave interference, amplitude, period, frequency & wavelength; diffusion, dissipation, random walks, and directed motions in biological systems; low Reynolds number - world of Biology, buoyant forces, Bernoulli's equation, viscosity, turbulence, surface tension, adhesion; laws of thermodynamics: Maxwell Boltzmann distribution, conduction, convection and radiation, internal energy, entropy, temperature and free energy, Maxwell's demon (entropic forces at work in biology, chemical assemblies, self-assembled systems, role of ATP); Coulomb's law, conductors and insulators, electric potential energy of charges, nerve impulses, voltage gated channels, ionic conductance; Ohms law (basic electrical quantities: current, voltage & power), electrolyte conductivity, capacitors and capacitance, dielectrics; various machines in biology *i.e.* enzymes, allostery and molecular motors (molecules to cells and organisms).

Unit II

Basic chemistry for biologists

Basic constituents of matter - elements, atoms, isotopes, atomic weights, atomic numbers, basics of mass spectrometry, molecules, Avogadro number, molarity, gas constant, molecular weights, structural and molecular formulae, ions and polyatomic

12 lectures:
10 hours teaching +
2 hours tutorials

ions; chemical reactions, reaction stoichiometry, rates of reaction, rate constants, order of reactions, Arrhenious equation, Maxwell Boltzmann distributions, rate-determining steps, catalysis, free-energy, entropy and enthalpy changes during reactions; kinetic versus thermodynamic controls of a reaction, reaction equilibrium (equilibrium constant); light and matter interactions (optical spectroscopy, fluorescence, bioluminescence, paramagnetism and diamagnetism, photoelectron spectroscopy; chemical bonds (ionic, covalent, Van der Walls forces); electronegativity, polarity; VSEPR theory and molecular geometry, dipole moment, orbital hybridizations; states of matter - vapor pressure, phase diagrams, surface tension, boiling and melting points, solubility, capillary action, suspensions, colloids and solutions; acids, bases and pH - Arrhenious theory, pH, ionic product of water, weak acids and bases, conjugate acid-base pairs, buffers and buffering action *etc*; chemical thermodynamics - internal energy, heat and temperature, enthalpy (bond enthalpy and reaction enthalpy), entropy, Gibbs free energy of ATP driven reactions, spontaneity versus driven reactions in biology; redox reactions and electrochemistry - oxidation-reduction reactions, standard cell potentials, Nernst equation, resting membrane potentials, electron transport chains (ETC) in biology, coupling of oxidative phosphorylations to ETC; theories of ATP production and dissipation across biological membranes; bond rotations and molecular conformations - Newman projections, conformational analysis of alkanes, alkenes and alkynes; functional groups, optically asymmetric carbon centers, amino acids, proteins, rotational freedoms in polypeptide backbone (Ramachandran plot).

Recommended Textbooks and References:

1. Baaquie, B. E. (2000). *Laws of Physics: a Primer*. Singapore: National University of Singapore.
2. Matthews, C. P., & Shearer, J. S. (1897). *Problems and Questions in Physics*. New York: Macmillan Company.
3. Halliday, D., Resnick, R., & Walker, J. (1993). *Fundamentals of Physics.* New York: Wiley.
4. Ebbing, D. D., & Wrighton, M. S. (1990). *General Chemistry*. Boston: Houghton Mifflin.
5. Averill, B., & Eldredge, P. (2007). *Chemistry: Principles, Patterns, and Applications*. San Francisco: Benjamin Cummings.
6. Mahan, B. H. (1965). *University Chemistry*. Reading, MA: Addison-Wesley Pub.
7. Cantor, C. R., & Schimmel, P. R. (2004). *Biophysical Chemistry*. San Francisco: W.H. Freeman.

Laboratory I: Biochemistry & Analytical Techniques

Credits

4

Course Objectives

The objective of this laboratory course is to introduce students to experiments in biochemistry. The course is designed to teach students the utility of set of experimental methods in biochemistry in a problem oriented manner.

Student Learning Outcomes

On completion of this course, students should be able to:

- To elaborate concepts of biochemistry with easy to run experiments;
- To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

Syllabus

1. Preparing various stock solutions and working solutions that will be needed for the course.

2. To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbach equation.
3. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
4. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography.
5. Purification and characterization of an enzyme from a recombinant source (such as Alkaline Phosphatase or Lactate Dehydrogenase or any enzyme of the institution's choice).
   a) Preparation of cell-free lysates
   b) Ammonium Sulfate precipitation
   c) Ion-exchange Chromatography
   d) Gel Filtration
   e) Affinity Chromatography
   f) Dialysis of the purified protein solution against 60% glycerol as a demonstration of storage method
   g) Generating a Purification Table (protein concentration, amount of total protein; Computing specific activity of the enzyme preparation at each stage of purification)
   h) Assessing purity of samples from each step of purification by SDS-PAGE Gel Electrophoresis
   i) Enzyme Kinetic Parameters: Km, Vmax and Kcat.
6. Experimental verification that absorption at OD_{260} is more for denatured DNA as compared to native double stranded DNA. reversal of the same following DNA renaturation. Kinetics of DNA renaturation as a function of DNA size.
7. Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. (Optional Experiments)
8. Biophysical methods (Circular Dichroism Spectroscopy, Fluorescence Spectroscopy).
9. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry.

Laboratory II: Microbiology

Credits

2

Course Objectives

The objective of this laboratory course is to provide practical skills on basic microbiological techniques.

Student Learning Outcomes

Students should be able to:

- Isolate, characterize and identify common bacterial organisms;
- Determine bacterial load of different samples;
- Perform antimicrobial sensitivity tests;
- Preserve bacterial cultures.

Syllabus

1. Sterilization, disinfection and safety in microbiological laboratory.
2. Preparation of media for cultivation of bacteria.
3. Isolation of bacteria in pure culture by streak plate method.
4. Study of colony and growth characteristics of some common bacteria: *Bacillus, E. coli, Staphylococcus, Streptococcus, etc.*
5. Preparation of bacterial smear and Gram's staining.
6. Enumeration of bacteria: standard plate count.
7. Antimicrobial sensitivity test and demonstration of drug resistance.
8. Maintenance of stock cultures: slants, stabs and glycerol stock cultures
9. Determination of phenol co-efficient of antimicrobial agents.
10. Determination of Minimum Inhibitory Concentration (MIC)

11. Isolation and identification of bacteria from soil/water samples.

Recommended Textbooks and References:

1. Cappuccino, J. G., & Welsh, C. (2016). *Microbiology: a Laboratory Manual*. Benjamin-Cummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). *Collins and Lyne's Microbiological Methods* (8th ed.). Arnolds.
3. Tille, P. M., & Forbes, B. A. *Bailey & Scott's Diagnostic Microbiology.*

Laboratory III: Plant and Animal Biotechnology

Credits

2

Course Objectives

The objectives of this course are to provide hands-on training in basic experiments of plant and animal biotechnology.

Student Learning Outcomes

On completion of course, students should be able to gain basic skills in plant and animal biotechnology.

Syllabus

Plant Biotechnology

1. Prepare culture media with various supplements for plant tissue culture.
2. Prepare explants of *Valleriana wallichii* for inoculation under aseptic conditions.
3. Attempt *in vitro* andro and gynogenesis in plants *(Datura stramonium)*.
4. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG (available material).
5. Culture *Agrobacterium tumefaciens* and attempt transformation of any dicot species.
6. Generate an RAPD and ISSR profile of *Eremurus persicus* and *Valleriana wallichii*.
7. Prepare karyotypes and study the morphology of somatic chromosomes of *Allium cepa, A. sativum, A. tuberosum* and compare them on the basis of karyotypes.
8. Pollen mother cell meiosis and recombination index of select species (one achiasmate, and the other chiasmate) and correlate with generation of variation.
9. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometeric methods.
10. Perform PCR amplification of 'n' number of genotypes of a species for studying the genetic variation among the individuals of a species using random primers.
11. Study genetic fingerprinting profiles of plants and calculate polymorphic information content.

Syllabus

Animal Biotechnology

1. Count cells of an animal tissue and check their viability.
2. Prepare culture media with various supplements for plant and animal tissue culture.
3. Prepare single cell suspension from spleen and thymus.
4. Monitor and measure doubling time of animal cells.
5. Chromosome preparations from cultured animal cells.
6. Isolate DNA from animal tissue by SDS method.
7. Attempt animal cell fusion using PEG.

Semester Two

Genetic Engineering

Credits

3

Course Objectives

The objectives of this course are to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.

Student Learning Outcomes

Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practicals in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.

Unit I

Introduction and tools for genetic engineering

6 lectures

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.

Unit II

Different types of vectors

7 lectures

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.

Unit III

Different types of PCR techniques

7 lectures

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.

Unit IV

Gene manipulation and protein-DNA interaction

7 lectures

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Unit V

Gene silencing and genome editing technologies

13 lectures

Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies

(*Drosophila*), worms (*C. elegans*), frogs (*Xenopus*), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.

Recommended Textbooks and References:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*

Immunology

Credits

3

Course Objectives

The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

Student Learning Outcomes

On completion of this course, students should be able to:

- Evaluate usefulness of immunology in different pharmaceutical companies;
- Identify proper research lab working in area of their own interests;
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).

Unit I

Immunology: fundamental concepts and overview of the immune system

5 lectures

Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.

Unit II

Immune responses generated by B and T lymphocytes

8 lectures

Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

Unit III

Antigen-antibody interactions

6 lectures

Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

Unit IV

Vaccinology

8 lectures

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.

Unit V

Clinical immunology

8 lectures

Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.

Unit VI

Immunogenetics

5 lectures

Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: implication for linkage disequilibrium and disease associations, genetic studies of rheumatoid arthritis, systemic lupus erythematosus and multiple sclerosis, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex.

Recommended Textbooks and References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology.* London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology.* New York: Garland Science.
4. Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press.
5. Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology.* London: Academic Press.
6. Parham, P. (2005). *The Immune System*. New York: Garland Science.

Bioinformatics

Credits

2

Course Objectives

The objectives of this course are to provide theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.

Student Learning Outcomes

Student should be able to :

- Develop an understanding of basic theory of these computational tools;
- Gain working knowledge of these computational tools and methods;
- Appreciate their relevance for investigating specific contemporary biological questions;
- Critically analyse and interpret results of their study.

Unit I

Bioinformatics basics

5 lectures

Bioinformatics basics: Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools.

Unit II

DNA sequence analysis

5 lectures

DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.

Unit III

Multiple sequence analysis

5 lectures

Multiple sequence analysis; multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.

Unit IV

Protein modelling

5 lectures

Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment- methods, evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; software accessibility; building peptides; protein displays; substructure manipulations, annealing.

Unit V

Protein structure prediction and virtual library

6 lectures

Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; threading techniques; topology fingerprint approach for prediction; evaluation of alternate models; structure prediction on a mystery sequence; structure aided sequence techniques of structure prediction; structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methods of structure prediction, prediction using inverse folding, fold prediction; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of in silico drug design; Virtual library: Searching PubMed, current content, science citation index and current awareness services, electronic journals, grants and funding information.

Recommended Textbooks and References:

1. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.
2. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. New York: Wiley-Interscience.
4. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*. Hoboken, NJ.: Wiley-Blackwell.
5. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
6. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics.* Oxford: Oxford University Press.

Approved in Academic Council Meeting held on August 06, 2020

Genomics and Proteomics

Credits

2

Course Objectives

The objectives of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.

Student Learning Outcomes

Students should be able to acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.

Unit I

Basics of genomics and proteomics

3 lectures

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.

Unit II

Genome mapping

4 lectures

Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.

Unit III

Genome sequencing projects

3 lectures

Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.

Unit IV

Comparative genomics

5 lectures

Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.

Unit V

Proteomics

5 lectures

Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.

Unit VI

Functional genomics and proteomics

8 lectures

Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.

Recommended Textbooks and References:

1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
2. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology.* Totowa, NJ: Humana Press.
3. Campbell, A. M., & Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.

Molecular Diagnostics

Credits

2

Course Objectives

The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.

Student Learning Outcomes

Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

Unit I

Genome biology in health and disease

4 lectures

DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs.

Unit II

Genome: resolution, detection & analysis

5 lectures

PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF-MS; Bioinformatics data acquisition & analysis.

Unit III

Diagnostic metabolomics

2 lectures

Metabolite profile for biomarker detection the body fluids/tissues in various metabolic disorders by making using LCMS & NMR technological platforms.

Unit IV

Detection and identity of microbial diseases

4 lectures

Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of *in vitro* cultivation as well as genotypic markers of microbial resistance to specific antibiotics.

Unit V

Detection of inherited diseases

4 lectures

Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancersyndromes.

Unit VI

Molecular oncology

5 lectures

Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.

