Kolhapur Institute of Technology's
College of Engineering Kolhapur
(Empowered Autonomous)

KOLHAPUR INSTITUTE OF TECHNOLOGY'S
COLLEGE OF ENGINEERING KOLHAPUR
(EMPOWERED AUTONOMOUS)

Department of Biotechnology

Curriculum and Syllabus for

B. Tech. Biotechnology

Scheme: 2023-24 (As Per NEP, 2020)

ABOUT THE DEPARTMENT

The Department of Biotechnology Engineering was established in 2002 with approval from DTE and AICTE, India, by the dynamic and proactive management of KIT\'s College of Engineering (Autonomous) Kolhapur. This move was made in recognition of the important role that biotechnology engineers were to play in the future industrial development of biotechnology related processes and products. It has a unique place in the development of Biotechnology Engineering discipline in Maharashtra. We currently offer B. Tech. (Biotechnology Engineering) programme at undergraduate and M.Tech (Biochemical Engineering and Biotechnology) programme at post graduate level. B Tech (Biotechnology Engineering) 4 years UG programme focuses more on studies of fermentative productions of various products such as insulin like biopharmaceuticals, antibiotics, fine chemicals, enzymes etc. Students completing their HSC are to obtain at least 45% for open category and 40% for backward class category/EWS/PwD, with non -zero score in CET(PCM /PCB)/NEET / JEE (MAIN) are eligible for B.Tech Biotechnology Engg. programme.

DEPARTMENT VISION

To be the Center of Excellence in Biotechnology Engineering and the preferred choice of Students, Faculty, Industry and Society at global level

DEPARTMENT MISSION

M1:	To use sophisticated techniques of modern biotechnology to strength and develop human resources and institutional capacity.
M2:	To transfer know how and develop appropriate facility and training in biotechnology related subjects considering safety in biotechnology by assessing management risk.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)	
PEO1:	**Preparation:** To prepare Biotechnology Engineering students, i)To excel in higher studies in Biotechnology engineering and management ii) To succeed in all Biotechnology industrial areas through global and rigorous education.
PEO2:	**Core Competence:** To provide students of Biotechnology Engineering with a solid foundation in the thrust areas such as Bioprocesses, Molecular Biology, Genetic Engineering, Pharmaceutical Biotechnology etc. required to work in Biotechnology industries.
PEO3:	**Breadth:** To train Biotechnology Engineering students with good scientific and engineering breadth particularly in Bioinformatics, Biostatistics, Biomedical Engineering, Food Technology, Medical Biotechnology so as to comprehend, analyze, design and create novel product and solutions to real life problems.
PEO4:	**Professionalism:** To inculcate in Biotechnology Engineering students i) Professional and ethical attitude, effective communication, teamwork skills, entrepreneurship skills with multidisciplinary approach ii) An ability to relate engineering issues in biotechnology for the welfare of mankind and environment.
PEO5:	**Learning Environment:** To provide students of Biotechnology Engineering with better social and academic environment aware of excellence, leadership, intellectual property rights, written ethical guidelines, and the life-long learning needed for a successful professional career.

PROGRAMME OUTCOMES (PO)	
PO1:	Apply the knowledge of mathematics, basic science and in-depth technical competence in Biotechnology engineering discipline to meet the solution of complex engineering problems.
PO2:	Apply the knowledge of mathematics, basic science and in-depth technical competence in Biotechnology engineering discipline to meet the solution of complex engineering problems.
PO3:	Design complex processes to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

PO4:	Use research-based knowledge and research methods in the field of Biotechnology engineering to conduct experiments, analyze and interpret the data, design the equipment and processes as per the specifications and needs of biotech industries.
PO5:	Create, select, and apply appropriate techniques, resources, and software tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6:	Apply reasoning gained from the contextual knowledge of biotechnological engineering to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7:	Apply ethical principles and commit to professional ethics, responsibilities and norms of the biotechnology engineering practice.
PO8:	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary environments
PO9:	Communicate effectively on complex biotechnology engineering activities with the engineering community and with society at large, such as being able to make effective presentations, write effective reports and design documentation.
PO10:	Demonstrate knowledge and understanding of the biotechnology engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments.
PO11:	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of biotechnology engineering and technological change

PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO1:	**Research aptitude:** Inculcate the applicative knowledge of engineering & applied science to demonstrate research aptitude/skills in Emerging fields of biotechnology.
PSO2:	**Process & Product Development:** Display skills of Bioprocess Technology towards development of processes and products in global context
PSO3:	**Good Lab Practices (GLP) & Good manufacturing practices (GMP):** Exhibit adequate proficiency of GLP and GMP in terms of accuracy & precision, safety, ethics and reproducibility and able to follow standard operating procedures (SOP).

As per NEP Guidelines

Scheme of Credit Distribution

	Year	FY		SY		TY		B. Tech			
Sr. No.	**Curriculum Components**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Actual**	**NEP Guidelines**
1	Basic Science Course **(BSC)**	8	8							**16**	**14-18**
2	Engineering Science Course **(ESC)**	10	3							**13**	**12-16**
3	Programme Core Courses **(PC)**		3	16	15	10	11	11		**66**	**44-56**
4	Programme Elective Course **(PEC)**					3	3	3	6	**15**	**20**
5	Multi Minor **(MM)**			2	3	3	3	3		**14**	**14**
6	Open Elective **(OE)**					3	3	2		**8**	**8**
7	Vocational And Skill Enhancement Course **(VSEC)**	1	3		1	1				**6**	**8**
8	Ability Enhancement Course **(AEC)**		3				1			**4**	**4**
9	Entrepreneurship / Economics/ Management Courses (MGMT/ Economics/ Marketing/ Finance) **(HSSM)**			2		2				**4**	**4**
10	Indian Knowledge System **(IKS)**	2								**2**	**2**
11	Value Education Course **(VEC)**			2	2					**4**	**4**
12	Research Methodology (Project) **(RM)**							4		**4**	**4**
13	Community Engagement Project/Field Project (PBL/Seminar/Mini Project) **(CEP)**					1	1			**2**	**2**
14	Project **(PP)**								4	**4**	**4**
15	Internship/OJT (PBL/ Seminar/ Mini Project/ Virtual Internship/ Physical) **(OJT)**			1	1				6	**8**	**12**
16	Co-curricular Courses **(CC)**		1		1		1		1	**4**	**4**
		20-22	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**174**	
		21	**21**	**23**	**23**	**23**	**23**	**23**	**17**	**174**	

SEMESTER-I												
Sr. No.	**Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs. / Week**	**Credits**	**Evaluation Scheme Component**			
1.	BSC	UHSBS0101	Engineering Mathematics-I	3	1	-	4	4	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
2.	BSC	UHSBS0108	General Physics and Optics	3	-	-	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
3.	ESC	UHSES0109	Engineering Mechanics	3	-	-	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
4.	ESC	UHSES0110	Basic Mechanical Engineering	2	-	-	2	2	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
5.	ESC	UHSES0111	Introduction to Python Programming	2	-	-	2	2	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
6.	BSC	UHSBS0128	General Physics and Optics Lab	-	-	2	2	1	ISE	50	20	
7.	ESC	UHSES0129	Engineering Mechanics Lab	-	-	2	2	1	ISE	50	20	
8.	ESC	UHSES0130	Basic Mechanical Engineering Lab	-	-	2	2	1	ISE	50	20	
9.	ESC	UHSES0131	Introduction to Python programming Lab	-	-	2	2	1	ISE	50	20	
10.	VSEC	UHSVS0132	Workshop Practice Lab	-	-	2	2	1	ISE	50	20	
11.	IKS	UHSIK0136	Ecology, Energy & Environment	2	-	-	2	2	ISE	100	40	
Total:							**26**	**21**	**Total Marks: 800** **Total Credit: 21**			

SEMESTER-II

Sr. No.	Category	Course Code	Course Name	L	T	P	Hrs. / Week	Credits	Evaluation Scheme Component			
1.	BSC	UHSBS0201	Engineering Mathematics-II	3	1	-	4	4	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
2.	BSC	UHSBS0212	Applied Chemistry	3	-	-	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
3.	AEC	UHSAE0203	Communication Skills	2	-	-	2	2	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
4.	ESC	UHSES0213	Basic Civil Engineering	2	-	-	2	2	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
5.	PC	UHSPC0214	Fundamentals of Electrical Engineering	2	-	-	2	2	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
6.	BSC	UHSBS0233	Applied Chemistry Lab	-	-	2	2	1	ISE	50	20	
7.	AEC	UHSAE0222	Communication Skills Lab	-	-	2	2	1	ISE	50	20	
8.	ESC	UHSES0234	Basic Civil Engineering Lab	-	-	2	2	1	ISE	50	20	
9.	PC	UHSPC0235	Fundamentals of Electrical Engineering Lab	-	-	2	2	1	ISE	50	20	
10.	VSEC	UHSVS0238	Computer Aided Engineering Drawing	-	-	2	2	3	ISE1	25		40
									ISE2	25		
									ESE (POE)	50	20	
11.	CC	UHSCC0239	Co-Curricular Course	1	-	-	-	1	ISE	100	40	
Total:							**24**	**21**	**Total Marks: 800** **Total Credit: 21**			

SEMESTER III

Sr. No.	Category	Course Code	Course Name	L	T	P	Hrs. / Week	Credits	Evaluation Scheme			
									Component	Marks		
										Max	Min for Passing	
1.	PC	UBTPC0301	Fluid Mechanics	3	1	0	4	4	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
2.	PC	UBTPC0302	Microbiology	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
3.	PC	UBTPC0303	Biochemistry	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
4.	PC	UBTPC0304	Cell and Molecular Biology	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
5.	VEC	UBTVE0305	Constitution of India	2	0	0	2	2	ISE	50	20	
6.	HSSM	UBTEM0306	Industrial Organization and Management	2	0	0	2	2	ESE	50	20	
7.	PC	UBTPC0331	Microbiology Laboratory	0	0	2	2	1	ISE	50		30
									ESE (POE)	25	10	
8.	PC	UBTPC0332	Biochemistry Laboratory	0	0	2	2	1	ISE	25	10	
9.	PC	UBTPC0333	Cell and Molecular Biology Laboratory	0	0	2	2	1	ISE	25		20
									ESE (OE)	25	10	
10.	OJT	UBTIL0371	Mini Project-I	0	0	2	2	1	ISE	50	20	
11.	MM	UBTMM03**	Multidisciplinary Minor	2	0	0	2	2	ESE	100	40	
							27	**23**	**Total Marks: 800 Total Credit: 23**			

Multi Disciplinary Minor - I (Data Analytics)		Multi Disciplinary Minor –II (Finance)	
UBTMM0341	Computational statistics	UBTMM0342	Fundamentals of Financial Accounting

SEMESTER IV

Sr. No.	Category	Course Code	Course Name	L	T	P	Hrs. / Week	Credits	Evaluation Scheme		
									Component	Marks Max	Marks Min for Passing
1	PC	UBTPC0401	Heat Transfer	2	0	0	2	2	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
2	PC	UBTPC0402	Genetic Engineering	3	0	0	3	3	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
3	PC	UBTPC0403	Immunology	3	0	0	3	3	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
4	PC	UBTPC0404	Enzyme Technology	2	0	0	2	2	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
5	PC	UBTPC0405	Bioinformatics	3	0	0	3	3	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
6	VEC	UBTVE0406	Environmental Studies	2	0	0	2	2	ISE	50	20
7	PC	UBTPC0431	Heat Transfer Laboratory	0	0	2	2	1	ISE	25	20
									ESE (OE)	25	10
8	PC	UBTPC0432	Genetic Engineering Laboratory	0	0	2	2	1	ISE	25	20
									ESE (POE)	25	10
9	VSEC	UBTVS0433	Immunology Laboratory	0	0	2	2	1	ISE	25	10
10	CC	UBTCC0434	Co-Curricular Activities - II	0	0	2	2	1	ISE	50	20
11	OJT	UBTIL0471	Mini Project II	0	0	2	2	1	ISE	25	10
12	MM	UBTMM04**	Multidisciplinary Minor	3	0	0	3	3	ESE	100	40
			Total:				**28**	**23**	**Total Marks: 850 Total Credit: 23**		

Multi Disciplinary Minor - I (Data Analytics)		Multi Disciplinary Minor –II (Finance)	
UBTMM0441	Python and R language for data science (MM-I)	UBTMM0442	Cost and Management accounting(MM-II)

SEMESTER V

Sr. No.	Category	Course Code	Course Name	L	T	P	Hrs. / Week	Credits	Evaluation Scheme		
									Component	Marks: Max	Marks: Min for Passing
1	PC	UBTPC0501	Bioreaction Engineering	3	0	0	3	3	ISE1	10	
									MSE	30	
									ISE2	10	40
									ESE	50	20
2	PC	UBTPC0502	Mass Transfer	2	0	0	2	2	ISE1	10	
									MSE	30	
									ISE2	10	40
									ESE	50	20
3	PC	UBTPC0503	Fermentation Technology	3	0	0	3	3	ISE1	10	
									MSE	30	
									ISE2	10	40
									ESE	50	20
4	PEC	UBTPE05**	Program Elective I	3	0	0	3	3	ISE1	10	
									MSE	30	
									ISE2	10	40
									ESE	50	20
5	OE	UBTOE05**	Open Elective I	3	0	0	3	3	ISE1	10	
									MSE	30	
									ISE2	10	40
									ESE	50	20
6	AEC	UBTAE0501	Business Communication and Value Science	0	0	2	2	1	ISE	50	20
7	PC	UBTPC0531	Bioreaction Engineering Laboratory	0	0	2	2	1	ISE	25	
									ESE (OE)	25	10	20
8	VSEC	UBTVS0532	Fermentation Technology Laboratory	0	0	2	2	1	ISE	25	
									ESE (POE)	25	10	20
9	PC	UBTPC0533	Bioinformatics Laboratory	0	0	2	2	1	ISE	25	10
10	CEP	UBTIL0571	Mini Project III	0	0	2	2	1	ISE	25	10
11	MM	UBTMM05**	Multidisciplinary Minor	3	0	0	3	3	ESE	100	40
			Total:				**28**	**22**	**Total Marks: 800 Total Credit: 22**		

Multi Disciplinary Minor - I (Data Analytics)		Multi Disciplinary Minor –II (Finance)	
UBTMM0541	Fundamentals of data science (MM-I)	UBTMM0542	Taxation and Audit (MM-II)

Program Elective- I	
UBTPE0511	Cell Culture Technology (PE-I)
UBTPE0512	Biological Thermodynamics (PE-I)

Sr. No.	Open Elective – I T.Y.B.Tech (Sem-V)	Course Code	Credits
1	Sales and Distribution Management	UILOE0521	03
2	Global Marketing Management	UILOE0522	03
3	Customer Relationship Management	UILOE0523	03
4	Water Resources Management	UILOE0524	03
5	Agile Project Management	UILOE0525	03
6	Product Design and Manufacturing	UILOE0526	03
7	Leadership and Corporate Strategy	UILOE0527	03
8	Human Resource Development	UILOE0528	03
9	Corporate Finance	UILOE0529	03
10	Green Buildings	UILOE0530	03
11	Ethics in Engineering Practices	UILOE0531	03

SEMESTER VI

Sr. No.	Category	Course Code	Course Name	L	T	P	Hrs. / Week	Credits	Evaluation Scheme		
									Component	Marks Max	Marks Min for Passing
1	PC	UBTPC0601	Bioseparations	3	0	0	3	3	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
2	PC	UBTPC0602	Process Calculations	3	0	0	3	3	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
3	PC	UBTPC0603	Bioprocess Equipment Design	2	0	0	2	2	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
4	PEC	UBTPE06**	Program Elective II	3	0	0	3	3	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
5	OE	UBTOE06**	Open Elective II	3	0	0	3	3	ISE1	10	40
									MSE	30	
									ISE2	10	
									ESE	50	20
6	HSSM	UBTEM0601	Biotech Industry: Practices and Entrepreneurship	2	0	0	2	2	ESE	50	20
7	PC	UBTPC0631	Bioseparations Laboratory	0	0	2	2	1	ISE	25	20
									ESE (POE)	25	10
8	PC	UBTPC0632	Bioprocess Equipment Design Laboratory	0	0	2	2	1	ISE	25	20
									ESE (OE)	25	10
9	PC	UBTPC0633	Effluent Treatment Laboratory	0	0	2	2	1	ISE	25	10
10	CC	UBTCC0634	Co-Curricular Activities - III	0	0	2	2	1	ISE	50	20
11	FP	UBTIL0671	Mini project IV	0	0	2	2	1	ISE	25	10
12	MM	UBTMM06**	Multidisciplinary Minor	3	0	0	3	3	ESE	100	40
							28	**24**	**Total Marks: 850 Total Credit: 24**		

Multi Disciplinary Minor - I (Data Analytics)		**Multi Disciplinary Minor –II (Finance)**	
UBTMM0641	Data Mining (MM-I)	UBTMM0642	Financial Management(MM-II)
Program Elective- II			
UBTPE0611		Plant Biotechnology (PE- II)	
UBTPE0612		Bioprocesses (PE- II)	

Sr. No.	Open Elective – II T.Y.B.Tech (Sem-VI)	Course Code	Credits
1	Intellectual Property	UILOE0621	03
2	Engineering Econometrics	UILOE0622	03
3	Entrepreneurship Development	UILOE0623	03
4	Positive Psychology	UILOE0624	03
5	Landscape Design	UILOE0625	03
6	Microeconomics	UILOE0626	03
7	Waste Management	UILOE0627	03
8	Social Entrepreneurship	UILOE0628	03
9	Industrial Health & Safety	UILOE0629	03
10	Appropriate Technology	UILOE0630	03
11	Six Sigma	UILOE0631	03

SEMESTER VII

Sr. No.	Category	Course Code	Course Name	L	T	P	Hrs. / Week	Credits	Evaluation Scheme		
									Component	Marks	
										Max	Min for Passing
1	PC	UBTPC0701	Analytical Techniques in Biotechnology	3	0	0	3	3	ISE1	10	
									MSE	30	
									ISE2	10	
									ESE	50	20
											40
2	PC	UBTPC0702	Good Manufacturing Practices	3	0	0	3	3	ISE1	10	
									MSE	30	
									ISE2	10	
									ESE	50	20
											40
3	PC	UBTPC0703	Process Engineering Costing and Plant design	3	0	0	3	3	ISE1	10	
									MSE	30	
									ISE2	10	
									ESE	50	20
											40
4	PEC	UBTPE07**	Program Elective III	3	0	0	3	3	ISE1	10	
									MSE	30	
									ISE2	10	
									ESE	50	20
											40
5	OE	UBTOE07**	Open Elective III	2	0	0	2	2	ISE1	10	
									MSE	30	
									ISE2	10	
									ESE	50	20
											40
6	PC	UBTPC0731	Analytical Techniques Laboratory	0	0	2	2	1	ISE	25	
									ESE (OE)	25	10
											20
7	PC	UBTPC0732	Animal And Plant Tissue Culture Laboratory	0	0	2	2	1	ISE	25	
									ESE (OE)	25	10
											20
8	RM	UBTIL0771	Project –I	0	0	8	8	4	ISE	50	
									ESE (OE)	50	20
											40
9	MM	UBTMM07**	Multidisciplinary Minor	3	0	0	3	3	ESE	100	40
			Total:				**29**	**23**	**Total Marks: 800 Total Credit: 23**		