Unit VII

Quality assurance and control

1 lecture

Quality oversight; regulations and approved testing.

Recommended Textbooks and References:

1. Campbell, A. M., & Heyer, L. J. (2006). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: BenjaminCummings.
2. Brooker, R. J. (2009). *Genetics: Analysis & Principles*. New York, NY: McGraw-Hill.

3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press.
4. Coleman, W. B., & Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: Humana Press.

Research Methodology and Scientific Communication Skills

Credits

2

Course Objectives

The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.

Student Learning Outcomes

Students should be able to:

- Understand history and methodologies of scientific research, applying these to recent published papers;
- Understand and practice scientific reading, writing and presentations;
- Appreciate scientific ethics through case studies.

Unit I
History of science and science methodologies
8 lectures

Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist *vs* holistic biology.

Unit II
Preparation for research
2 lectures

Choosing a mentor, lab and research question; maintaining a lab notebook.

Unit III
Process of communication
5 lectures

Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

Unit IV
Scientific communication
9 lectures

Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Recommended Textbooks and References:

1. Valiela, I. (2001). *Doing Science: Design, Analysis, and Communication of Scientific Research.* Oxford: Oxford University Press.
2. *On Being a Scientist: a Guide to Responsible Conduct in Research.* (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. *The Science of Scientific Writing*. American Scientist, 78 (Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). *Speaking English Effectively*. Delhi: Macmillan India.
5. Movie: Naturally Obsessed, The Making of a Scientist.

Laboratory IV: Molecular Biology and Genetic Engineering

Credits

4

Course Objectives

The objectives of this course are to provide students with experimental knowledge of molecular biology and genetic engineering.

Student Learning Outcomes

Students should be able to gain hands-on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

Syllabus

1. Concept of lac-operon:
   a) Lactose induction of B-galactosidase.
   b) Glucose Repression.
   c) Diauxic growth curve of *E.coli*
2. UV mutagenesis to isolate amino acid auxotroph
3. Phage titre with epsilon phage/M13
4. Genetic Transfer-Conjugation, gene mapping
5. Plasmid DNA isolation and DNA quantitation
6. Restriction Enzyme digestion of plasmid DNA
7. Agarose gel electrophoresis
8. Polymerase Chain Reaction and analysis by agarose gel electrophoresis
9. Vector and Insert Ligation
10. Preparation of competent cells
11. Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency
12. Confirmation of the insert by Colony PCR and Restriction mapping
13. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in *E.coli,* SDS-PAGE analysis
14. Purification of His-Tagged protein on Ni-NTA columns
    a) Random Primer labeling
    b) Southern hybridization.

Recommended Textbooks and References:

1. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Laboratory V: Immunology

Credits

Course Objectives

The objectives of this laboratory course are to develop an understanding about practical aspects of components of immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells *etc.* and how they can be used in respective research work.

Student Learning Outcomes

Students should be able to:

- Evaluate usefulness of immunology in different pharmaceutical companies;
- Identify proper research lab working in area of their own interests;
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in setting of infection (viral or bacterial) by looking at cytokine profile.

Syllabus

1. Selection of animals, preparation of antigens, immunization and methods of blood collection, serum separation and storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Complement fixation test.
5. Isolation and purification of IgG from serum or IgY from chicken egg.
6. SDS-PAGE, Immunoblotting, Dot blot assays.
7. Blood smear identification of leucocytes by Giemsa stain.
8. Separation of leucocytes by dextran method.
9. Demonstration of Phagocytosis of latex beads and their cryopreservation.
10. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation.
11. Demonstration of ELISPOT.
12. Demonstration of FACS.

Semester Three

Bioprocess Engineering & Technology

Credits

Course Objectives

The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.

Student Learning Outcomes

Students should be able to:

- Appreciate relevance of microorganisms from industrial context;
- Carry out stoichiometric calculations and specify models of their growth;
- Give an account of design and operations of various fermenters;
- Present unit operations together with the fundamental principles for basic methods in production technique for bio-based products;
- Calculate yield and production rates in a biological production process, and also interpret data;
- Calculate the need for oxygen and oxygen transfer;
- Critically analyze any bioprocess from market point of view;
- Give an account of important microbial/enzymatic industrial processes in food and fuel industry.

Unit I

Basic principles of biochemical engineering

4 lectures

Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.

Unit II

Stoichiometry and models of microbial growth

4 lectures

Elemental balance equations; metabolic coupling – ATP and NAD+; yield coefficients; unstructured models of microbial growth; structured models of microbial growth.

Unit III

Bioreactor design and analysis

8 lectures

Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.

Unit IV

Downstream processing and product recovery

8 lectures

Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.

Unit V

Fermentation economics

4 lectures

Isolation of micro-organisms of potential industrial interest; strain improvement; market analysis; equipment and plant costs; media; sterilization, heating and cooling; aeration and agitation; bath-process cycle times and continuous cultures; recovery costs; water usage and recycling; effluent treatment and disposal.

Unit VI

Applications of enzyme technology in food processing

4 lectures

Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

Unit VII

Applications of microbial technology in food process operations and production, biofuels and biorefinery

4 lectures

Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery

Recommended Textbooks and References:

1. Shuler, M. L., & Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts.* Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). *Principles of Fermentation Technology*. Oxford: Pergamon Press.
3. Blanch, H. W., & Clark, D. S. (1997). *Biochemical Engineering.* New York: M. Dekker.
4. Bailey, J. E., & Ollis, D. F. (1986). *Biochemical Engineering Fundamentals*. New York: McGraw-Hill.

5 El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology.* Boca Raton: CRC/Taylor & Francis.

Emerging Technologies

Credits

2

Course Objectives

This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.

Student Learning Outcomes

Students should be to learn history, theoretical basis and basic understanding of latest technologies in area of biotechnology. They should also be able to learn about various applications of these technologies. The students may also learn one application in depth through an assignment and/or seminar.

Unit I
Optical microscopy methods
8 lectures

Basic Microscopy: Light Microscopy: lenses and microscopes, resolution: Rayleigh's Approach, Darkfield; Phase Contrast; Differential Interference Contrast; fluorescence and fluorescence microscopy: what is fluorescence, what makes a molecule fluorescent, fluorescence microscope; optical arrangement, light source; filter sets: excitation filter, dichroic mirror, and barrier, optical layout for image capture; CCD cameras; back illumination, binning; recording color; three CCD elements with dichroic beamsplitters, boosting the signal.

Advanced Microscopy: Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers & solid-state, primary beamsplitter; beam scanning, pinhole and signal channel configurations, detectors; pixels and voxels; contrast, spatial sampling: temporal sampling: signal-to-noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages of two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Evanescent Wave Microscopy; Near-Field and Evanescent Waves, Total Internal Reflection Microscopy; Near-Field Microscopy; Beyond the Diffraction Limit: Stimulated Emission Depletion (STED), Super-Resolution Summary, Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM).

Unit II
Mass spectroscopy
4 lectures

Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.

Unit III
Systems biology
3 lectures

High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modeling and designing testable predictions.

Unit IV
Structural biology
3 lectures

X-ray diffraction methods, solution & solid-state NMR, cryo-electron microscopy, small-angle X-ray scattering, Atomic force microscopy.

Unit V
CRISPR-CAS
6 lectures

History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for *in vivo* genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.

Unit VI

Nanobodies

4 lectures

Introduction to nanobodies, combining nanobody with phage-display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.

Recommended Textbooks and References:

1. Campbell, I. D. (2012). *Biophysical Techniques*. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). *Methods in Molecular Biophysics: Structure, Dynamics, Function*. Cambridge: Cambridge University Press.
3. Phillips, R., Kondev, J., & Theriot, J. (2009). P*hysical Biology of the Cell*. New York: Garland Science.
4. Nelson, P. C., Radosavljević, M., & Bromberg, S. (2004). *Biological Physics: Energy, Information, Life*. New York: W.H. Freeman.
5. Huang, B., Bates, M., & Zhuang, X. (2009). *Super-Resolution Fluorescence Microscopy.* Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
6. Mohanraju, P., Makarova, K. S., Zetsche, B., Zhang, F., Koonin, E. V., & Oost, J. V. (2016). *Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems.* Science, 353(6299). doi:10.1126/science.aad5147.
7. Lander, E. (2016). *The Heroes of CRISPR.* Cell, 164(1-2), 18-28. doi:10.1016/j.cell.2015.12.041.
8. Ledford, H. (2016). *The Unsung Heroes of CRISPR*. Nature, 535(7612), 342-344. doi:10.1038/535342a.
9. Jinek, M., Chylinski, K., Fonfara, I., Hauer, M., Doudna, J. A., & Charpentier, E. (2012). *A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity*. Science, 337(6096), 816-821. doi:10.1126/science.1225829.
10. Hamers-Casterman, C., Atarhouch, T., Muyldermans, S., Robinson, G., Hammers, C., Songa, E. B., Hammers, R. (1993). *Naturally Occurring Antibodies Devoid of Light Chains*. Nature, 363(6428), 446-448. doi:10.1038/363446a0.
11. Sidhu, S. S., & Koide, S. (2007). *Phage Display for Engineering and Analyzing Protein Interaction Interfaces.* Current Opinion in Structural Biology, 17(4), 481-487. doi:10.1016/j.sbi.2007.08.007.
12. Steyaert, J., & Kobilka, B. K. (2011). *Nanobody Stabilization of G Protein-Coupled Receptor Conformational States*. Current Opinion in Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.
13. Vincke, C., & Muyldermans, S. (2012). *Introduction to Heavy Chain Antibodies and Derived Nanobodies*. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779-968-6_2.
14. Verheesen, P., & Laeremans, T. (2012). *Selection by Phage Display of Single Domain Antibodies Specific to Antigens in their Native Conformation.* Single Domain Antibodies, 81-104. doi:10.1007/978-1-61779-968-6_6.
15. Li, J., Xia, L., Su, Y., Liu, H., Xia, X., Lu, Q. Reheman, K. (2012). *Molecular Imprint of Enzyme Active Site by Camel Nanobodies*. Journal of Biological Chemistry J. Biol. Chem., 287(17), 13713-13721. doi:10.1074/jbc.m111.336370.
16. Sohier, J., Laurent, C., Chevigné, A., Pardon, E., Srinivasan, V., Wernery, U. Galleni, M. (2013). *Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody.* Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305.
17. Chakravarty, R., Goel, S., & Cai, W. (2014). *Nanobody: The "Magic Bullet" for Molecular Imaging?* Theranostics, 4(4), 386-398. doi:10.7150/thno.8006.

Critical Analysis of Classical Papers

Credits

2

Course Objectives

The objectives of this course are to familiarize students with classic literature to make them appreciate how ground-breaking discoveries were made without, necessarily, use of high-end technologies.

Student Learning Outcomes

Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.

How does the Course Module work? Students may be divided in groups and each group may be responsible for one classical paper. Each week there may be a 1.5 hour presentation cum discussion for each of the papers. At the end of the semester each student will be asked to write a mini-review (2-3 pages long) on any one classical paper, other than the one he/she presented/discussed.

A list of sixteen classic papers and some suggested reference materials:

Syllabus

Molecular Biology

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from *Pneumococcus* type III.
   Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58.
   Note: This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.
2. Independent functions of viral protein and nucleic acid in growth of bacteriophage
   Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56.
   Note: Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells.
3. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid
   Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8
   Note: In this one page paper Watson and Crick first described the structure of DNA double helix
   Study help - Watson_Crick_Nature_1953_annotated
4. Transposable mating type genes in *Saccharomyces cerevisiae*
   James Hicks, Jeffrey N. Strathern & Amar J.S. Klar; Nature 282, 478-483,1979
   Note: This paper provided evidence for 'cassette hypothesis' of yeast mating type switches *i.e.* interconversion of mating types in yeast *(S. cerevisiae)* occurs by DNA rearrangement.
5. Messelson & Stahl experiment demonstrating semi-conservative replication of DNA.
   Meselson M and Stahl FW.; Proc Natl Acad Sci U S A. 1958 Jul 15;44(7):671-82
   Note: The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology"
6. *In vivo* alteration of telomere sequences and senescence caused by mutated *Tetrahymena* telomerase RNAs
   Guo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990
   Note: This paper demonstrates that the telomerase contains the template for telomere synthesis

Syllabus

Cell Biology

1. A protein-conducting channel in the endoplasmic reticulum
   Simon SM AND Blobel G.; Cell. 1991 May 3;65(3):371-80
   Note: This paper demonstrates the existence of a protein conducting channel
   Study help - A brief history of Signal Hypothesis

2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway
   Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15
   Note: In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion
3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum
   Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45
   Note: Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC)
   Suggested reference paper - A biochemical assay for identification of PCC.
4. Reconstitution of the Transport of Protein between Successive Compartments of the Golgi
   Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16
   Note: This paper describes setting up of an *in vitro* reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP *etc.*
5. A complete immunoglobulin gene is created by somatic recombination
   Brack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14
   Note: This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination.
6. A novel multigene family may encode odorant receptors: a molecular basis for odor recognition
   Buck L and Axel R; Cell. 1991 Apr 5;65(1):175-87
   Note: This paper suggests that different chemical odorants associate with different cell-specific expression of a transmembrane receptor in *Drosophila* olfactory epithelium where a large family of odorat receptors is expressed.
7. Kinesin walks hand-over-hand
   Yildiz A, Tomishige M, Vale RD, Selvin PR.; Science. 2004 Jan 30;303(5658):676-8
   Note: This paper shows that kinesin motor works as a two-headed dimeric motor walking hand-over-hand rather than like an inchworm on microtubule tract using the energy of ATP hydrolysis.