Multi Disciplinary Minor - I (Data Analytics)		Multi Disciplinary Minor –II (Finance)	
UBTMM0741	Data Visualization and analytics (MM- I)	UBTMM0742	Banking and Financial Services (MM-II)

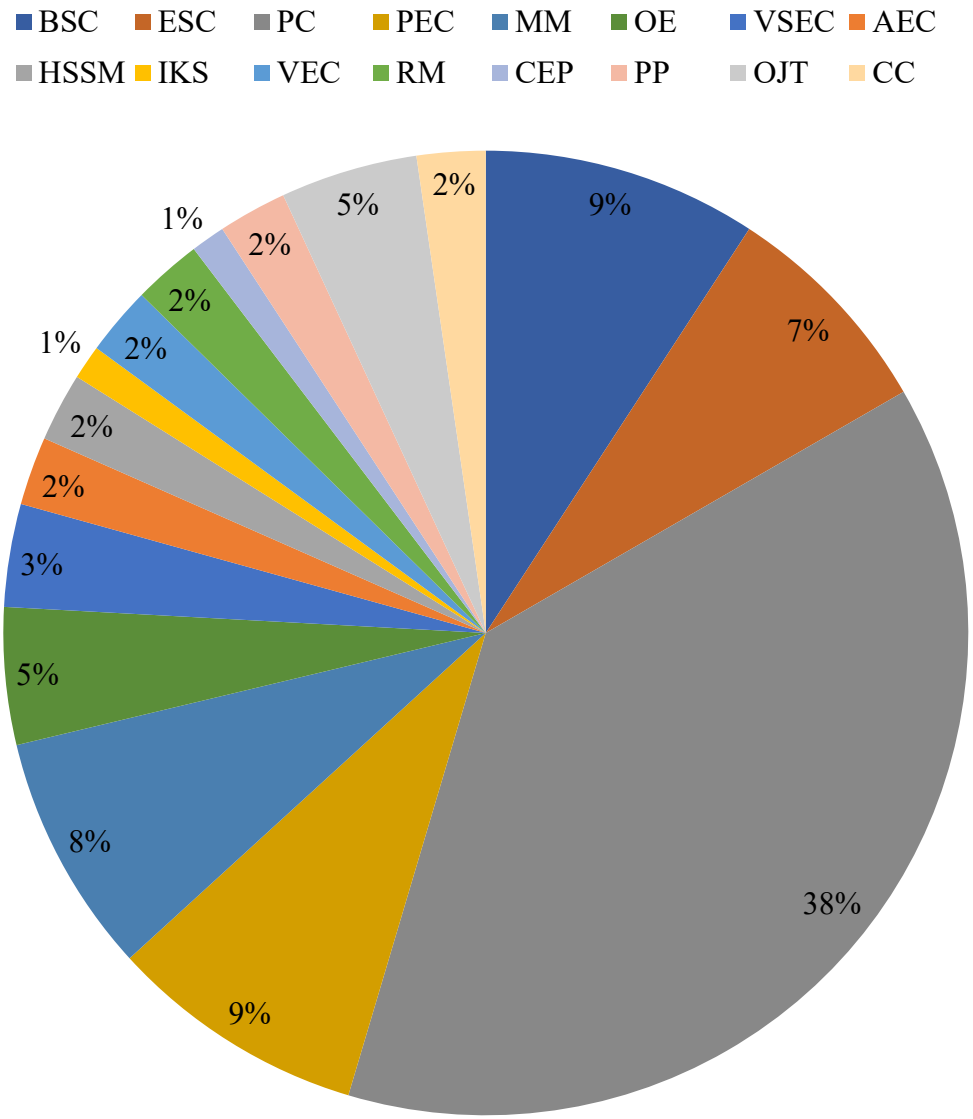
Program Elective- III	
UBTPE0711	Biopharmaceuticals (PE- III)
UBTPE0712	Food Technology (PE- III)

Sr. No.	Open Elective – III Final Year B.Tech (Sem-VII)	Course Code	Credits
1	Effective Paper Writing Skills	UILOE0721	02
2	Desktop Support and Services	UILOE0722	02
3	Healthcare and Technology	UILOE0723	02
4	Industrial Instrumentation	UILOE0724	02
5	Sustainable Energy Systems	UILOE0725	02
6	Urban and Rural Planning	UILOE0726	02
7	Design of Experiments and Research Methodology (DERM)	UILOE0727	02
8	Graphic and Product Design	UILOE0728	02
9	Environmental Policies and Law	UILOE0729	02
10	Environmental Impact Assessment	UILOE0730	02
11	Incubation and Entrepreneurship Enhancement	UILOE0731	02

SEMESTER VIII												
Sr. No.	**Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs. / Week**	**Credits**	**Evaluation Scheme**			
									Component	Marks		
										Max	Min for Passing	
1	PEC	UBTPE08**	Program Elective IV	3	0	0	3	3	ISE1	10		
									MSE	30		
									ISE2	10		40
									ESE	50	20	
2	PEC	UBTPE08**	Program Elective V	3	0	0	3	3	ISE1	10		
									MSE	30		
									ISE2	10		40
									ESE	50	20	
3	RM	UBTIL0871	Project –II	0	0	8	8	4	ISE	50		40
									ESE (OE)	50	20	
4	FP	UBTIL0872	Internship	0	0	12	12	6	ISE I	75	30	
									ISE II	75	30	
5	CC	UBTCC0831	Co-Curricular Activities - IV	0	0	2	2	1	ISE	50	20	
			Total:				**28**	**17**	**Total Marks: 500 Total Credit: 17**			

Program Elective IV		**Program Elective V**	
UBTPE0811	Tissue Engineering and organ Printing (PE- IV)	UBTPE0813	Next generation Sequencing and Analysis (PE-V)
UBTPE0812	Green Technology (PE-IV)	UBTPE0814	Drug development process (PE-V)

Curriculum Components and Credit Distribution



Multi-Disciplinary Minor - I Data analytics								
Sr. No.	**Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs. / Week**	**Credits**
1	MM-I	UBTMM0341	Computational statistics	2	0	0	2	2
2	MM-I	UBTMM0441	Python and R language for data science	3	0	0	3	3
3	MM-I	UBTMM0541	Fundamentals of data science	3	0	0	3	3
4	MM-I	UBTMM0641	Data Mining	3	0	0	3	3
5	MM-I	UBTMM0741	Data Visualization and analytics	3	0	0	3	3
			Total:				**14**	**14**

Multi-Disciplinary Minor-II Finance								
Sr. No.	**Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs./ Week**	**Credits**
1	MM-II	UBTMM0342	Fundamentals of Financial Accounting	2	0	0	2	2
2	MM-II	UBTMM0442	Cost and Management accounting	3	0	0	3	3
3	MM-II	UBTMM0542	Taxation and Audit	3	0	0	3	3
4	MM-II	UBTMM0642	Financial Management	3	0	0	3	3
5	MM-II	UBTMM0742	Banking and Financial Services	3	0	0	3	3
						Total:	14	14

Emerging minor- I Bioinformatics											
Sr. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs. / Week**	**Credits**	**Evaluation Scheme**			**Category**
								Component	Marks		
									Max	Min for Passing	
1	UBTMN0361	Biology for Engineers	3	1	0	4	4	ESE	100	40	MN
2	UBTMN0461	Fundamentals of Biomolecules	3	1	0	4	4	ESE	100	40	MN
3	UBTMN0561	Basics of Bioinformatics	3	1	0	4	4	ESE	100	40	MN
4	UBTMN0661	Structural Bioinformatics and Proteome based Technology	3	1	0	4	4	ESE	100	40	MN
5	UBTMN0761	Genomics and Proteomics	2	0	0	2	2	ESE	100	40	MN
		Total:				**18**	**18**	**Total Marks: 500 Total Credit: 18**			

B. Tech (Hons.) Biotechnology Engineering with Specialization in Biosimilar Technology

Sr. No.	Course Code	Course Name	L	T	P	Hrs./ Week	Credits	Evaluation Scheme			Category
								Component	Marks		
									Max	Min for Passing	
1	UBTHN0351	Biosimilar Therapeutics: Introduction	3	1	0	4	4	ESE	100	40	HN
2	UBTHN0451	Biosimilar: Manufacturing Technology-I	3	1	0	4	4	ESE	100	40	HN
3	UBTHN0551	Biosimilar Manufacturing Technology-II	3	1	0	4	4	ESE	100	40	HN
4	UBTHN0651	Biosimilar Therapeutics: Characterization	3	1	0	4	4	ESE	100	40	HN
5	UBTHN0751	Biosimilar Therapeutics: RegulatoryApproval Processes	2	0	0	2	2	ESE	100	40	HN
		Total:				**18**	**18**	**Total Marks: 500 TotalCredit:18**			

EXIT COURSES-Courses after Second year exit											
Sr. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs./ Week**	**Credits**	**Evaluation Scheme**			**Category**
								Component	Marks		
									Max	Min	
1	UBTEX0491	Agricultural Biotechnology	3	0	0	3	3	ISE	50	20	MEES
2	UBTEX0492	Introduction to Plant tissue culture	3	0	0	3	3	ISE	50	20	MEES
3	UBTEX0493	Training	0	0	2	2	2	ISE	50	20	MEES
					Total:	**8**	**8**	**Total Marks: 150 Total Credit: 8**			

EXIT COURSES-Courses After Third year exit											
Sr. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs./ Week**	**Credits**	**Evaluation Scheme**			**Category**
								Component	Marks		
									Max	Min	
1	UBTEX0691	Upstream Processing	3	0	0	3	3	ISE	50	20	MEES
2	UBTEX0692	Downstream Processing	3	0	0	3	3	ISE	50	20	MEES
3	UBTEX0693	Training	0	0	2	2	2	ISE	50	20	MEES
					Total:	**8**	**8**	**Total Marks: 150 Total Credit: 8**			

Class: Final Year B Tech Biotechnology Engineering **Title of the Course:** Analytical Techniques in Biotechnology **Course Code:** UBTPC0701	**L**	**T**	**P**	**Credit**
	03 hours per week			03

Course Pre-Requisite: Basic knowledge of physics and chemistry of 10th to 12thalong with understanding of biological, physical and chemical properties of small and macromolecules is required.