Syllabus

Developmental Biology/ Genetics

1. Mutations affecting segment number and polarity in *Drosophila*
   Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980
   Note: This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well.
2. Information for the dorsal--ventral pattern of the *Drosophila* embryo is stored as maternal mRNA
   Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7
   Note: This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes
3. Hedgehog signalling in the mouse requires intraflagellar transport proteins
   Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.; Nature. 2003 Nov 6;426(6962):83-7
   Note: One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it.
   Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse.

Bioentrepre-neurship

Credits

2

Course Objectives

Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Student Learning Outcomes

Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.

Unit I

Innovation and entrepreneurship in bio-business

8 lectures

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals *vs.* Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

Unit II

Bio markets - business strategy and marketing

8 lectures

Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

Unit III

Finance and accounting

8 lectures

Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

Unit IV

Technology management

8 lectures

Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Recommended Textbooks and References:

1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Bloxham: Scion.
2. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.

3. Onetti, A., & Zucchella, A. *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge*. Routledge.
4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences*. London: CRC Press.
5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management*. New Delhi: Himalaya Pub. House.

Intellectual Property Rights, Biosafety and Bioethics

Credits

2

Course Objectives

The objectives of this course are:

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development;
- To become familiar with India's IPR Policy;
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products;
- To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.

Student Learning Outcomes

On completion of this course, students should be able to:

- Understand the rationale for and against IPR and especially patents;
- Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations;
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents;
- Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations;
- Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

Unit I

Introduction to IPR

5 lectures

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

Unit II

Patenting

5 lectures

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

Unit III

Biosafety

5 lectures

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops *vs* cisgenic plants or products derived from RNAi, genome editing tools.

Unit IV

National and international regulations

5 lectures

International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

Unit V

Bioethics

5 lectures

Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

Recommended Textbooks and References:

1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* New Delhi: Tata McGraw-Hill Pub.
2. *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
6. Karen F. Greif and Jon F. Merz, *Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies*, MIT Press
7. World Trade Organisation. http://www.wto.org
8. World Intellectual Property Organisation. http://www.wipo.int
9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
10. National Portal of India. http://www.archive.india.gov.in
11. National Biodiversity Authority. http://www.nbaindia.org
12. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf
13. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). *Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants*. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
14. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). *An Overview of General Features of Risk Assessments of Genetically Modified Crops*. Euphytica, 164(3), 853-880. doi:10.1007/s10681-007-9643-8

15. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
16. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp
17. Alonso, G. M. (2013). *Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments*. Retrieved from http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews.

Project Proposal Preparation & Presentation

Credits

2

Course Objectives

The purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.

Student Learning Outcomes

Students should be able to demonstrate the following abilities:

- Formulate a scientific question;
- Present scientific approach to solve the problem;
- Interpret, discuss and communicate scientific results in written form;
- Gain experience in writing a scientific proposal;
- Learn how to present and explain their research findings to the audience effectively.

Syllabus

Project Proposal Preparation

Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven.
Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources.
Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, *etc.* Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.

Syllabus

Poster Presentation

Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.

Syllabus

Oral Presentation

At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.

Laboratory VI: Bioprocess Engineering & Technology

Credits

4

Course Objectives

The objectives of this laboratory course are to provide hands-on training to students in upstream and downstream unit operations.

Student Learning Outcomes

Students should be able to:

- Investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems;
- Apply skills and knowledge gained will be useful in solving problems typical of bio industries and research.

Syllabus

1. Basic Microbiology techniques
   a) Scale up from frozen vial to agar plate to shake flask culture.
   b) Instrumentation: Microplate reader, spectrophotometer, microscopy.
   c) Isolation of microorganisms from soil samples.
2. Experimental set-up
   a) Assembly of bioreactor and sterilization.
   b) Growth kinetics.
   c) Substrate and product inhibitions.
   d) Measurement of residual substrates.
3. Data Analysis
   a) Introduction to Metabolic Flux Analysis (MFA).
4. Fermentation
   a) Batch.
   b) Fed-batch.
   c) Continuous.
5. Unit operations
   a) Microfiltrations: Separation of cells from broth.
   b) Bioseparations: Various chromatographic techniques and extractions.
6. Bioanalytics
   a) Analytical techniques like HPLC, FPLC, GC, GC-MS *etc.* for measurement of amounts of products/substrates.

Recommended Textbooks and References:

1. Shuler, M. L., & Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts*. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P.F., & Whitaker, A. (2010). *Principles of Fermentation Technology*. Oxford: Pergamon Press.
3. Blanch, H. W., & Clark, D. S. (1997). *Biochemical Engineering*. New York: M. Dekker.
4. Bailey, J.E., & Ollis, D.F. (1986). *Biochemical Engineering Fundamentals*. New York: McGraw-Hill.
5. El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology*. Boca Raton: CRC/Taylor & Francis.

Laboratory VII: Bioinformatics

Credits

2

Course Objectives

The aim of this course is to provide practical training in bioinformatic methods including accessing major public sequence databases, use of different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages.

Student Learning Outcomes

On completion of this course, students should be able to:

- Describe contents and properties of most important bioinformatics databases;
- Perform text- and sequence-based searches and analyze and discuss results in light of molecular biological knowledge;
- Explain major steps in pairwise and multiple sequence alignment, explain principle and execute pairwise sequence alignment by dynamic programming;
- Predict secondary and tertiary structures of protein sequences.

Syllabus

1. Using NCBI and Uniprot web resources.
2. Introduction and use of various genome databases.
3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.
4. Similarity searches using tools like BLAST and interpretation of results.
5. Multiple sequence alignment using ClustalW.
6. Phylogenetic analysis of protein and nucleotide sequences.
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
8. Using RNA structure prediction tools.
9. Use of various primer designing and restriction site prediction tools.
10. Use of different protein structure prediction databases (PDB, SCOP, CATH).
11. Construction and study of protein structures using Deepview/PyMol.
12. Homology modelling of proteins.
13. Use of tools for mutation and analysis of the energy minimization of protein structures.
14. Use of miRNA prediction, designing and target prediction tools.

Semester Four

Dissertation

Credits

24

(Semester III: 4 Credits; Semester IV: 20 Credits)

Course Objectives

The objectives of this course are to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.

Student Learning Outcomes

Students should be able to learn how to select and defend a topic of their research, how to effectively plan, execute, evaluate and discuss their experiments. Students should be able to demonstrate considerable improvement in the following areas:

- In-depth knowledge of the chosen area of research.
- Capability to critically and systematically integrate knowledge to identify issues that must be addressed within framework of specific thesis.
- Competence in research design

and planning.
- Capability to create, analyse and critically evaluate different technical solutions.
- Ability to conduct research independently.
- Ability to perform analytical techniques/experimental methods.
- Project management skills.
- Report writing skills.
- Problem solving skills.
- Communication and interpersonal skills.

Syllabus

Planning & performing experiments

Based on the project proposal submitted in earlier semester, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment.

Syllabus

Thesis writing

At the end of their project, thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent application.

Recommended Electives

Biological Imaging

Credits

2

Course Objectives

The objectives of this course are to provide complete overview of state-of-art live-cell imaging techniques using microscopes currently available in literature. Live-cell imaging techniques allow real-time examination of almost every aspect of cellular function under normal and experimental conditions. With live-cell imaging experiments, main challenges are to keep cells alive and healthy over a period of time. The growing number of live-cell imaging techniques means one can obtain greater amounts of information without stressing out cells.

Student Learning Outcomes

On completion of this course, students shall be able to gain a complete overview of super-resolution field from fundamentals to state-of-art methods and applications in biomedical research. The students shall learn the comparative advantages and disadvantages of each technique, covers all key techniques in field of biomedical science. The students shall also learn how to use new tools to increase resolution in sub-nanometer-scale images of living cells and tissue, which leads to new information about molecules, pathways and dynamics and state-of-the-art examples of applications using microscopes.

Unit I

Widefield fluorescent microscopy

3 lectures

One of the most basic techniques for live-cell imaging is widefield fluorescent microscopy. Standard inverted research grade microscopes can yield valuable results if you are imaging adherent cells, large regions of interest (such as organelles) or very thin tissue sections (less than 5 micrometer). In widefield, a CCD camera is usually used to

capture images and the epi-fluorescence illumination source can be a mercury lamp, xenon lamp, LED's, *etc.* Each of light sources require carefully matched interference filters for specific excitation and emission wavelengths of your fluorophore of interest. With widefield microscopy, your specimen is only exposed to excitation light for relatively short time periods as the full aperture of emission light is collected by the objectives. Widefield fluorescence microscopy can be used in combination with other common contrast techniques such as phase contrast and differential interference contract (DIC) microscopy. This combination is useful when performing live-cell imaging to examine general cell morphology or viability while also imaging regions of interest within cells.

Unit II

Confocal laser scanning microscopy (CLSM)

3 lectures

CLSM has ability to eliminate out-of-focus light and information. It is also possible to obtain optical serial sections from thicker specimens. A conjugate pinhole in optical path of confocal microscope prevents fluorescence from outside of focal plane from being collected by photomultiplier detector or imaged by camera. In CLSM, a single pinhole (and single focused laser spot) is scanned across specimen by scanning system. This spot forms a reflected epi-fluorescence image back on original pinhole. When specimen is in focus, fluorescent light from it passes through pinhole to detector. Any out-of-focus light is defocused at pinhole and very little of this signal passes through to detector meaning that background fluorescence is greatly reduced. The pinhole acts as a spatial filter for emission light from the specimen.

Unit III

Spinning disc confocal microscopy (SDCM)

2 lectures

This method utilises a 'Nipkow Disc' which is a mechanical opaque disc which has a series of thousands of drilled or etched pinholes arranged in a spiral pattern. Each illuminated pinhole on disc is imaged by microscope objective to a diffraction-limited spot on region of interest on specimen. The emission from fluorophores passes back though Nipkow disc pinholes and can be observed and captured by a CCD camera. The effect of spinning disc is that many thousands of points on specimen are simultaneously illuminated. Using SDCM to examine a specimen means that real-time imaging (30-frames-per-second or faster) can be achieved, which is extremely useful if you are looking at dynamic changes within living cells over a wide spectrum of time-scales.

Unit IV

Light-sheet fluorescence microscopy (LSFM, or SPIM)

2 lectures

This method enables one to perform live-cell imaging on whole embryos, tissues and cell spheroids *in vivo* in a gentle manner with high temporal resolution and in three dimensions. One is able to track cell movement over extended periods of time and follow development of organs and tissues on a cellular level. The next evolution of light-sheet fluorescence microscopy, termed lattice light-sheet microscopy as developed by Eric Betzig (Nobel Prize Laureate 2014 for PALM super-resolution microscopy) will even allow live-cell imaging with super-resolved *in vivo* cellular localization capabilities.

Unit V

Super-resolved fluorescence microscopy

8 lectures

Super-Resolution in a Standard Microscope: From Fast Fluorescence Imaging to Molecular Diffusion Laws in Live Cells; Photoswitching Fluorophores in Super-Resolution Fluorescence Microscopy; Image Analysis for Single-Molecule Localization Microscopy Deconvolution of Nanoscopic Images; Super-Resolution Fluorescence Microscopy of the Nanoscale Organization in cells; Correlative Live-Cell and Super-Resolution Microscopy and Its Biological Applications; SAX Microscopy and Its Application to Imaging of 3D-Cultured Cells; Quantitative Super-Resolution Microscopy for Cancer Biology and Medicine.

Unit VI

Re-scan confocal microscopy

4 lectures

Structured Illumination Microscopy; Correlative Nanoscopy: AFM Super-Resolution (STED/STORM) ; Stochastic Optical Fluctuation Imaging.