Course Description: This course summarizes the study of analytical and characterization instruments required in biotechnology with respect to principles, layout, different parts, function and their applications.

Course Learning Objectives:

1. To explain the principle of analytical instruments and recognize its end use application.
2. To illustrate layouts of instruments.
3. To select the analytical method based on the phenomena.
4. To train students in selection, calibration, and interpretation of analytical data.

Course Outcomes:

CO	**After the completion of the course, the student will be able to**	**Bloom's Taxonomy Descriptor**
CO1	Illustrate the construction and working of analytical instruments.	Cognitive (Apply) L2
CO2	Explain the end use application of an analytical instrument	Cognitive (Understand)L2
CO3	Select the analytical method based on the process requirement	Cognitive (Create) L3
CO4	Analyze the data obtained from different analytical methods	Cognitive (Analyze) L4

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO3**
1	2										1		2	
2	3	3	3	3	3	1					2			
3	2	2	3	3	2						3	3		
4	3	3	2	2										

Assessments:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10

ESE	50
• **ISE 1 and ISE 2** are based on Assignment / Declared test / Quiz / Seminar / Group discussions / presentation, case study etc. • **MSE** is based on 50% of course content (first three units). • **ESE** is based on 100% course content with 60-70% weightage for course content (last three units) covered after MSE.	
Course Contents:	
Unit 1: Spectroscopic Techniques UV-Visible spectrophotometry: Single and double beam, Beer–Lambert law limitations & deviations Infrared spectrophotometry, Flame spectrophotometry, Fluorescence spectroscopy.	08 Hrs.
Unit 2: Microscopic Techniques Fluorescence microscopy, Phase contrast microscope, Confocal microscopy, Electron microscope, Scanning electron microscopy, Transmission electron microscope. Application of microscope in analyzing biological samples.	05 Hrs.
Unit 3: NMR and Mass Spectroscopic Techniques NMR: Theory and Principle of NMR - Multi nuclear NMR- Analysis of spectra and Interpretations - Case studies of drugs, peptides and proteins. NMR spectra Analysis Recent advances in protein NMR. Mass Spectrometer: Principles of modern ionization methods and mass analyzers (TOF), hybrid/tandem mass methods (MS-MS) and applications of MS in the analysis of drugs and macromolecules.	09 Hrs.
Unit 4: Electrophoretic Techniques Electrophoresis; Principle, Design of horizontal and vertical gel electrophoresis apparatus. SDS PAGE, Discontinuous (Disc) Gel Electrophoresis, High Voltage (HVE) Electrophoresis, Isoelectric focusing, 2D Gel Electrophoresis, Pulse-Field Gel Electrophoresis.	08 Hrs.
Unit 5: Chromatographic Techniques Planar Chromatography- Paper Chromatography, Thin Layer Chromatography. Column Chromatography- Adsorption Chromatography, Partition Chromatography, Liquid-Liquid Chromatography, Gas-Liquid Chromatography, High Performance Liquid Chromatography, GCMS, LCMS, HPTLC.	08 Hrs.
Unit 6: Modern Analytical Techniques: Radiation, Thermal, and Cell-Based Methods Scintillation counter, TGA-DSC, flow cytometry, other Immuno techniques, Cell based assays.	07 Hrs.

Textbooks:

1. Biophysical Chemistry-Principles and Techniques, A. Upadhyay, K. Upadhyay, N. Nath. (Himalaya Publishing House)
2. Bioinstrumentation, J. Webster (John Wiley and Sons Inc.,).
3. Skoog, D.A., Crouch, S.R., and Holler, F.J. "Principles of Instrumental Analysis", 6th edition, Brooks/Cole, USA, 2006.
4. Williams, D. and Fleming, I. "Spectroscopic Methods in Organic Chemistry", 6th edition, McGraw-Hill Higher Education, Maidenhead, UK, 2008.
5. Freifelder D., Physical Biochemistry, "Application to Biochemistry and Molecular Biology", 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
6. Keith Wilson and John Walker, "Principles and Techniques of Practical Biochemistry", 5th Edition, Cambridge University Press, 2000.

Reference Books:

1. Bioanalytical Chemistry, A. Manz, N. Pamme and D. Iossifidis, (World Scientific Publishing Company)
2. Basic Methods in Microscopy, Protocols and concepts from cells: A Laboratory Manual, D. L. Spector & R. D. Goldman (Editors.), Cold Spring Harbor Laboratory Press, 2006
3. Live Cell Imaging: A Laboratory Manual R. D. Goldman, J. R. Swedlow and D. L.(Spector Cold Spring)
4. Kwon, Young Min, Ricke, Steven C. (Eds), "High-Throughput Next Generation Sequencing Methods and Applications", Volume. 733, Humana Press, 2011.

Class: Final Year B.Tech. Biotechnology **Title of the Course:** Good Manufacturing Practices	**L**	**T**	**P**	**Credit**
Course Code : UBTPC0702	3	-	-	3

Course Pre-Requisite: Knowledge of Industrial Practices, Industrial Organization and Management

Course Description: Good Manufacturing Practices, Intellectual property rights and bio safety in Industry.

Course Objectives:

1. To summarize Good Manufacturing and Good Laboratory Practices in industry
2. To relate Good Manufacturing Practices to management systems in industry
3. To apply the principles of validation in industry
4. To apply regulatory and intellectual property knowledge to basic pharmaceutical documentation and compliance scenarios.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive Descriptor
CO1	Summarize Good Manufacturing and Good Laboratory Practices in industry	Cognitive (Understand) L2
CO2	Relating Good Manufacturing Practices to Management systems in industry	Cognitive (Understand) L2
CO3	Apply the principles of validation in industry	Cognitive (Apply) L3
CO4	Apply regulatory and intellectual property knowledge to basic pharmaceutical documentation and compliance scenarios.	Cognitive (Apply) L3

CO-PO Mapping:

CO\PO	1	2	3	4	5	6	7	8	9	10	11	PSO 1	PSO 2	PSO3
CO1	2				1	3	3							3
CO2		2			3		3						1	3
CO3	1					3			2		1			3
CO4	1	2	1	1		3	3							3

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:-An Introduction To Pharmaceutical GMP Introduction, guidelines on GMP for pharmaceutical products, Good Laboratory Practices (GLP) and Good Documentation Practices (GDP), Concept of quality; Quality Assurance (QA) vs Quality Control (QC) Introduction to International regulations: US-FDA cGMP, EU GMP, WHO TRS, ICH Q-series guidelines	8 Hrs.
Unit 2:- Quality Standards and QA, QC in Pharmaceutical Industries Quality standards-advantages. Concept, role and importance of quality control, quality assurance- functions and advantages. Quality management in pharmaceutical industry. Customer requirement of quality.	8 Hrs.
Unit 3:-Pharmaceutical Validation Introduction of validation, types, scope and importance of validation. Limitations of validation, organization of validation. Elements of validation-IQ, OQ, PQ and DQ. Cleaning validation, process validation and validation of analytical procedures as per ICH guideline .	8 Hrs.
Unit 4:-Regulatory guideline.troduction to regulatory affairs. Necessity of regulatory affairs. Types of different applications- DMF, NDA, and ANDA. Types of DMF. Different regulatory agencies and their functions.	8 Hrs.
Unit 5:-Intellectual Property Rights: Types of intellectual property-patents, trademark, copyright and related right. Types of Patent Application- ordinary, PCT, conventional.	8 Hrs.
Unit 6:-Biosafety: Introduction- Introduction to biological safety guideline. Bio-safety levels. Containments to biohazards. Role of institutional Bio-safety committee-RCGM, GEAC. Recommended Bio-safety levels for infectious agents and infected animal.	8 Hrs.

Unit wise Measurable students Learning Outcomes:

1. To learn and identify importance of GMP.
2. To learn, Quality management in pharmaceutical industry.
3. To learn, Validation and Qualification of equipments, cleaning, and process.
4. To learn, the importance and functioning of different regulatory affair agencies.
5. To learn, different types of patents, copyrights and applications.
6. To learn, different Biosafety guidelines, committees and their functioning.