Recommended Textbooks and References:

1. Rajagopal Vadivambal, Digvir S. Jayas. (2015). *Bio-Imaging: Principles, Techniques, and Applications*. ISBN 9781466593671 -CAT# K20618.
2. Alberto Diaspro, Marc A. M. J. van Zandvoort. (2016). *Super-Resolution Imaging in Biomedicine*. ISBN 9781482244342 -CAT# K23483.
3. Taatjes, Douglas, Roth, Jürgen (Eds.). (2012). *Cell Imaging Techniques Methods and Protocols*. ISBN 978-1-62703-056-4.

Computational Biology

Credits

2

Course Objectives

The objective of this course is to provide students with theory and practical experience of essentials to aid for genomic, proteomic and metabolomics courses and drug design program.

Student Learning Outcomes

On completion of this course, the students are expected to:

- Develop an understanding of the basic theory of these computational tools;
- Develop required database extraction, integration, coding for computational tools and methods necessary for all Omics;
- Create hypothesis for investigating specific contemporary biological questions, provide help to experiment with or develop appropriate tools;
- Critically analyze and interpret results of their study with respect to whole systems.

Unit I

Introduction to computational biology basics and biological databases

4 lectures

Computers in biology and medicine; Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification database, Sequence formats & storage, Access databases, Extract and create sub databases, limitations of existing databases.

Unit II

Pairwise and multiple sequence alignments

5 lectures

Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA. Building Profiles, Profile based functional identification.

Unit III

Genome analysis

6 lectures

Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, Human genome project, Genomics and crop improvement. Study available GWAS, ENCODE, HUGO projects, extract and build sub databases; Visualization tools including Artemis and Vista for genome comparison; Functional genomics case studies.

Unit IV

Structure visualization

3 lectures

Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD.

Unit V

Molecular modelling

6 lectures

Significance and need, force field methods, energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; RMS fit of conformers and protein chains, assigning secondary structures; sequence alignment: methods, evaluation, scoring; protein curation: backbone construction and side chain addition; different types of protein chain modelling: ab initio, homology, hybrid, loop; Template recognition and alignments; Modelling parameters and considerations; Model analysis and validation; Model optimization; Substructure manipulations, annealing, protein folding and model generation; loop generating methods; loop analysis; Analysis of active sites using different methods in studying protein–protein interactions.

Unit VI

Structure-based drug development

6 lectures

Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information. Extra-precision docking platforms, Use of Small-molecule libraries, Natural compound libraries for virtual high throughput screenings.

Unit VII

Ligand-based drug development

6 lectures

Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based; Radar plots and contribution plots and Activity predictions, Pharmacophore modeling, Pharmacophore-based screenings of compound library, analysis and experimental validation.

Recommended Textbooks and References:

1. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
3. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.
4. Campbell, M & Heyer, L. J. (2006), *Discovering Genomics, Proteomics and Bioinformatics*, Pearson Education.
5. Oprea, T. (2005). *Chemoinformatics in Drug Discovery*, Volume 23. Wiley Online Library.
6. Gasteiger, J. & Engel, T. (2003), *Chemoinformatics: a Textbook*, Wiley Online Library.

Drug Discovery and Development

Credits

2

Course Objectives

This course will give a broad overview of research and development carried out in industrial setup towards drug discovery.

Student Learning Outcomes

On completion of this course, students should be able to understand basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields of pharmaceutical industry.

Unit I

Target identification and molecular modelling

7 lectures

Identification of target or drug leads associated with a particular disease by a number of different techniques including combinations of molecular modeling, combinatorial libraries and high-throughput screening (HTS); Conceptualizing the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds; Rational drug design, based on understanding the three-dimensional

structures and physicochemical properties of drugs and receptors; Modelling drug/receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling; Conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of combinatorial libraries of drug-like molecules, macromolecular and chemical databases.

Unit II
Lead optimization
5 lectures

Identification of relevant groups on a molecule that interact with a receptor and are responsible for biological activity; Understanding structure activity relationship; Structure modification to increase potency and therapeutic index; Concept of quantitative drug design using Quantitative structure–activity relationship models (QSAR models) based on the fact that the biological properties of a compound are a function of its physicochemical parameters such as solubility, lipophilicity, electronic effects, ionization, stereochemistry, *etc.*; Bioanalytical assay development in support of *in vitro* and *in vivo* studies (LC/MS/MS, GC/MS and ELISA).

Unit III
Preclinical development
5 lectures

Principles of drug absorption, drug metabolism and distribution - intestinal absorption, metabolic stability, drug-drug interactions, plasma protein binding assays, metabolite profile studies, Principles of toxicology, Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation Integration of non-clinical and preclinical data to aid design of clinical studies.

Unit IV
Drug manufacturing
4 lectures

Requirements of GMP implementation, Documentation of GMP practices, CoA, Regulatory certification of GMP, Quality control and Quality assurance, concept and philosophy of TQM, ICH and ISO 9000; ICH guidelines for Manufacturing, Understanding Impurity Qualification Data, Stability Studies.

Unit V
Clinical trial design
4 lectures

Objectives of Phase I, II, III and IV clinical studies, Clinical study design, enrollment, sites and documentation, Clinical safety studies: Adverse events and adverse drug reactions, Clinical PK, pharmacology, drug-drug interaction studies, Statistical analysis and documentation.

Unit VI
Fundamentals of regulatory affairs and bioethics
4 lectures

Global Regulatory Affairs and different steps involved, Regulatory Objectives, Regulatory Agencies; FDA guidelines on IND and NDA submissions, Studies required for IND and NDA submissions for oncology, HIV, cardiovascular indications, On-label *vs.* off-label drug use GCP and Requirements of GCP Compliance, Ethical issues and Compliance to current ethical guidelines, Ethical Committees and their set up, Animal Ethical issues and compliance.

Recommended Textbooks and References:

1. Krogsgaard-Larsen *et al. Textbook of Drug Design and Discovery*. 4th Edition. CRC Press.
2. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
3. Nally, J. D. (2006) *GMP for Pharmaceuticals*. 6th edition. CRC Press
4. Brody, T. (2016) *Clinical Trials: Study Design, Endpoints and Biomarkers,* Drug Safety, and FDA and ICH Guidelines. Academic Press.

Environmental Biotechnology

Credits

2

Course Objectives

This course aims to introduce fundamentals of Environmental Biotechnology. The course will introduce major groups of microorganisms-tools in biotechnology and their most important environmental applications. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature.

Student Learning Outcomes

On completion of course, students will be able to understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.

Unit I

Introduction to environment

6 lectures

Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.

Unit II

Bioremediation

6 lectures

Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT *etc.*), technological aspects of bioremediation (*in situ, ex situ*).

Unit III

Role of microorganisms in bioremediation

6 lectures

Application of bacteria and fungi in bioremediation: White rot fungi *vs* specialized degrading bacteria: examples, uses and advantages *vs* disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization).

Unit IV

Biotechnology and agriculture

11 lectures

Bioinsecticides: *Bacillus thuringiensis*, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (*e.g. Trichoderma, Pseudomonas fluorescens*); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.

Unit V

Biofuels

11 lectures

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

Recommended Textbooks and References:

1. G. M. Evans and J. C. Furlong (2003), *Environmental Biotechnology: Theory and Applications*, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), *Environmental Biotechnology: Principle & Applications*, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) *Environmental Biotechnology*. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), *Biofiltration for Air Pollution Control*, CRC Press.
5. H. J. Rehm and G. Reed, (2001), *Biotechnology – A Multi-volume Comprehensive Treatise*, Vol. 11, 2nd Ed., VCH Publishers Inc.

6. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, (2013), *Environmental Engineering*, McGraw-Hill Inc.

Microbial Technology

Credits

2

Course Objectives

The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society.

Student Learning Outcomes

On completion of this course, students would develop deeper understanding of the microbial technology and its applications.

Unit I

Introduction to microbial technology

8 lectures

Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Advanced genome and epigenome editing tools (*e.g.*, engineered zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcription factors for epigenome editing, and other emerging tools) for manipulation of useful microbes/ strains and their applications; Strain improvement to increase yield of selected molecules, *e.g.*, antibiotics, enzymes, biofuels.

Unit II

Environmental applications of microbial technology

6 lectures

Environmental application of microbes; Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in environment, food and pharmaceuticals.

Unit III

Pharmaceutical applications of microbial technology

8 lectures

Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (*Streptomyces* sp., Yeast) to be used as efficient cloning and expression hosts (biologicals production); Generating diversity and introduction of desirable properties in industrially important microbes (*Streptomyces*/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (*Streptomyces* sp., Yeast).

Unit IV

Food applications of microbial technology

7 lectures

Application of microbes and microbial processes in food and healthcare industries - food processing and food preservation, antibiotics and enzymes production, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors); Non-recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (*e.g.*, Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques (mutagenesis, protoplast fusion, breeding, genome shuffling, directed evolution *etc.*).

Unit V

Advances in microbial technology

8 lectures

Microbial genomics for discovery of novel enzymes, drugs/ antibiotics; Limits of microbial genomics with respect to use in human welfare; Metagenomics and metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global nutrient cycles & global sustainability, understanding evolution), Global metagenomics initiative - surveys/projects and outcome, metagenomic library construction and functional screening in suitable hosts – tools and techniques for discovery/identification of novel enzymes, drugs (*e.g.*, protease, antibiotic) *etc.*

Recommended Textbooks and References:

1. Lee, Y. K. (2013). *Microbial Biotechnology: Principles and Applications*. Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). *Comprehensive Biotechnology*. Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. *Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools*. Boston, MA: Springer US.
4. *The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet*. (2007). Washington, D.C.: National Academies Press.
5. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied microbiology and biotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology, (f) Current opinion in Microbiology, (g) Biotechnology Advances, (h) Genome Research)
6. Websites: http://jgi.doe.gov/our-science/

Protein Engineering

Credits

2

Course Objectives

The aim of this course is to introduce methods and strategies commonly used in protein engineering.

Student Learning Outcomes

On completion of this course, students should be able to:

- Analyse structure and construction of proteins by computer-based methods;
- Describe structure and classification of proteins;
- Analyse purity and stability of proteins and explain how to store them in best way;
- Explain how proteins can be used for different industrial and academic purposes such as structure determination, organic synthesis and drug design.

Unit I

Introduction to protein engineering

5 lectures

Protein engineering – definition, applications; Features or characteristics of proteins that can be engineered (definition and methods of study) – affinity and specificity; Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, *etc.* Protein engineering with unnatural amino acids and its applications.

Unit II

Stability of protein structure

5 lectures

Methods of measuring stability of a protein; Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UV CD; Fluorescence; UV absorbance; ORD; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured/obtained from NMR and their interpretation.

Unit III

Applications

5 lectures

Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation; Experimental methods of protein engineering: directed evolution like gene site saturation mutagenesis; Module shuffling; Guided protein recombination, *etc.*, Optimization and high throughput screening methodologies like GigaMetrix, High throughput microplate screens *etc.*, Application to devices with bacteriorhodopsin as an example; Engineering antibody affinity by yeast surface display; Applications to vaccines, Peptidomimetics and its use in drug discovery.

Unit IV
Computational approaches
5 lectures

Computational approaches to protein engineering: sequence and 3D structure analysis, Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles *vis-à-vis* those from mesophiles; Protein design, Directed evolution for protein engineering and its potential.

Unit V
Case studies
1 lecture

Case Studies.

Recommended Textbooks and References:

1. Edited by T E Creighton, (1997), *Protein Structure: a Practical Approach*, 2nd Edition, Oxford university press.
2. Cleland and Craik, (2006), *Protein Engineering, Principles and Practice*, Vol 7, Springer Netherlands.
3. Mueller and Arndt, *Protein Engineering Protocols*, 1st Edition, Humana Press.
4. Ed. Robertson DE, Noel JP, (2004), *Protein Engineering Methods in Enzymology*, 388, Elsevier Academic Press.
5. J Kyte; (2006), *Structure in Protein Chemistry*, 2nd Edition, Garland publishers.

Nano-biotechnology

Credits

Course Objectives

The course aims at providing a general and broad introduction to multi-disciplinary field of nanotechnology. It will familiarize students with the combination of the top-down approach of microelectronics and micromechanics with the bottom-up approach of chemistry/biochemistry; a development that is creating new and exciting cross-disciplinary research fields and technologies. The course will also give an insight into complete systems where nanotechnology can be used to improve our everyday life.

Student Learning Outcomes

On successful completion of this course, students should be able to describe basic science behind the properties of materials at nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.

Unit I
Introduction to nanobiotechnology
5 lectures

Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

Unit II
Nano – films
5 lectures

Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation.

Unit III
Nano – particles
5 lectures

Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

Unit IV
Applications of nano–particles
5 lectures

Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.

Unit V

Nano–materials

5 lectures

Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in sythesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.

Unit VI

Nano – toxicity

5 lectures

Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment.

Recommended Textbooks and References:

1. GeroDecher, Joseph B. Schlenoff, (2003); *Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials*, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); *Bionanotechnology: Lessons from Nature*; Wiley-Liss
3. Neelina H. Malsch (2005), *Biomedical Nanotechnology*, CRC Press
4. Greg T. Hermanson, (2013); *Bioconjugate Techniques*, (3rd Edition); Elsevier
5. Recent review papers in the area ofNanomedicine.

Vaccines

Credits

2

Course Objectives

This course will provide students with an overview of current developments in different areas of vaccines.

Student Learning Outcomes

By the end of this course, students should be able to:

- Understand fundamental concepts of human immune system and basic immunology;
- Differentiate and understand immune responses in relation to infection and vaccination;
- Understand requirement and designing of different types ofvaccines;
- Understand importance of conventional and new emerging vaccine technologies.

Unit I

Fundamentals of immune system

6 lectures

Overview of Immune system; Human Immune system: Effectors of immune system; Innate & Adaptive Immunity; Activation of the Innate Immunity; Adaptive Immunity; T and B cells in adaptive immunity; Immune response in infection; Correlates of protection.

Unit II

Immune response to infection

9 lectures

Protective immune response in bacterial; viral and parasitic infections; Primary and Secondary immune responses during infection; Antigen presentation and Role of Antigen presenting cells: Dendritic cells in immune response; Innate immune response; Humoral (antibody mediated) responses; Cell mediated responses: role of CD4+ and CD8+ T cells; Memory responses: Memory and effector T and B cells, Generation and Maintenance of memory T and B cells.

Unit III

Immune response to vaccination

8 lectures

Vaccination and immune response; Adjuvants in Vaccination; Modulation of immune responses: Induction of Th1 and Th2 responses by using appropriate adjuvants and antigen delivery systems - Microbial adjuvants, Liposomal and Microparticles as delivery systems; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity.

Unit IV

Vaccine types & design

3 lectures

History of vaccines, Conventional vaccines; Bacterial vaccines; Viral Vaccines; Vaccines based on routes of administration: parenteral, oral, mucosal; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine.

Unit V

Vaccine technologies

4 lectures

New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for targeted delivery (Vaccine Delivery systems); Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (Ebola, Zika).

Recommended Textbooks and References:

1. Janeway, C. A., Travers, P., Walport, M., & Shlomchik, M. J. (2005). *Immuno Biology: the Immune System in Health and Disease*. USA: Garland Science Pub.
2. Kindt, T. J., Osborne, B. A., Goldsby, R. A., & Kuby, J. (2013). *Kuby Immunology*. New York: W.H. Freeman.
3. Kaufmann, S. H. (2004). *Novel Vaccination Strategies*. Weinheim: Wiley-VCH.
4. Journal Articles (relevant issues) from: Annual Review of Immunology, Annual Review of Microbiology, Current Opinion in Immunology, Nature Immunology, Expert review of vaccines.

COURSE STRUCTURE
M.SC. (MICROBIOLOGY)

EFFECTIVE FROM ACADEMIC SESSION – 2021-22

Approved in Academic Council Meeting held on 28 July, 2021

M. SC. (MICROBIOLOGY) PROGRAM

I st SEMESTER (MBI)

S.No.	New Code	Subject	L-T-P	Credits
1	21MS1MB111	General Microbiology and Bacteriology	3-0-0	3
2	20MS1MA111	Basics of Mathematics and Statistics	2-0-0	2
3	20MS1BT111	Biochemistry	3-0-0	3
4	21MS1MB112	Molecular Biology	3-0-0	3
5	20B1WBI831	Virology	2-0-0	2
6	21MS1MB113	Fungal Biology	2-0-0	2
7	21MS7MB171	General Microbiology and Bacteriology Lab	0-0-4	2
8	21MS7BT171	Biochemistry Lab	0-0-2	1
9	21MS7MB172	Molecular Biology Lab	0-0-4	2
10	21MS7MB173	GLP and Bioinstrumentation Lab	0-0-2	1
		Total	**27**	**21**

II nd SEMESTER (MBII)

S.No.	New Code	Subject	L-T-P	Credits
1	18MS1BT211	Immunology and Immunotechnology	3-0-0	3
2	21MS1MB211	Enzymes and Bioprocess Technology	3-0-0	3
3	21MS1MB212	Microbial Genetics and Physiology	3-0-0	3
4	18MS1BT313	Recombinant DNA Technology	3-0-0	3
5	20MS1BT213	Bioinformatics	2-0-0	2
6	18MS7BT211	Immunology and Immunotechnology Lab	0-0-2	1
7	21MS7MB271	Enzymes and Bioprocess Technology Lab	0-0-2	1
8	18MS7BI214	Basic Bioinformatics Lab	0-0-2	1
9	18MS7BT373	Recombinant DNA Technology lab	0-0-4	2
10	18MS9BI211	Masters Research Review seminar	0-0-2	1
		Total	**26**	**20**

III rd SEMESTER (MBIII)

S.No.	Code	Subject	L-T-P	Credits
1	21MS1MB311	Environmental Microbiology	3-0-0	3
2	21MS1MB312	Diagnostic Microbiology and vaccines	3-0-0	3
3		Elective-I	3-0-0	3
4	21MS9MB311	Master's Dissertation &Thesis Part-I	0-0-16	8
		Total	**25**	**17**

IV th SEMESTER (MBIV)

S. No.	New Code	Subject	L-T-P	Credits
1	21MS1MB411	Food & Dairy Microbiology MBIV	3-0-0	3
2	21MS1MB412	Plant and Agricultural Microbiology MBIV	3-0-0	3
3		Elective-II	3-0-0	3
4	21MS9MB411	Master's Research Thesis Part-II	0-0-16	8
		Total	**25**	**17**

Total Credits: 75

Approved in Academic Council Meeting held on 28 July, 2021

ELECTIVE - 1				
S. No.	**New Code**	**Subject**	**L-T-P**	**Credits**
1	21MS2MB311	IPR, Biosafety and Bioethics	3-0-0	3
2	21MS2MB312	Biosensors:Principles & Applications	3-0-0	3
3	21MS2MB313	Computational Systems Biology	3-0-0	3
4	21MS2MB314	Protein Engineering	3-0-0	3

ELECTIVE - 2				
S. No.	**New Code**	**Subject**	**L-T-P**	**Credits**
1	21MS2MB411	Microbial Toxicology MBIV	3-0-0	3
2	21MS2MB412	Experimental models in microbial Research MBIV	3-0-0	3
3	21MS2MB413	Nano-Biotechnology MBIV	3-0-0	3
4	21MS2MB414	QC Analysis and Management MBIV	3-0-0	3

I[st] SEMESTER (MBI)

GENERAL MICROBIOLOGY AND BACTERIOLOGY **COURSE CODE: 21MS1MB111** **L-T-P: 3-0-0** Credits: 3	**Course Objectives** To acquaint the students with the development and techniques of microbiology useful in biotechnology industry**.** Scientific evaluation of various characteristics of icroorganisms, especially bacteria their metabolism and role in various domains of life.	**Students Learning outcomes** Students should be able to: ▪ Acquire the principles of Microbiology and fundamental concepts related to microbial classification and methods ▪ Scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic microbiological techniques including growth and control of bacteria. ▪ Analyze and interpret the experiments/pathways relevant to bacterial analysis ▪ Designate vital role of the bacteria in the environment and their genetics and association with human beings. ▪ Retrieve and use cotemporary information and industrial potential related to microbial world.

Syllabus:

Unit	Topics Covered
Unit 1: Introduction, history and scope of Microbiology 4 lectures	Introduction, history and scope of Microbiology. General characteristics and composition of Prokaryotes and Eukaryotes. Classification of Microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese, classification and salient features of bacteria according to Berger's Manual of Determinative Bacteriology. Nomenclature and modern methods of Bacterial taxonomy.
Unit 2: Morphology and Anatomy of bacteria 6 lectures	Morphology and ultra-structure of bacteria: size, shape, and arrangement of bacteria, ultra-structure of bacterial cell wall of eubacteria and archeabacteria. Protoplast and spheroplast formation and L-form. Components external to cell wall: Structure and function of flagella, fimbriae and pilli, capsule- types, composition and function, slime layers, S-layers. Prokaryotic cell membrane and cytoplasmic matrix – cell membrane structure and function of bacteria and archaebacteria, mesosomes, ribosomes, cytoplasmic inclusion bodies (polyhydroxy butyrate, polyphosphate granules, oil droplets, cyanophycean granules) and nucleoid. Bacterial response to external stimulus and bacterial endospores: Chemotaxis and phototaxis structure, formation and germination of bacterial

	endospore.
Unit 3: Analytic techniques and control measures in bacteriology 7 lectures	Staining methods: fixation, types of dyes, simple staining, differential staining - Gram and Acid-fast staining, staining of specific structures capsule, flagella and spore staining Control of microorganisms: Microbial death curve, concept of bio-burden, thermal death time and decimal reduction time. Factors influencing the effectiveness of antimicrobial agents. Control of bacteria by physical agents: heat - moist and dry, filtration and radiation. Chemical control of microorganisms: Halogens, phenol and other phenolic compounds, heavy metals, alcohols, ethylene oxide and aldehydes
Unit 4: Bacterial growth and kinetics 7 lectures	Bacterial nutrition: Basic nutritional requirements, growth factors, nutritional categories, physical requirements of bacterial growth. Bacteriological media: types (complex, synthetic, differential, enrichment and selective media) and their uses, culture characteristics of bacteria on different media. Cultivation of bacteria: aerobic and anaerobic culture, pure culture techniques, shaker and still culture, maintenance and preservation of microbial culture. Bacterial growth: growth kinetics, growth curve. Batch, continuous and synchronous culture. Measurement of growth and influence of environmental factors affecting growth.
Unit 5: Bacterial reproduction and genetics 7 lectures	General concept of Prokaryotic and Eukaryotic genome. Genome of *E. coli.* Genetic recombination and transformation. Transduction: generalized and specialized transduction, phage conversion. Plasmid: types and their significance. Conjugation and chromosomal mobilization. *E. coli* as model prokaryotes.
Unit 6: Bacterial epidemiology and diseases 5 lectures	Human diseases caused by bacteria; The epidemiology, pathogenesis, antigenic characteristics and diagnosis of diseases
Unit 7: Microbial Ecology and Industrial applications 6 lectures	Thermophiles, Alkaliphiles, Acidophiles, Halophiles, Psychrophiles, Radiophiles, Fermented foods and beverages, Biofertilizers, Biopesticides, Biofuels and Bioenergy

Recommended Textbooks and References:

1. Prescott, Harley and Klein: Microbiology, 6th Edition, McGraw Hill 2005.
2. Pelczar, Chan and Krieg: Microbiology by; Tata McGraw Hill.
3. Madigan, M.T., Martinko, J.M., Parker, J: Brock Biology of Microorganisms. 10th Edition.: Publisher: Prentice Hall 2003
4. Gerard J. Tortura, Berdell R. Funke, and Christine L: Microbiology An Introduction: Case. 8th Ed., Pearson/Benjamin Cummings, 2004.
5. Nester: Microbiology Study Guide McGraw Hill.
6. Black: Microbiology: Principles and Applications Prentice Hall

Basics of Mathematics and Statistics **COURSE CODE: 20MS1MA111** **L-T-P: 2-0-0** Credits 2	**Course objective** The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students for application in biological sciences	**Students Learning Outcomes** On completion of this course, students should be able to: ▪ Gain broad understanding in mathematics and statistics; ▪ Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.

Unit I Algebra 8 lectures	Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models *etc*.), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices.
Unit II Calculus 6 lectures	Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series *etc*.).
Unit III Mathematical models in biology 6 lectures	Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modelling chemical reaction networks and metabolic networks.
Unit IV Statistics 8 lectures	Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.

Recommended Textbooks and References:

1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science.
3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley.
4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*. New York: Wiley.

Biochemistry **COURSE CODE: 20MS1BT111** **L-T-P: 3-0-0** Credits 3	**Course objective** Following are the objectives of Biochemistry course. ▪ To understand the basic biochemical processes and their principles those govern complex biological systems. ▪ To understand the structure, functions of essential biomolecules and their interactions with each other. ▪ To understand the various metabolic and energy generation processes which are essential for sustainability of life.	**Students Learning outcomes** After learning and completion of Biochemistry course, student will be able to: ▪ Define the structural features of basic biomolecules ▪ Describe the functionality of biomolecules in relation to their usage for steady state of an organism. ▪ Get complete understanding of metabolic processes and their integration with each other.