Textbooks:

1 BAREACT, Indian Patent Act 1970 Acts & Rules, (Universal Law Publishing Co.)

2. Genetic Patent Law & Strategy, KankanalaC .Manupatra Informatics Solutions Pvt.Ltd.,.

3. Patents, Subbaram, N.R. (Syndicate)

4. Basic Biotechnology b Ignacimuthu, S.(Tata McGraw-Hill)

5. Genetically yours by Lim, H.A. (World Scientific)

References:

1 Biotechnologies and Development (UNESCO Publications)

2. cGMP for Pharmaceuticals-Manohar Potdar (Pharma Med Press)

3.Validation of Active Pharmaceutical Ingredients-Ira Berry(CRC Press)

4.Quality Assurance and Quality Management in Pharmaceutical Industry-Y. Anjaneyulu

5. Quality assurance in Analytical Chemistry, B.W. Wenclawiak., M.Koch.E. Hajicostas,

Class: Final Year B.Tech. Biotechnology **Title of the Course:** Process Engineering Costing and Plant design **Course Code:** UBTPC0703	**L**	**T**	**P**	**Credit**
	03 hours per week	-	-	3

Course Pre-Requisite: Students shall have the basic knowledge of industrial Processes, industrial workflow, bioprocess equipment design drawing

Course Description: The first section of this course explains the basics of plant design and managing projects from their inception to erection, commissioning and final runs. The second section explains the industrial cash flow with details about total capital investment, profit and loss calculation and interests, taxes and many commerce calculations required to run the business.

Course Learning Objectives:

1. To explain basic fundamentals of Flow sheet synthesis, development and general plant designing procedures
2. To analyse different costing strategies and cost estimation methods.
3. To compare different Interest and profitability methods
4. To determine interest, taxes, fixed charges for different practical situations

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy Descriptor**
CO1	Explain fundamentals of flow sheet synthesis and general plant designing considerations.	Cognitive (Understanding) L1
CO2	Explain different concepts in process design development.	Cognitive (Understanding) L1
CO3	Analyse different costing strategies and cost estimation methods.	Cognitive (Analyze) L4
CO4	Calculate interest, taxes, and fixed charges for different industrial processes.	Cognitive (Analyze) L4

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	1	2	2	1	3	2	2				2		3	
2	1	2	2	1	3	2	2				2		3	
3	2	3	3								3	1	2	
4	1	2	3								3	1	2	

Assessments:

Assessment	Weightage (Marks)
ISE-1	10
MSE	30
ISE-2	10
ESE	50

ISE-1 and ISE-2: Assessment is based on Assignment/Declared Test/Quiz/Seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules).
ESE: Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.

Course contents :

Unit 1: General Plant Design Considerations : Plant location, Plant Layout, Health and Safety , loss prevention, environmental protection, Plant operation and control, patent consideration	08 Hrs.
Unit 2 : Process Design Development : Development of design database, literature survey, process creation, process synthesis steps, process design, and types of process designs.	08 Hrs.
Unit 3: Flow Sheet Synthesis and Development : General procedure, Process Information, Input/output structure, Functions diagrams, operation diagrams, process flow sheets, use of software in flow sheet synthesis	08 Hrs.
Unit 4 : Analysis of Process Cost Estimation: Industrial Cash Flow, Factors Affecting Investment and Production Cost, Capital Investment, Estimation of Capital Investment, Cost Components in Capital Investment, Estimation of Total Product Cost.	08 Hrs.
Unit 5:Interest, Time Value of Money, Taxes and fixed charges Interest, cost of capital, time value of money, cash flow patterns, Income taxes, fixed charges	08 Hrs.
Unit 6: Profitability, Alternative Investments and Replacements Profitability standards, methods for calculating profitability, alternative investments, replacements, and practical factors in alternative investment and replacements analysis.	08 Hrs.

Text Books :

1. Plant Design & Economics for Chemical Engineers- M. S. Peters , K. D. Timmerhaus, R.E. West (McGraw Hill) Fifth edition
2. Chemical Engineering Design, Coulson & Richardson's Volume 6 – R.K. Sinnott
3. Contemporary Engineering Economics – Chan S. Park (Perason Pretice Hall)
4. Bioseparation Science and Engineering – Harrison R.G., Todd P., Rudge S.R., Petrides D.P.(Oxford University Press)
5. Biochemical Engineering Fundamentals, Bailey & Ollis. (McGraw Hill Book Co.)

Reference Books :

1. Conceptual Design of Chemical Processes, Douglas, James M., (McGraw-Hill, International Editions)
2. A Guide to Chemical Engg. Process Design & Economics" Gael D .Ulrich, (JohnWiley & Sons)
3. Chemical Project Economics, Mahajani, V.V., (Macmillan Indian Ltd.)

Class: Final Year B.Tech. Biotechnology **Title of the Course:** Biopharmaceuticals (Program Elective III) **Course Code:** UBTPE0711	**L**	**T**	**P**	**Credit**
	03 hours per week	-	-	3

Course Pre-Requisite: Students shall have the basic knowledge of life sciences, chemical sciences and engineering sciences learnt till previous semester

Course Description: This course explains case studies of different biopharmaceuticals with their technology.

Course Learning Objectives:

1. To understand the different biopharmaceuticals modalities available in the market
2. To explain the patho-physiology and mechanism of action of biopharmaceuticals
3. To apply principles of different unit operations in manufacturing biopharmaceutical technology.
4. To analyze biopharmaceutical products with respect to quality and regulatory aspects

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy Descriptor**
CO1	Summarize the mechanism of action of Biopharmaceutical modalities	Cognitive (Understanding) L2
CO2	Apply principles of upstream technology for the manufacturing of Biopharmaceuticals	Cognitive (Applying) L3
CO3	Apply principles of downstream technology for the manufacturing of Biopharmaceuticals	Cognitive (Applying) L3
CO4	Analyze Biopharmaceutical products with respect to quality aspects	Cognitive (Analyze) L4

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	3	3	3							1	2		
2	3	3	3	3							1	3	3	
3	3	3	3	3							1	3	3	
4	2	3	3	3		2								3

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE-1 and ISE-2:** Assessment is based on Assignment/Declared Test/Quiz/Seminar/Group Discussions etc.
- **MSE:** Assessment is based on 50% of course content (Normally first three modules).

ESE: Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.

Course contents:

Note – All case studies to be taught with reference to pathophysiology, chemical description, expression

systems, production and purification technology, biochemical and biophysical analysis, fill finish and formulation, regulatory and quality considerations	
Unit 1: Vaccines Concept of different therapeutic modalities (Recombinant Proteins, Peptides, Antibodies, Nucleic Acids, Gene Therapies, Cell Therapies, Vaccines etc.) Types of Vaccines, Bacterial Vaccines, Viral Vaccines, Combination Vaccines, Recombinant Vaccines , Modern Vaccines, Case Studies	08 Hrs
Unit 2: Nucleic Acid Therapeutics and Gene Therapies DNA , RNA based therapeutics, Oligonucleotides Biochemistry, Antisense Technology; Triplex Technology, Aptamer Technology, Ribozyme Technology, Case Studies , Gene Augmentation, Gene Editing, Oncolytic virotherapy, Delivery system considerations, Case Studies	08 Hrs
Unit 3: Cell Therapies Autologous versus Allogeneic Cell Therapies, Stem Cell Therapy, CAR-T Cell Therapy, Case Studies	08 Hrs
Unit 4: Antibody Therapeutics Case Studies on Polyclonal anti-sera products, Case Studies on Monoclonal antibodies and related versions such as Antibody Fragments, Antibody Drug conjugates, Bispecific Antibody, Peptibody etc.	08 Hrs
Unit 5: Hormone and Cytokine Therapeutics Case Studies on Insulin, Follicle Stimulating Hormone, Human Chorionic Gonadotrophin, Somatotropin, Erythropoietin, G-CSF, Interleukins, Interferons etc.	08 Hrs
Unit 6: Plasma Proteins and Enzyme Therapeutics Case Studies on Albumin, Fibrinogen, Factor VIII, DNase, tissue Plasminogen Activator (tPA), Streptokinase etc.	08 Hrs

Text Books :

1. Understanding Biopharmaceuticals: Manufacturing and Regulatory Issues by Grindley, Jill E. Ogden (CRC Press)
2. Pharmaceutical Biotechnology by Crommelin D.J.A. , Sindelar R. D ,Bernd Meibohm (Springer)
3. Pharmaceutical Biotechnology by Gary Walsh (Wiley)

Reference Books :

1. Pharmaceutical Biotechnology by O. Kayser, R. H. Muller (Wiley - VCH)
2. Handbook of Pharmaceutical Biotechnology by Jay P Rho, Stan G Louie (Haworth Press)

Class: Final Year B.Tech. Biotechnology **Title of the Course:** Food Technology (PE- III) **Course Code:** UBTPE0712	L	T	P	Credit
	03 hours per week	-	-	3

Course Pre-Requisite: Biochemistry, Microbiology, Bioprocesses,

Course Description: Course emphasizes food analysis, processing, packaging and preservation.

Course Objectives:

1. To understand the composition of foods, preliminary processing, contamination risks, preservation methods, and basic Food Safety Management Systems
2. To apply knowledge of sterilization, pasteurization, and packaging methods to extend shelf life and ensure food safety.
3. To analyze the Indian and global food scenario and current FSSAI standards.