Unit/ Module	Description
Unit I: Origin of Life (Biochemical basis) 4 lectures	Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water and its essential role for life, pH and its regulation in relation to microorganisms
Unit II: Biomolecules in Microbial world 8 lectures	**Carbohydrates:** Classification, basic chemical structures and their role in microbial life. **Lipids:** Classification, structure and function of major lipid subclasses in microbe's especial consideration bacterial membranes. **Proteins:** Amino acids: Classification, Properties, Protein Structure: primary, secondary, tertiary and quaternary structure, basics of enzymes and their catalysis. **Nucleotides:** Nucleotides, Nucleosides structures, Different confirmations of DNA
Unit III: Microbial nutrition and basic biochemical process for growth 4 lectures	Microbial metabolic diversity and classification based on nutritional types. Transport Mechanisms across membrane: Diffusion, facilitated Diffusion, Active and passive transport.
Unit IV: Central Metabolic Pathways and Carbohydrate metabolism 10 lectures	Bacterial aerobic respiration, Embden-Meyerhof pathway, Entner-Doudoroff pathway, Pentose phosphate pathway, Tricarboxylic acid cycle, components of electron transport chain, chemiosmotic theory, oxidative and substrate level phosphorylation, , Utilization of sugars other than glucose and complex polysaccharides. Bacterial anaerobic respiration and fermentation
Unit IV: Metabolism of lipids and hydrocarbons: 6 lectures	Biosynthesis and degradation of fatty acids and phospholipids, lipopolysaccharide biosynthesis
Unit V: Protein and amino-acid metabolism 6 lectures	Metabolism of amino acids: Amino acid biosynthesis and utilization, lysine and glutamine overproduction, polyamine biosynthesis and regulation.
Unit VI: Metabolism of nucleotides 4 lectures	Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.

Recommended Textbooks and References:

1. J M Berg, L Stryer, J Tymoczko, G Gatto, “Biochemistry”, 9th Ed., (2019) W H Freeman
2. D L Nelson and MM Cox, “Lehninger Principles of Biochemistry”, 7th Ed. (2017) WH Freeman
3. J Willey, L Sherwood, C J Woolverton “Prescott's Microbiology”, 10th Ed., (2016) Mc GRaW-Hill

	Course objective	Students Learning outcomes
Molecular Biology **COURSE CODE: 21MS1MB112** **L-T-P: 3-0-0** Credits 3	The objective of this course is to equip students with detailed knowledge of molecular biology, applications of molecular biology, and enhance their abilities to understand modern research and developments in the life science sector.	On successful completion of this course, student will be able to: ▪ Understand physical and chemical properties nucleic acids ▪ Develop deep understanding about DNA replication, damage and repair ▪ Understand the processes of transcription and translation at molecular level ▪ Will recognize the different mechanism of gene regulation in microbial systems ▪ Will get apprised with different molecular biology techniques and their applications in modem research and life science sector

Unit I **Chemical and Physical Properties of Nucleic acids** 3 lectures	Introduction to molecular Biology; Chemical and physical properties of Nucleic acids
Unit II **DNA replication Damage and repair** 8 lectures	DNA replication, Nature of replication, Enzymes and proteins involved, Replication Fork and priming, leading and lagging strand, Process of Replication: initiation elongation, termination, specific features of replication in Prokaryotes, fidelity of replication, inhibitors of replications and their applications, DNA damage repair and recombination: DNA damage, DNA Mismatch Repair, Double Strand Break Repair, Homologue and site-specific recombination,
Unit III **RNA synthesis and processing** 8 lectures	Transcription: Transcription machinery of prokaryotes, various transcription enzymes and cofactors, initiation, elongation and termination, sigma factors, post-transcriptional processes: RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing, RNAi and miRNAs, post-transcriptional gene regulation.
Unit IV **Protein synthesis and processing** 8 lectures	Translation: Mechanisms of translation in prokaryotes, initiation complex, ribosomes and tRNA, factors, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational elongation and termination, inhibitors of translation

Unit V **Gene Regulation expression** 8 Lectures	Control of gene expression at transcription and translation level regulating the expression of phages, viruses, prokaryotic and
Unit VI **Molecular Biology Techniques** 7 Lectures	Labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, Hybridization techniques: northern, southern, fluorescence in situ hybridization, Polymerase chain reaction and its variations

Recommended Textbooks and References:

Suggested Text Book(s):

1. Lehninger "Principles of Biochemistry".
2. Principles of Genetics – D. Peter Snustad, Michael J. Simmons

Suggested Reference Book(s):

1. Lewin's GENES XI
2. Lodish H, Berk A, Zipursky LS, Matsudaira P, Baltimore D, Darnell J (2000). Molecular Cell Biology.
3. W. H. Freeman and Company
4. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levin, R. Losick, 6th edition, Benjamin Cummings, San Francisco, USA, 2007.
5. Molecular Biology by R.F. Weaver, 4th edition, McGraw Hill. New York. USA, 2007.
6. Molecular Biology of the Cell by B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, 5th edition, Garland Science, New York and London, 2007. 5.

VIROLOGY COURSE CODE: 20B1WB831 L-T-P: 2-0-0 Credits: 3	**Course Objectives** To acquaint the students with the development and techniques of virology useful in biotechnology industry**.** Scientific evaluation of various characteristics of viruses, their metabolism and role in various domains of life.	**Students Learning outcomes** Students should be able ▪ To acquire the knowledge about fundamental concepts related virology and its history ▪ Scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic virological techniques including growth and control of viruses ▪ Analyze and interpret the experiments/pathways relevant to virus analysis

Unit 1 **Introduction and classification of viruses** 4 Lectures	Brief outline on discovery and origin of viruses. General properties of viruses, Classification and general properties of major families of viruses
Unit 2 **Structure and morphology of viruses** 4 Lectures	Morphology and ultra-structure of viruses, capsid and their arrangements, types of envelopes and their composition, measurement of viruses. Viral genome; their types and structure, viral related agents-viroids and prions.
Unit 3 **Cultivation and analytical techniques in virology** 7 Lectures	Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures; primary and secondary cell cultures; suspension cell cultures and monolayer cell cultures; cell strains, cell lines and transgenic systems; serological methods – haemagglutination and HAI; complement fixation; immunofluorescence methods, ELISA and Radioimmuno assays; assay of viruses – physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy) – Infectivity assay (plaque method, end point method) – Infectivity assay of plant viruses.
Unit 4 **Viral replication; uncoating, assembly and release** 6 Lectures	Bacteriophage: classification, morphology and ultra structure. One step growth curve (latent period, eclipse period, and burst of size.) Life cycle: lytic and lysogenic life cycle of bacteriophages. Brief account of M13, Mu, T4, Ø x174 and lambda phage. Uncoating, assembly and release

Unit 5 **Plant viruses: Infection and diseases of plants** 7 Lectures	Classification and nomenclature; effects of viruses on plants; appearance of plants; histology, physiology and cytology of plants; common virus diseases of plants; paddy, cotton, tomato and sugarcane; viruses of cyanobacteria, algae, fungi, life cycle; type species of plant viruses like TMV, Cauliflower Mosaic Virus and Potato Virus X; transmission of plant viruses with vectors (insects, nematodes, fungi) and without vectors (contact, seed and pollens); diagnostic techniques in seeds; seed stocks and diseased plants (seed morphology, seedling symptomatology, indicator plants, serological methods, histochemical tests and fluorescent microscopy); prevention of crop loss due to virus infection – virus- free planting material; vector control
Unit 6 **Animal viruses: infections and diagnosis** 7 Lectures	Classification and nomenclature of animal human viruses; epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA virurses Picorna, Ortho myxo, Paramyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes, Adeno, SV 40; Hepatitis viruses.
Unit 7 **Viral vaccines and antiviral agents** 7 Lectures	Viral vaccines (conventional vaccines, genetic recombinant vaccines used in national immunization programmes with examples, newer generation vaccines including DNA vaccines with examples) interferons and antiviral drugs.

Recommended Textbooks and References:

1. Reference Books 1. Virology; Renato Dulbecco and Harold S. Ginsberg

2. An Introduction to viruses, S. B. Biswas and Amita Biswas. Forth edition, Vikas Publishing House PVT LTD New Delhi.

	Course objective	Students Learning Outcomes
Fungal Biology COURSE CODE: 21MS1MB113 L-T-P: 3-0-0 Credits 2	The objectives of this course are to introduce field of field biology with special emphasis on fungal diversity, morphology, physiology and reproduction; their application to industry and a human-host or plant-fungal interactions.	Students should be able to: Identify major categories of fungi and analyze their classification, diversity, and ubiquity Identify major categories of fungi, demonstrate and evaluate interactions between hosts (plant/human) and environment.

Unit I **Introduction and classifications** 3 lectures	Introduction to the course; characteristics of fungi Fungal life cycles, ecological role of fungi, and human-fungus interactions, Model organisms and genetics
Unit II **Division or Phylum Zygomycota** 04 lectures	**General overview** **Class Zygomycetes (Order Mucorales)** Fermented Foods etc
Unit III **Division or Phylum Basidiomycota (General overview) Class Basidiomycetes** 07lectures	Cultivation of mushrooms & other fungi Spore release and dispersal Poisonous and hallucinogenic mushrooms; Mycotoxins in the grain and other food products. **Class Urediniomycetes & Ustomycetes (Rusts and Smuts)**
Unit IV **Division or Phylum Ascomycota** 08 lectures	**General overview** Ergot & ergotism; Mycotoxins in Food Alcoholic fermentations, cheeses, and fungal metabolites Physiology of Fungal Growth Bioremediation Yeast-Model organism and expression system
Unit V **IMPERFECT FUNGI** **FUNGUS-LIKE ORGANISMS** 7 lectures	**Form Division or Form Phylum Deuteromycota: (General overview)** Symbiotic and Parasitic relations Allergies and Fungal Diseases of Animals & Humans Slime molds Zoosporic Fungi: Chytrids, Oomycetes, and others

Recommended Textbooks and References:

1. Introduction to Fungi. 3rd Edition (2007) Webster & Webster. Cambridge University Press.
2. Bessette, A. E., Bessette, A. F., & Lewis, D. P. (2019). Mushrooms of the Gulf Coast States: A Field Guide to Texas, Louisiana, Mississippi, Alabama, and Florida. University of Texas Press.
3. https://fungalbiolbiotech.biomedcentral.com/articles
4. https://www.frontiersin.org/research-topics/9823/innovative-approaches-in-diagnosis-of-emergingre-emerging-infectious-diseases
5. https://www.frontiersin.org/research-topics/11600/fungal-genetics-in-plant-biomass-conversion
6. https://www.frontiersin.org/research-topics/13305/plant-pathogenic-fungi-molecular-systematics-genomics-and-evolution

General Microbiology and Bacteriology Lab **COURSE CODE: 21MS7MB171** **L-T-P: 0-0-4** Credits: 2	**Course Objectives** The objective of this laboratory course is to provide practical skills on basic microbiological techniques.	**Students Learning outcomes** Students should be able to: ▪ Isolate, characterize and identify ▪ Common bacterial organisms ▪ Determine bacterial load of different samples ▪ Perform antimicrobial sensitivity tests ▪ Preserve bacterial cultures.

Syllabus:

1. To study construction and working of compound microscope and study of microbiology lab instruments
2. Sterilization, disinfection and safety in microbiological laboratory.
3. Preparation of media for cultivation of bacteria.
4. Isolation of bacteria in pure culture by streak plate method.
5. Pour plate technique and study of colony and growth characteristics of some common bacteria
6. Preparation of bacterial smear and Gram's staining.
7. Acid-fast staining for study and differentiation of acid-fast bacteria.
8. Enumeration of bacteria: serial dilution and standard plate count.
9. Antimicrobial sensitivity test and demonstration of drug resistance
10. Determination of Minimum Inhibitory Concentration (MIC)
11. Maintenance of stock cultures: slants, stabs and glycerol stock cultures
12. Determination of phenol co-efficient of antimicrobial agents.
13. Isolation and identification of bacteria from soil/water samples.
14. Study of bacterial growth kinetics.

Recommended Textbooks and References:

1. Cappuccino, J. G., & Welsh, C. (2016). *Microbiology: a Laboratory Manual*. Benjamin-Cummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). *Collins and Lyne's Microbiological Methods* (8th ed.). Arnolds.
3. Benson, Harold J. (2007) *Microbiological Applications : Laboratory Manual in General Microbiology*, McGraw-Hill Higher Education
4. Tille, P. M., & Forbes, B. A. *Bailey & Scott's Diagnostic Microbiology.*

BIOCHEMISTRY LAB COURSE CODE: 21MS7BT171 L-T-P: 0-0-2 Credits: 1	**Course Objectives** The Objective of the course is ▪ To provide training and skills for the handling and analysis of biomolecules. ▪ To acquaint the students with laboratory techniques related to detection and estimation of primary biomolecules which are essential in an organism for life sustainability.	**Students Learning outcomes** After completion of Biochemistry lab, student will be able ▪ To understand the basic biochemistry laboratory practices and independently handle different instruments utilized ina biochemistry lab. ▪ To identify and quantify accurately different biochemical identities in a given sample. ▪ To observe, analyze and record the results of biochemical experiments and independently draw reasonable conclusions from results.

Syllabus:

1. Basic guidelines for safety measures to avoid hazards in biochemistry lab and preparing various stock solutions and working solutions.
2. To prepare buffer solution of varying pH by using Henderson-Hasselbalch equation and pH meter.
3. To identify and classify different sugars on the basis of qualitative methods.
4. To determine concentration of carbohydrates by Anthrone method: a quantitative approach.
5. To isolate the proteins from bacterial culture using differential centrifugation and their detection using qualitative methods.
6. To estimate concentration of proteins with Bradford's method.
7. To estimate concentration of proteins by Lowry's method.
8. To separate different bacterial proteins using SDS PAGE technique.
9. To study the enzyme activity (amylase enzyme) using DNS method.
10. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
11. To determine presence of lipid in a given sample through qualitative method.
12. To Estimate the Saponification value of oils.
13. To quantify the concentration of DNA using spectrophotometer.
14. To detect the presence of microorganism in milk using specific biochemical tests.

Recommended Textbooks and References:

1) Irwin H. Segel "Biochemical Calculations", 2ed (2010) Wiley
2) Andreas Hofmann & Samuel Clokie Wilson and Walker's "Principles and Techniques of Biochemistry and Molecular Biology" (2018) Cambridge university press

Molecular Biology Lab **COURSE CODE: 21MS7MB172** **L-T-P: 0-0-4** Credits 1	**Course objective** The objective of this course is to familiarize the students with some basic and advanced techniques of molecular biology.	**Students Learning outcomes** On successful completion of this course, student will be able to: ▪ Understand the fundamentals of procedure of isolation, quantification and visualization of various biomolecules from different cellular or tissue. ▪ Interpret and conclude experimental results involving molecular biology

Syllabus

1. Introduction to molecular biology lab and facilities, Calculations of molarity and normality of the solutions
2. Preparation of Buffer Stocks (TBE, TAE, TE) and Buffers for gel electrophoresis
3. To perform agarose gel electrophoresis of DNA samples
4. Estimation of DNA quantity and quality by gel electrophoresis
5. To isolate genomic DNA from *E. coli* (DH5-α) using heat boiling method
6. To isolate *E. coli* (DH5-α) genomic DNA using phenol chloroform
7. Isolation of genomic DNA from human blood sample
8. Preparation of reagents and isolation plant genomic DNA using CTAB method
9. Quantification of DNA concentration and purity by spectrometric/nanodrop method
10. Introduction to Polymerase Chain Reaction and to amplify gene using genomic DNA of *E. coli.*
11. To separate serum and plasma proteins from human blood
12. To visualize human serum and plasma proteins using SDS-PAGE technique
13. To isolate RNA from bacterial cell and its quantification

Recommended Textbooks and References:

1. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Good Laboratory Practice and Bioinstrumentation Lab **COURSE CODE: 21MS7MB173** **L-T-P: 0-0-2** Credits: 1	**Course Objectives** The Objective of the course is to provide training of good laboratory practices and various instrumentations used in Biotech/Pharmaceutical industry. This course covers practical aspects of modern instrumentation used for analysis in biological research	**Students Learning outcomes** Students should be able to: ▪ To understand basic guidelines, importance of good laboratory practice, documentation and conduct of non-clinical studies ▪ To Understand basic principles and applications of bio-instruments ▪ To develop necessary critical thinking skills in order to do data analysis and interpretation in relation to the research process

Syllabus:

1. To introduce good lab practices, Lab safety and Bio hazard
2. Introduction to the OECD Principles of good laboratory practice. Overview and Purpose of GLP
3. Good Documentation practice and maintenance of lab note book
4. Quality control & Quality Assurance in laboratory
5. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
6. Instrumentation and working principles of infra red (IR) spectroscopy using salt plates.
7. Chromatography (Ion exchange, Molecular Sieve, Affinity, Thin layer, GC)
8. Instrumentation and working principles of HPLC
9. Instrumentation and working principles Electron Microscopy
10. Principle and application Gel electrophoresis
11. Principle and application of lypholization
12. Instrumentation and working principles of mass spectroscopy
13. Determination of molar mass of simple compounds using mass spectroscopy.
14. MALDI-TOF instrumentation and analysis of serum proteins
15. To study the effect of chemical denaturants on protein stability using CD spectroscopy.
16. Principle and applications of Centrifugation and ultracentrifugation

Recommended Textbooks and References:

1. Milton. A. Anderson (2002) GLP Essentials: a Concise Guide to Good Laboratory Practices
2. Sandy Weinberg (2007) Good Laboratory Practice Regulations
3. Nally, J. D. 6th edition. CRC Press (2006) *GMP for Pharmaceuticals*
4. Andreas Hofmann & Samuel Clokie Cambridge university press (2018) Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology

IInd SEMESTER (MBII)

	Course objective	Students Learning outcomes
Immunology and Immunotechnology **COURSE CODE: 18MS1BT211** **L-T-P: 3-0-0** Credits 3	The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.	On successful completion of this course, student will be able to: • Evaluate usefulness of immunology in different pharmaceutical companies; • Identify proper research lab working in area of their own interests; • Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).

Unit I **Immunology fundamental Concepts:** 6 lectures	Historical perspectives, Cells and organs of the immune system, Types of immunity (innate and acquired immunity), Components of innate and acquired immunity, Antigens: mitogens Immunogenicity, antigenicity, epitopes, haptens.
Unit II **Immune responses generated by B and T lymphocytes** 8 lectures	Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants, B-cell receptor, B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system,
Unit III **Antigen-antibody interactions** 5 lectures	Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and FACS.
Unit IV **Vaccinology** 7 lectures	A short history of vaccination, Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin

Unit V **Clinical immunology** 8 Lectures	Autoimmunity: Types of autoimmune diseases (organ specific and systemic), Mechanisms of autoimmunity, Hypersensitivity reactions: Type I, II, II and IV, hypersensitivity reactions, treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy
Unit VI **Immune response to infectious diseases and tumor immunity** 4 Lectures	Viral, bacterial, protozoan diseases, parasitic infections, Immunodeficiency diseases: Primary and secondary immunodeficiency diseases, Acquired immunodeficiency syndrome (AIDS)
Unit VII **Immunogenetics** 4 Lectures	Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing. General organization and inheritance of MHC, structure of MHC class I and II molecules, peptide binding by MHC molecules, MHC and susceptibility to disease.

Recommended Textbooks and References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
4. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.
5. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology. London: Academic Press.
6. Parham, P. (2005). The Immune System. New York: Garland Science.

	Course objective	Students Learning outcomes
Enzymes & Bioprocess Technology **COURSE CODE: 21MS1MB211** **L-T-P: 3-0-0** Credits 3	The objectives of this course are to develop an understanding in students about the fundamental and important concepts of enzymes and bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.	On successful completion of this course, student will be able to: • Describe the fundamentals and importance of enzymes and its kinetics • Appreciate relevance of microorganisms from industrial context • Analyze bacterial growth kinetics in batch/continuous/Fed-batch reactor and thermal death kinetics • Give an account of bioreactor design and their applications • Calculate yield and production rates, the need for oxygen and oxygen transfer in a biological production process, and also interpret data; • Apply principles of various unit operations in designing and optimization of downstream processes • Give an account of importance of enzymes and microbials in food processing and production of various bioproducts.

Unit I **Enzymology** 5 lectures	Introduction to Enzymes; Classification; General properties; Kinetics; Reversible and irreversible inhibition; Coenzyme and cofactors; Isoenzymes
Unit II **Basic Principles of Bioprocess Technology** 4 lectures	Introduction to fermentation; Isolation, screening, preservation and maintenance of industrially important microbes; Strain improvement
Unit III Bioreactor Design and Analysis 10 lectures	Microbial growth and Death Kinetics; Factors affecting microbial growth; Batch and Continuous Fermentation; Modifying Batch and continuous Fermentation: Fed-batch, Chemostat with recycle, multistage chemostat systems; Cell and enzyme immobilization Criteria for ideal fermenter; Configuration; Bioreactor designs-mechanically agitated; Pneumatic and hydrodynamic fermenters. Whole Cell Immobilized Fermenters; Stability of microbial reactors
Unit IV **Upstream processing**	Fermentation media; Media formulation; Sterilization; Aeration, agitation and heat transfer in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process

6 lectures	
Unit V Downstream processing and Product Recovery 7 Lectures	Separation of insolubles: Filtration, Centrifugation, Sedimentation; Cell disruption; Separation of solubles: Liquid-liquid extraction; Precipitation; chromatographic techniques; Reverse osmosis and ultra and micro filtration; Final purification: Drying; Crystallization; Storage and packaging; Effluent Treatment and its disposal
Unit VI Applications of Enzyme technology in food processing 4 Lectures	Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes; high-fructose corn syrup; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions food processing
Unit VII Applications of microbial technology in bioproduct production 6 Lectures	Industrial Production of Bioproducts: Ethanol, Acids (Citric, acetic, Lactic and gluconic), Antibiotics (Penicillin, streptomycin, tetracycline), Semi-synthetic antibiotics, Ethanol, Single Cell Protein

Recommended Textbooks and References:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
2. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.
3. Pauline M. Doran, "Bioprocess Engineering Principles", 8th ed., Academic press, New York, 2003.
4. M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
5. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).
6. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
7. Illanes A, "Enzyme Biocatalysis", Springer Science, 2008.
8. Klaas Van't Riet, Johannes Tramper, "Basic Bioreactor Design", 2nd ed., Marcel Dekker, Inc., New York, 1991.
9. JE Bailey and DF Ollis, "Biochemical Engineering Fundamentals", 2nd ed., McGraw-Hill Book Company, New York, 1986.
10. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.
11. Abhilasha S. Mathuriya, "Industrial Biochnology" 1st ed., Ane Books Pvt. Ltd., New Delhi, 2009.

Microbial Genetics and Physiology **COURSE CODE: 21MS1MB212** **L-T-P: 3-0-0** Credits 3	**Course objective** The objectives of this course are to take students through basics of genetics and physiology covering prokaryotic/phage genetics to yeast and higher eukaryotic domains. Students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, genetics of evolution, microbial metabolism, energy generation, microbial communication and energetics.	**Students Learning Outcomes** On successful completion of this course, student will be able to: ▪ Describe fundamental molecular principles of genetics. ▪ Describe the basics of genetic mapping. ▪ Understand the principles of Population genetics. ▪ Acquaint with energy generation and fermentation pathways. ▪ Acquaint with energetics of Chemolithotrophs, and microbial cross-talk

Unit I Genetics of bacteria, bacteriophages, and Yeast 10 lectures	Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; Yeast mating type switch; dominant and recessive genes/mutations, complementation groups, transposon mutagenesis, Mapping QTLs
Unit II **Drosophila genetics as a model of higher eukaryotes** 5 lectures	Analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics
Unit III **Population genetics and genetics of evolution** 7 lectures	Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, Fishers theorem, Hardy Weinberg equilibrium, in-breeding depression & mating systems; population bottlenecks
Unit IV Microbial Physiology 10 lectures	Metabolic genetic regulation, Energy, oxidation-reduction vs. fermentation, Microbial growth: Growth cycle, continuous culture, factors affecting growth. Regulatory systems during aerobic- anaerobic shifts. Osmotic control of gene expression, SOS response and Heat shock response, Phosphate starvation
Unit V Energetics of autotrophs and chemolithotrophs 10 Lectures	pH Homeostasis, specific transport systems, Fermentation pathways in specific group of microorganisms: Lactic acid, propionic acid, butyric acid producing fermentation; Characteristics and Metabolism of autotrophs; Biosynthesis of Fatty acids; Degradation of Lipids, Endospore formation (differentiation). Bacterial Quorum sensing

Recommended Textbooks and References:

1. Hartl, D. L., & Jones, E. W. Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett.

2. Pierce, B. A. Genetics: a Conceptual Approach. New York: W.H. Freeman.

3. Tamarin, R. H., & Leavitt, R. W. Principles of Genetics. Dubuque, IA: Wm. C. Brown.

4. Smith, J. M. Evolutionary Genetics. Oxford: Oxford University Press.

5. Klug, W.S., Cummings, R., Spencer, C. A., & Michael A. P., Concepts of Genetics. Pearson Publications

6. Albert G. M., & John W. F., Microbial Physiology, Wiley-Liss, A John Wiley& Sons, Inc. Publications.

7. Trudy T. A, Endang P. et al, Microbial Physiology and Genetics. Intelliz Press,

8. Davis K. Microbial Physiology and Genetics. Apple Academic Press.

Recombinant-DNA Technology **COURSE CODE: 18MS1BT313** **L-T-P: 3-0-0** **Credit 3**	**Course objective** The objectives of this course are to teach students with various approaches to conducting recombinant DNA technology and their applications in biological research as well as industries.	**Students Learning outcomes** Given the impact of recombinant DNA technology in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practical in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.