Course Outcomes:

CO	After the completion of the course the student will be able to	**Bloom's Taxonomy Descriptor**
CO1	Understand the composition of foods, preliminary processing.	Cognitive (Understand) L2
CO2	Illustrate the contamination risks, preservation methods, and basic Food Safety Management Systems.	Cognitive (Understand) L2
CO3	Apply the knowledge of sterilization, pasteurization, and packaging methods to extend shelf life and ensure food safety.	Cognitive (Apply) L3
CO4	Analyze the Indian and global food scenario and current FSSAI standards.	Cognitive (Analyze) L4

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	1	1			3	3							
2	2		1		1		2							3
3	2	2	1		2	3	2						1	3
4			1			2	2							3

Assessments:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and One End Semester Examination (ESE) have 20%, 30% and 50% weightage respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on Assignment / Declared test / Quiz / Seminar / Group discussions /

Presentation etc. MSE is based on 50% of course content ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.	
Course Contents:	**Hours**
Unit: 1 Introduction to food technology, Food Chemistry and Biochemistry World food demand and Indian scenario, constituents of food (Water, Carbohydrates, Fats and oils, Proteins), quality and nutritive aspects. Food additives. Introduction to FSSAI standards. Deteriorative factors and their control, preliminary processing methods and preservation operation. Introduction to Food Safety Management System (FSMS) andHACCP	08 Hrs
Unit: 2 Food Product Development Milk and Milk products: Fluid Milk and some of its derivatives, Ice cream and related frozen desserts, Cheese and their varieties, reduced fat dairy products, Meat, Poultry and Eggs: Meat and meat products, Poultry, Eggs Sea Foods: Fish procurement, Marine fish, Shellfish, Fish byproducts, Contaminants in Fish Spoilage micro-organisms, treatmentanddisposal of food processing wastes Development of processed foods, beverages, dairy, bakery and confectionery products, cereals/pulses, fruits & vegetable products;	08 Hrs
Unit: 3 Food microbiology, Analysis, Quality Control & Safety Microorganisms in food — beneficial (fermentation) and spoilage / pathogens; microbial growth; fermentation microbiology; starter cultures; microbial safety & hygiene. Food analysis techniques; detection of contaminants; foodborne pathogen testing; quality assurance; food laws, safety standards; hygiene & sanitation; food toxicology & allergenicity; regulatory aspects	06 Hrs
Unit: 4Energy engineering in food processing Generation of steam, Fuel utilization, Electric power Utilization, Process controls in Food Processing, Systems for heating and cooling food products, thermal properties of foods, Modes of heat transfer- freezing systems, Frozen food properties, freezing time, refrigeration System for food products	08 Hrs
Unit: 5 Microbial growth and Food preservation Processing Systems, Microbial Survivor Curves, Influence of External Agents, Thermal Death Time, and Spoilage Probability. Preservation by heat and cold dehydration, concentration, frying, irradiation, microwave Heating, sterilization and pasteurization, fermentation and pickling, packing methods.	08 Hrs
Unit: 6 Downstream processing in food industries and packaging Electro dialysis Systems, Reverse Osmosis System, Types of Reverse- Osmosis and Ultra Filtration, Drying Processes & Dehydration Systems, Dehydration System Design, Sedimentation and Centrifugation, Process intensification Packaging: Introduction, Food Protection, Product contaminants, Product communication and	07 Hrs

Product convenience, Mass transfer in packaging material, packaging material and product shelf life, Food canning technology, Heat sterilization of canned food.	

Textbooks:

1. Food Science: 5th Edition-Potter, Norman N. (CBS Publishers & Distributors)
2. Fennema's Food Chemistry, Fourth Edition Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema
3. Food Processing Technology: Principles and Practice by P J Fellows, Wood Head Publishing Limited.
4. Food Process Engineering-Heldman D. R. (AVI Publishing Co)

References:

1.Food Processing and preservation- B. Sivsankar PHI Learning Pvt. Ltd.

2.Introduction to Food Engineering - R. Paul Singh,Dennis

Class: Final Year B Tech Biotechnology Engineering **Title of the Course:** Analytical Techniques Laboratory **Course Code:** UBTPC0731	**L**	**T**	**P**	**Credit**
	--	--	02 hours per week	01

Course Pre-Requisite: Knowledge of physics and chemistry of 10thto 12th along with understanding of biological, physical and chemical properties of small and macromolecules is required.

Course Description: This course describes performing various analytical techniques and handling various instruments.

Course Learning Objectives:

1. To define different parts, symbols of various instruments
2. To Explain working principle and application of instrument.
3. To Interpret the results of analysis.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy Descriptor**
CO1	Define the components, parts, symbols, and basic layout of analytical instruments	Cognitive (Remember) L1
CO2	Explain the working principle and application of analytical instruments.	Cognitive (Understand) L2
CO3	Interpret and analyze experimental data generated from spectroscopic, chromatographic, electrophoretic, mass-spectrometric, and microscopic experiments to draw meaningful biological conclusions.	Cognitive (Analyze) L4

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO 3**
1	3				1									
2	3	3	3	2	3			3	3	3	2	3		3
3	3	3		2	2	3		3	3	3	2	3	2	3

Assessments:

In semester evaluation will based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc. Oral examination (OE) is based on viva conducted by external examiner on all the practical covered.

Assessment	Marks
ISE	25
ESE(OE)	25

- **ISE:** Based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
- **OE:** Assessment is based on oral examination conducted by external.

Experiment No. 1: Spectrophotometer- Absorption Mixture • **Aim & Objective:** To detect of components of mixtures using spectrophotometer	2Hrs
Experiment No. 2: **Spectrophotometer- Kinetics Method** • **Aim & Objective**: To study kinetics of enzyme catalyzed reaction using UV-Vis Spectrophotomete	2Hrs
Experiment No. 3: Phase Contrast Microscopy • **Aim & Objective**: To study phase contrast microscopy.	2 Hrs
Experiment No 4: Separation of Plant Pigments by Column Chromatography • **Aim & Objective:** To separate chlorophyll and carotenoid pigments from leaf extract.	2Hrs
Experiment No. 5: SDS PAGE • **Aim & Objective:** Demonstration of SDS PAGE	2Hrs
Experiment No. 6: HPLC • **Aim & Objective**: Demonstration of HPLC	2Hrs
Experiment No. 7: FTIR • **Aim & Objective:** Demonstration of FTIR	2Hrs
Experiment No. 8: GCMS	2Hrs

• **Aim & Objective:** Demonstration of GCMS	
Experiment No. 9: LCMS • **Aim & Objective:** Demonstration of LCMS	2Hrs
Experiment No. 11: XRD • **Aim & Objective:** Demonstration of XRD	2Hrs

Textbooks:

1. Willard, Merritt, Dean & Settle – Instrumental Methods of Analysis
2. Douglas A. Skoog et al. – Principles of Instrumental Analysis
3. Wilson & Walker – Principles and Techniques of Biochemistry and Molecular Biology
4. S. Sadasivam & A. Manickam – Biochemical Methods
5. Sample: MLShuler, FKargi 'Bioprocess Engineering: Basic Concepts', Illustrated, Prentice Hall Edition

Reference Books:

1. Chatwal & Anand – Instrumental Methods of Chemical Analysis
2. David Harvey – Modern Analytical Chemistry
3. Plummer – An Introduction to Practical Biochemistry
4. Snyder, Kirkland & Dolan – Introduction to Modern Liquid Chromatography
5. Scopes – Protein Purification: Principles and Practice
6. Pavia et al. – Introduction to Spectroscopy
7. Cullity & Stock – Elements of X-Ray Diffraction

Title of the Course: Animal and plant tissue culture Lab	**L**	**T**	**P**	**Credit**
Course Code: UBTPC0732	-	-	2	1

Course Pre-Requisite: Basics of Tissue culture

Course Description: This course describes performing various animal and Plant tissue culture techniques.

Course Objectives:

1. To define different media components and instruments
2. To Explain working principle and application of instruments.
3. To Interpret the results of analysis.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy**	
		level	Descriptor
CO1	Explain the fundamental concepts of Plant and Animal tissue culture.	2	Understand
CO2	Apply the techniques of upstream processes involved in plant and animal cell culture.	3	Apply

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2							3	3					
2	2	3						3	3			3		

Assessments:

In semester evaluation will be based on practical performance/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

Assessment	**Marks**
ISE	25
ESE (OE)	25

Experiment No. 1: Preparation of MS medium for Plant tissue culture and sterilisation techniques.	2 Hrs.

Experiment No. 2: Callus culture	2 Hrs.
Experiment No. 3: Micro propagation	2 Hrs.
Experiment No. 4: Anther culture	2 Hrs.
Experiment No. 5: Plant suspension Culture for secondary metabolite Production	2 Hrs.
Experiment No. 6: Aseptic Techniques for animal cell culture	2 Hrs.
Experiment No. 7: Revival of cryopreserved animal cells	2 Hrs.
Experiment No. 8: passaging cell lines and counting	2 Hrs.
Experiment No. 9: Viability test (Trypen Blue or Hemocytometer)	2 Hrs.
Experiment No. 10: MTT Assay	2 Hrs.
Experiment No. 11: Microscopy based live/dead cell analysis	2 Hrs.

Textbooks and references:

1. Bhojwani, S. S. and Razdan, M. K. 1983. Plant tissue culture, theory and practice. Elsevier Publ.
2. Dixon, R. A. 1985. Plant cell culture- a practical approach. Oril Press Oxford.
3. Doddas, J. H. and Roverts, L.W.1985. Experiments in plant tissue culture. Cambridge Uni. press.

Title of the Course: Project Phase I **Course Code**: UBTIL0771	**L**	**T**	**P**	**Credit**
	-	-	8	2

Course Pre-Requisite: All theoretical and practical skills learnt till previous semester

Course Description: Project phase-I includes a group of students working on a problem statement identification, carrying out literature review, preparing work plan and submit a synoptic summary in the form of report.

Course Objectives:

1. To summarize the knowledge of contemporary issues for problem identification for choice of field of research.
2. To evaluate scientific research articles for finalizing aim and objectives of the project.
3. To develop a plan of work based on aim and objectives finalized.
4. To elaborate the synoptic plan to a panel of experts effectively using oral and written means.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy**	
		level	Descriptor
CO1	Summarize the knowledge of contemporary issues for problem identification for choice of field of research.	2	Understand
CO2	Evaluate scientific research articles for finalizing aim and objectives of the project.	5	Evaluate
CO3	Develop a plan of work based on aim and objectives finalized in a team.	6	Create
CO4	Elaborate the synoptic plan to a panel of experts effectively using oral and written means.	6	Create

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1		3	3	2	2	1						3		
2		3												
3			3						1			1		
4				1					3	3	2			

Assessments:

Two components of In Semester Evaluation (ISE), one End Semester Examination (ESE) having 50% and 50% weights respectively.

Assessment	**Marks**
ISE	50
ESE (OE)	50

ISE is based on the rubrics based progressive report submission and presentation to respective supervisors. ESE is based on presentation of synopsis to expert panel.

Description: The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the course. The

Project Work Phase - I consists of following phases: 1. Surveying the contemporary knowledge, work and issues in the related field of interest for identification of problem 2. Collection of literature and reviewing 3. Presenting a plan of work to attain aim and objectives Projects Areas can be - 1. Processes based project: Product manufacturing, Waste treatments etc. 2. Equipment based Project: Detailed design and fabrication, prototype development etc. 3. Industrial problems: Any problem or project directly related to existing plants for modification of process or equipment or regarding pollution control and energy conservation. Students may undergo studies such as study of the selection of the process, computation of material and energy balances, process design, and detailed design of one of the main equipments; cost estimation, economic analysis etc. Suggested fields for project work - 1. Fermentation based: Microbial fermentation, Animal cell fermentation, Plant cell Fermentation Combitorial chemistry: Enzymatic processes 2. Microbial/enzymatic treatment of domestic and industrial waste water treatment. 3. Modeling and Simulation: Microbial fermentation, Waste water treatment, modeling genetic regulation (genetic switches, signal transduction, mixed cascadic systems), Insilco microorganisms (metabolic flux analysis, elementary mode analysis of metabolic fluxes),Insilco mammalian/animal organs, Virtual patients (analysis by top to bottom and bottom top analysis) 4. Bioinformatics: Sequence homology, clustering of genes, parametric analysis for homology and catalytic activity of enzyme, microarray data analysis. 5. Immunological studies: Modeling and experimental verification of antigen antibody interactions (steady state and dynamic modeling). 6. Metabolic Engineering and Genetic Engg. (modeling and experimental aspects of metabolic flux analysis for inhibitor development and planning for genetic mutation/deletion/strain improvement) 7. Toxicological studies: Effect of synthetic and plant extracted active compounds on eukaryotic organisms (Yeast and animal cells). 8. Extraction and purification techniques: Solvent/supercritical extraction of biologically active compounds from plants and herbs, Chromatographic purification. 9. Nutritional analysis of local food components and linear programming for balance diet design for Kolhapur region. 10. Techniques development for the preservation of farmer’s products (fruits and vegetables)and scale-up of exiting techniques such as ozonation , γ-rays preservation; Optimization of long term preservation of milk by supercritical carbon dioxide. 11. Food industry: Optimization/Modification of microbial processes of food industry, nutritional enrichment of food products. 12. Production of Bioinsecticides and pesticides

Class: Final Year B.Tech. Biotechnology **Title of the Course: Data Visualization and analytics (MM-I)** **Course Code:** UBTMM0741	**L**	**T**	**P**	**Credit**
	03 hours per week	-	-	3

Course Pre-Requisite: Python programming, Basics of statistics, Database concepts

Course Description:

This course is designed for Biotechnology Engineering students to develop skills in analyzing and visualizing biological and experimental data. It focuses on transforming complex datasets from areas such as genomics, proteomics, bioprocessing, and clinical studies into meaningful insights. Students will learn analytical techniques and visualization methods to interpret trends, patterns, and relationships in biological data. Emphasis is placed on clear scientific communication through graphs, dashboards, and visual reports. By the end of the course, learners will be able to apply data-driven approaches to support research, innovation, and decision-making in biotechnology.

Course Learning Objectives:

1. Analyse and interpret biotechnology-related datasets using appropriate statistical and analytical techniques.
2. Create effective data visualizations to represent biological, experimental, and bioprocess data clearly.
3. Apply data analytics tools to identify patterns, trends, and relationships in complex biological systems.
4. Communicate data-driven insights ethically and effectively to support research and decision-making in biotechnology.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy Descriptor**
CO1	Explain fundamental concepts of data analytics and visualization used in biotechnology applications.	Cognitive (Explain) L2
CO2	Apply suitable data visualization methods to represent biotechnology data effectively.	Cognitive (Apply) L3
CO3	Analyze biological and experimental datasets using basic analytical techniques.	Cognitive (Analyze) L4
CO4	Compare different visualization approaches for clarity and effectiveness in biotechnology contexts.	Cognitive (Compare) L4

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	2	1		1		1		1			2	1	
2	2	2	2	2	3	1	1	1	2			3	2	
3	3	3	2	3	2	1	1		2			3	2	
4	2	2	3	2	2	1	2	1	3			3	2	

Assessments:

One End Semester Examination (ESE) has 100% weightage.

Assessment	Marks
ESE	100

ESE: Assessment is based on 100% course content.

Unit 1 : Introduction to Data Visualization & Analytics Role of data visualization in biotechnology and life sciences, Types of data: biological, experimental, clinical, and omics data, Overview of visualization systems: static vs. interactive, Data analytics workflow for biotech applications, Elements of good visualization: clarity, accuracy, and aesthetics, Introduction to dashboards and storytelling with data, Case studies: visualization in genomics, proteomics, and bioprocess engineering	07 Hrs.
Unit 2 : Data Preparation & Preprocessing for Visualization Data cleaning: handling missing, noisy, and inconsistent biological data, Data transformation: normalization, scaling, and log transformation (common in omics), Data integration from lab instruments, sensors, and public databases, Feature selection and dimensionality reduction basics, Data formats in biotechnology (FASTA, CSV, Excel, VCF, etc.), Preparing tidy data in Python (Pandas) and R (tidyverse), Introduction to reproducible workflows in scientific analysis	08 Hrs.
Unit 3 : Visualization Techniques Using Python Basic plots using Matplotlib: line, bar, scatter, histogram, boxplot, Advanced visualizations using Seaborn: heatmaps, pairplots, violin plots, Plotly for interactive biological data visualization, Time-series visualization for bioprocess and biosensor data, Visualizing high-dimensional omics data, Customizing figures: annotations, color maps, themes, Exporting plots for publications and presentations	07 Hrs.
Unit 4 : Visualization Techniques Using R ggplot2 grammar of graphics: aesthetics, geoms, facets, Exploratory Data Analysis (EDA) in R for biological datasets, Specialized plots: MA plots, volcano plots, Manhattan plots, Heatmaps, clustering plots, and PCA visualizations in R, Interactive visualization using Shiny, Visualization using Bioconductor packages, Comparative visualization: Python vs R for life-science datasets	07 Hrs.
Unit 5 : Data Analytics Approaches in Biotechnology Descriptive analytics: summarizing biological data, Diagnostic analytics: identifying patterns and anomalies in experiments, Predictive analytics:	08 Hrs.

regression, classification, and basic machine learning models, Prescriptive analytics in bioprocess optimization, Survival analysis and clinical trial data visualization, Network analytics: biological networks and pathway analysis, Visualization of machine learning outputs	
Unit 6 : Applications, Dashboards, and Project Development Designing dashboards for biotech data using Plotly Dash / R Shiny, Visual analytics for genomics, transcriptomics, and proteomics data, Case study: visualizing next-generation sequencing (NGS) results, Visualization in drug discovery and molecular modelling, Report generation (Jupyter Notebook, R Markdown), Best practices for reproducibility and documentation, Mini-project: end-to-end visualization for a biotechnology dataset	07 Hrs.

Textbooks:

1. Data Visualization a practical introduction, Kieran Healy, Published by Princeton University Press
2. Practical Statistics for Data Scientists, Peter Bruce & Andrew Bruce, O'Reilly Media, Inc
3. Python Data Science Handbook, Jake VanderPlas, O'Reilly Media, Inc

References:

1. Bioinformatics Data Skills reproducible and robust research with open source tools, Vince Buffalo, O'Reilly Media, Inc
2. R for Data Science, Hadley Wickham & Garrett Grolemund, O'Reilly Media, Inc

Title of the Course: Tissue Engineering and organ Printing (PE- IV) **Course Code:** UBTPE0811	**L**	**T**	**P**	**Credit**
	3	-	-	3

Course Pre-Requisite: Anatomy and physiology, biomaterials

Course Description: This course helps the learners to understand thoroughly the key concepts of tissue organization, remodelling and strategies for restoration of tissue function. This will enable them to design tissue regeneration and tissue injury repair strategies.