Unit I **Introduction and tools for rDNA technology** 3 lectures	Recombinant DNA technology: gene cloning, Genetic engineering, - concept and basic steps - rDNA Glossary, history of rDNA-recombinant Insulin
Unit II **DNA modifying enzymes and cloning techniques** 06 lectures	Restriction Endonucleases, DNA Ligation Enzymes and, DNA Modifying Enzymes: Nucleases, Kinases, phosphatases, and Reverse transcriptase other tools used for DNA Modification
Unit III **Cloning Vectors and Expression Vectors** 12 lectures	Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Vectors for Cloning Large DNA Molecules Principles for maximizing gene expression, expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant-based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors
Unit IV **Construction libraries and sequencing technologies** 10 lectures	Genomic library, cDNA library, Growing & Storing Libraries, construction of microarrays, cDNA Cloning (5'&3' RACE) Basic DNA Sequencing, Whole genome sequencing, Next generation sequencing technologies
Unit V **Gene Expression in Microbial and Eukaryotic Systems** 06 lectures	Microbial, Yeast Saccharomyces *Cerevisiae* as heterologous protein expression platforms, Protein expression in insect Cells and Mammalian Cells; protein-protein interactions using yeast two-hybrid system;
Unit VI **Genetic Manipulation Of microorganisms** 05 lectures	Gene transfer techniques, Application of Genetically Engineered Strains of microbes; Biosafety Issues related to recombinant DNA Technology Genetic Manipulation of microorganisms

Recommended Textbooks and References:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*

Bioinformatics **MBII** **COURSE CODE: 20MS1BT213** **L-T-P: 2-0-0** Credits 2	**Course objective** The objectives of this course are to provide theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.	**Students Learning outcomes** On successful completion of this course, student will be able to: ▪ Develop an understanding of basic theory of these computational tools; ▪ Gain working knowledge of these computational tools and methods; ▪ Prediction of structure from sequence and subsequently testing the accuracy of predicted structures ▪ Appreciate their relevance for investigating specific contemporary biological questions; ▪ Critically analyse and interpret results of their study.

Unit I **Introduction** 4 lectures	Bioinformatics basics: Protein and nucleic acid databases; Structural databases; search tools: biological background for sequence analysis; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; sequence, sequence similarity, homology, alignment.
Unit II **Pairwise Sequence Alignment** 6 lectures	Different scoring models, Substitution matrices (PAM and BLOSUM), Pairwise Alignment: Concept of Global and Local Alignment, Dot matrix method, Dynamic programming (Needleman-Wunsch algorithm, Smith-Waterman algorithm, Choosing of best scoring matrix, gap penalties, Significance of score, FASTA and BLAST algorithms.
Unit III **Multiple Sequence alignment** 6 lectures	Multiple Sequence Alignment methods (MSA), Scoring of a MSA, Progressive (CLUSTALW and PILEUP), Iterative (Genetic) and Hidden Markov Model (HMM) based methods of MSA, Profile and BLOCK level analysis, Motif and Pattern searching and primer designing.
Unit IV **Phylogenetic Analysis** 4 lectures	Molecular evolution basics, phylogenetic tree and terminology, different methods of Phylogenetic tree prediction: maximum parsimony, distance (UPGMA, NJ), maximum likelihood methods, Phylogenetic and evolutionary analysis.
Unit V Structural Alignment Tools and Protein Tertiary Structure Prediction 5 Lectures	Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; structure aided sequence techniques of structure prediction; structural profiles.
Unit VI **RNA Structure Analysis**	terminology of RNA secondary structure, inferring structure by comparative sequence analysis, RNA secondary structure prediction, Basic algorithms and methods of RNA folding.

3 Lectures	

Recommended Textbooks and Reference books:

Text Books:

1. D.W. Mount *Bioinformatics: Genome and Sequence Analysis*: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
2. Ian Korf, Mark & Josaph: *BLAST*, Oreilly Publisher, 2003
3. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids.* Cambridge University Press.
4. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
5. A.D. Baxevanis & B.F.F. Oulette *Bioinformatics – A practical guide to the Analysis of Genes and Proteins*,2002, Willey International publishers.
6. M.J. Bishop and C.J. Rawlings (editors), *DNA and Protein Sequence Analysis---A Practical Approach* IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)
7. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.

Reference Books:

1. J. Setubal and J. Meidanis (1997) *Introduction to Computational Molecular Biology***,** PWS Publishing Co.

2. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Immunology and Immunotechnology Lab **COURSE CODE: 18MS7BT211** **L-T-P: 0-0-2** Credits: 1	**Course Objectives** The objectives of this lab course are to develop an understanding about practical aspects of components of immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells *etc.* and how they can be used in respective research work.	**Students Learning outcomes** **Students should be able** • Evaluate usefulness of immunology in different pharmaceutical companies; • Identify proper research lab working in area of their own interests; • Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in setting of infection. (viral or bacterial) by looking at cytokine profile.

Syllabus:

1. To perform blood typing by agglutination.
2. To antigen detection by Dot ELISA method.
3. To quantify the concentration of unknown antigen by radial Immunodiffusion (RID).
4. To perform ouchterlony antigen for antibody titration.
5. To quantify the concentration of unknown antigen by rocket Immunoelectrophoresis.
6. To characterized the given antibody by Immunoelectrophoresis.
7. To quantify the amount of precipitation by Quantitative precipitation assay.
8. To determine the concentration of antigen by sandwich ELISA method.
9. To separate mononuclear cells from peripheral blood
10. To isolate the lymphocyte from whole blood by density gradient centrifugation method
11. To estimate the antibody titer using haemagglutination assay.
12. To determine Total Leukocytes Count (TLC) of the given blood sample.
13. To determine the relative number of white cells in the blood by performing differential cell counts
14. To perform Erythrocyte Rosette-forming Cell Test, ERFC

Recommended Textbooks and References:

1. Lab Manual of the Department of Biotechnology and Bioinformatics, JUIT,Waknaghat.

2. Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing. 3.

3. Virtual Lab. (http://vlab.amrita.edu/?sub=3&brch=70),
https://vlab.amrita.edu/?sub=3&brch=69)

Enzymes & Bioprocess Technology Lab **COURSE CODE: 20MS7MB271** **L-T-P: 0-0-2** Credits: 1	**Course Objectives** The objective of the course is to provide hands on training to students in bioprocess technology with the usage of microbials and enzymes. This course covers practical aspects of upstream processing and downstream unit operations with respect to current requirements of the manufacturing industries.	**Students Learning outcomes** **Students should be able** ▪ To investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess technology problems; ▪ To learn how to operate bench scale bioreactor; ▪ To learn how to determine various Monod's Kinetics parameter; ▪ To learn how to determine various Michaelis Menten Kinetics parameter; ▪ To learn how to recover the various bioproduct after their production; ▪ To learn how to characterize the products after their recovery

Syllabus:

1. Describe the various parts of the bench-top fermenter (bioreactor) along with their functions.
2. Batch fermentation using shake-flask for ethanol production by *Saccharomyces cerevisae*.
3. To study growth kinetics parameters of *E. coli*.
   a) Specific growth rate (μ) h^{-1}
   b) Doubling time (t_d) h
   c) Maximum specific growth rate (μ_m) h^{-1}
   d) Saturation constant (K_s) gm/l
4. Setting up of a fermentation process for the production of extracellular industrial enzyme from the selected microbe of industrial importance
5. Determination of Growth yield coefficient ($Y_{x/s}$) and Productivity of biomass after setting of a fermentation

6. Downstream processing of the industrial enzyme produced by the fermentation process.
    a) Clarification
    b) Yield estimation
    c) Concentration using salt-induced precipitation
    d) Dialysis
    e) Purity check through SDS-PAGE and specific activity determination
7. Disruption of yeast cells using sonication to recover intracellular Invertase enzyme
8. Determination of protein and enzyme content in the cell lysate after the cell disruption
9. Determination of Michaelis Menten's kinetics parameters of purified amylase enzyme
10. Preparation of Immobilized yeast cells in calcium alginate beads
11. Characterization of immobilized yeast cells in terms of activity and stability
12. Preparation of Immobilized enzyme in calcium alginate beads
13. Characterization of immobilized enzyme in terms of activity and stability

Recommended Textbooks and References:

1) Lab Manual of the Department of Biotechnology and Bioinformatics, JUIT,Waknaghat.
2) M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
3) Keith Wilson, John Walker, "Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, Singapore, 2010.
4) Raja Ghosh, "Principles of Bioseparation Engineering", World Scientific Publishing Co. Pte. Ltd., Singapore, 2006.
5) Pauline M. Doran, "Bioprocess Engineering Principles", 8th ed., Academic press, New York, 2003.
6) Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).
7) Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
8) Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.
9) Nicholas C. Price and Lewis Stevens, "Fundamental of Enzymology", Oxford University Press, Oxford. ISBN: 9780198502296.
10) Sawney S.K., Singh R. "Introductory Practical Biochemistry", Narosa Publisher, 2000. ISBN 9788173193026.

Bioinformatics MBII Lab **COURSE CODE: 18MS7BI214** **L-T-P: 0-0-2** Credits: 1	**Course Objectives** The objectives of this course are to provide practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.	**Students Learning outcomes** **Students should be able** ▪ Understand the use of common bioinformatics resources (NCBI) ▪ Understand various databases and tools in NCBI (PubMed, Nucleotide, gene, proteins, BLAST) ▪ Understand various databases and tools in Expasy (Swissprot, PROSITE) ▪ Hands-on of pairwise sequence alignment tools-global and local ▪ Hands-on of multiple sequence alignment tools ▪ Developing three-dimensional model of a protein structure ▪ Hands-on of phylogenetic analysis tools and visualization

Syllabus:

1. Retrieval of literature and biological sequences from PubMed and NCBI.
2. BLAST program for comparing primary biological sequence information.
3. Protein resources: Use of ExPASy for sequence retrieval and analysis.
4. Use of EMBOSS tools for sequence analysis: Pairwise Sequence Alignment.
5. Use of Clustal and other tools (MAFFT, MUSCLE) for Multiple Sequence Alignment (MSA).
6. Use of PDB structural database and structure visualization using Pymol, Rasmol, and Discovery Studio.
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
8. Phylogenetic analysis of protein and nucleotide sequences.
9. Secondary structure prediction using protein sequence.
10. Use of different protein structure prediction databases (SCOP & CATH).
11. Homology modelling of proteins in MODELLER.
12. Use of various primer designing and restriction site prediction tools.
13. Prediction of RNA secondary structure.
14. Use of tools for mutation and analysis of the energy minimization of protein structures.

Recommended Textbooks and References:

Text Books:

1. D.W. Mount *Bioinformatics: Genome and Sequence Analysis*: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
2. Ian Korf, Mark & Josaph: *BLAST*, Oreilly Publisher, 2003
3. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids.* Cambridge University Press.
4. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
5. A.D. Baxevanis & B.F.F. Oulette *Bioinformatics – A practical guide to the Analysis of Genes and Proteins*,2002, Willey International publishers.
6. M.J. Bishop and C.J. Rawlings (editors), *DNA and Protein Sequence Analysis---A Practical Approach* IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)
7. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.
8. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Recombinant DNA Technology Lab COURSE CODE: 18MS7BT373 L-T-P: 0-0-4 Credits: 2	**Course Objectives** The objectives of this course are to provide students with experimental knowledge and hands-on skills of methods and techniques for recombinant DNA technology and molecular cloning.	**Students Learning outcomes** Students should be able to gain hands-on experience in recombinant DNA technology techniques of gene cloning, protein expression. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

Syllabus:

1. Preparation of stock buffers (TBE, TAE, TE) and Agarose gel electrophoresis
2. Plasmid DNA isolation and DNA quantitation
3. Extraction of DNA from gel
4. In vitro amplification of DNA fragment by Polymerase Chain Reaction
5. Designing of Primers and PCR cycle for given DNA sequence and analysis by Gradient PCR
6. Restriction Enzyme digestion of plasmid DNA (Blunt & Cohesive)
7. Vector and Insert Ligation (Using T_4 DNA ligase)
8. Preparation of competent cells by $CaCl_2$ treatment
9. Transformation of *E. coli* with standard plasmids, Calculation of transformation efficiency
10. Electroporation of plasmid DNA into mycobacterial cells
11. Confirmation of the insert by Colony PCR and Restriction mapping
12. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in *E. coli*
13. SDS-PAGE analysis of proteins
14. Plating of Bacteriophage

Recommended Textbooks and References:

1. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.