Course Objectives:

1. To make students understand the basic utility and potential of tissue engineering principles
2. To Create Problem Solving Ability Among Students for Developing Strategies to Build Tissue Engineering Solutions.
3. To Encourage Students for Fabricating Tissue Engineering Products.
4. To Prepare Students for Advance Level Courses in 3D tissue designing and 3D tissue/organ printing.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy**	
		level	Descriptor
CO1	Explain the fundamental concepts of tissue engineering	2	Understand
CO2	Apply enabling technologies in tissue engineering by identifying suitable biomaterials, scaffold fabrication techniques	3	Apply
CO3	Explain various bioprinting techniques	5	Analyse

CO-PO-PSO Mapping:

CO	**POs**											**PSOs**		
s	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	**2**													
2	**2**	**2**	2		2							3		
3	**2**	**2**	2		2							3		

Assessments:

Assessment	**Marks**
ISE1	10
ISE2	10
MSE	30
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three modules) ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Unit: UNIT:1 Fundamental of Tissue Engineering Introduction to tissue Engineering, Structure and organization of tissue: various cell and tissue types, it's organization structure-function relationship	6 Hrs.

Fundamentals of Stem Cell Tissue Engineering; Stem cells: stem cell types, their characteristics, potency cell isolation, culture differentiation: primary cell isolation techniques, cell culture needs, Growth Factors; Extracellular Matrix: Structure, Function and Tissue Engineering Application; Mechanical Forces on Cells; Cell Adhesion; Cell Migration.	
UNIT:2 Tissue Engineering Enabling Technologies Biomaterials in tissue engineering, current biomaterials, Natural vs. Synthetic, Role of a biomaterial in tissue engineering, it's properties Biodegradable and 3D Polymer Scaffold processing techniques, Cell-cell and cell-matrix interactions: knowhow and importance of such interactions, extracellular matrices. Polymer Scaffold for Tissue Engineering Applications; Biomimetic Materials; Nanocomposite Scaffolds Tissue Engineering; Bioreactors; Regulatory Issues in Tissue Engineering.	6 Hrs.
UNIT:3 Tissue Engineering Application I Bioengineering of Human Skin Substitute; Nerve Tissue Engineering; Musculoskeletal Tissue Engineering; Bone Tissue Engineering; Cartilage Tissue Engineering; Temporomandibular Tissue Engineering; Smooth Muscle Tissue Engineering; Esophagus Tissue Engineering	6 Hrs.
UNIT:4 Tissue Engineering Application II Vascular Graft Tissue Engineering Cardiac Tissue Engineering; Heart Valve Tissue Engineering; Urologic Organ Tissue Engineering; Hepatic Tissue Engineering; Renal Tissue Engineering; Dental Tissue Engineering; Tracheal Tissue Engineering	6 Hrs.
UNIT 5 Introduction to Bioprinting Different types of bioprinting techniques and their advantages and disadvantages.3D tissue designing and 3D tissue/organ printing; various process parameters and their role in bioprinting	6 Hrs.
UNIT 6 Bio printing process and its applications In vitro manipulation of cells and biomaterials with a bioprinter to engineer tissues for regenerative medicine or in vitro tissue/organ models, In situ bioprinting and 4D bioprinting with examples from recent literature, Next step in bioprinting (challenges and future direction); ethical issues related to bioprinting.	6 Hrs.
Textbooks and References: 1. Atala et al., Essentials of 3D Biofabrication and Translation. 1st edition, ISBN-13: 978-0128009727. 2. Zhang et al., 3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine. 1st edition, ISBN 9780128005477. 3. Forgacs et al., Biofabrication - Micro- and Nano-fabrication, Printing, Patterning and Assemblies, 1st Edition, ISBN 9781455728527. 4. Derby B. Printing and prototyping of tissues and scaffolds. Science. 2012. 338:921-6. 5. Seliktar D. Designing cell-compatible hydrogels for biomedical applications. Science. 2012. 336:1124-8. 6. Murphy SV, Atala A. 3D bioprinting of tissues and organs. Nature Biotechnology. 2014. 32:773-85	

Class: Final Year B Tech Biotechnology Engineering **Title of the Course:** Green Technology (PE-IV) **Course Code:** UBTPE0812	**L**	**T**	**P**	**Credit**
	03 hours per week	-	-	**3**

Course Pre-Requisite:

Students should have basic knowledge of environmental biotechnology, microbiology, and bioprocess engineering. Familiarity with chemical processes, energy systems, and environmental management will help in understanding sustainable and green technology applications.

Course Description:

This course introduces the principles and applications of green technology aimed at sustainable development. It emphasizes biotechnological innovations for renewable energy, waste management, pollution control, and eco-friendly industrial processes. Students will learn to analyze, design, and evaluate technologies that minimize environmental impact and promote sustainability.

Course Learning Objectives:

1. Introduce the fundamental concepts of green technology and sustainable development principles relevant to biotechnology and environmental engineering.
2. Teach students about renewable and clean energy generation methods such as biofuels, biogas, and microbial fuel cells.
3. To develop knowledge of eco-friendly biotechnological processes for industrial production, waste treatment, and pollution control.
4. To encourage ethical, policy-oriented, and innovative thinking for designing sustainable biotechnological solutions and green industrial processes.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy** Descriptor
CO1	Explain the principles of green technology and green engineering, and their relevance to biotechnology.	Cognitive (Understand) L2
CO2	Describe various bioenergy technologies and green nanotechnology approaches and their applications in sustainable development.	Cognitive (Apply) L3
CO3	Apply concepts of biocatalysis, biopolymers, bioremediation, and circular economy for waste management and green manufacturing	Cognitive (Apply) L3
CO4	Analyze Life Cycle Assessment (LCA), environmental policies, and emerging trends in biotechnology.	Cognitive (Analyze) L4

CO-PO-PSO Mapping:

COs	POs											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
1	2		3	1	1	3	3				3	1		
2	2	2	3	2	2	3	2				2		1	
3	2	2	3	2	2	3	2				3	1	3	1
4					1	3	3				3		1	

Assessments:

Assessment	Marks
ISE 1	10
ISE2	10
MSE	30
ESE	50

- **ISE 1 and 2** are based on various tools such as assignment/declared test/quiz/seminar/group discussion/case study presentation, etc.
- **MSE:** Assessment is based on 50% of course content (Normally first 3 modules)
- **ESE:** Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.

Course Contents:

Unit 1: Introduction to Green Technology and Sustainability Concept and principles of Green Technology, Goals of sustainable development, Three pillars: Environmental, Economic, and Social sustainability. Role of biotechnology in achieving sustainability, Green chemistry and green engineering fundamentals	7 Hrs.
Unit 2: Bioenergy Biofuels: bioethanol, biodiesel, biogas, Hydrogen and microbial fuel cells, Enzyme and microbial technology for bioenergy production, Case studies	8 Hrs.
Unit 3: Green Nanotechnology Concept of green nanotechnology and eco-friendly synthesis of nanoparticles, Applications of nanobiotechnology, Green materials: bio-based composites and catalysts, Recent trends in sustainable nanomaterials, Case studies	7 Hrs.
Unit 4: Green Technology for catalysis and Waste Management Biocatalysis and biotransformations, Biopolymers and biodegradable plastics, Green synthesis of chemicals using microbes, Solvent-free and low-energy bioprocesses, Role of metabolic engineering and synthetic biology, Bioremediation, Waste valorization, Circular economy and zero-waste concepts Case studies	11 Hrs.
Unit 5: Life Cycle Assessment (LCA) – Concepts, Methods & Tools ISO 14040 & 14044 standards, Stages of LCA: Goal & Scope Definition, life Cycle Inventory (LCI), Life Cycle Impact Assessment (LCIA), Interpretation, LCA data quality, assumptions & limitations, LCA databases & software (GaBi, SimaPro, OpenLCA), LCA in biotechnology	6 Hrs.

Unit 6: Policies, Ethics, and Future Trends National and international environmental policies and protocols (e.g., Kyoto, Paris), Environmental Management Systems (ISO 14000), Intellectual Property Rights (IPR) in green innovations, Corporate social responsibility (CSR) and sustainability reporting, Future trends: carbon capture, green computing, and AI in sustainability	6 Hrs.

Textbooks and references:

Textbooks

1. Rittmann, B. & McCarty, P. *Environmental Biotechnology: Principles and Applications.* McGraw Hill.
2. Rao, C. S. *Environmental Pollution Control Engineering.*
3. Rao, M. N. (2007). *Waste Management and Pollution Control.* Oxford & IBH Publishing.

Reference Books

1. Anastas, P. & Warner, J. *Green Chemistry: Theory and Practice.* Oxford University Press.
2. Scrivens, J. & Savage, N. *Green Nanotechnology: Solutions for Sustainability and Energy.*
3. Pandey, A. et al. *Biotechnology for Sustainable Environment.* Elsevier.
4. Allen, D. T. & Shonnard, D. R. (2001). *Green Engineering: Environmentally Conscious Design of Chemical Processes.* Prentice Hall.

Class: Final Year B.Tech. Biotechnology **Title of the Course:** Next generation Sequencing and Analysis (PE-V) **Course Code:** UBTPE0813	**L**	**T**	**P**	**Credit**
	03 hours per week	-	-	3

Course Pre-Requisite: Basic knowledge of molecular biology, bioinformatics, and computational tools (R/Python or Linux) is required.

Course Description: This course introduces the principles, technologies, and workflows of Next Generation Sequencing (NGS) used for genome, transcriptome, and epigenome analysis. It emphasizes data processing, quality assessment, and interpretation using bioinformatics tools for real-world biological applications.

Course Objectives:

1. To understand the principles, platforms, and methodologies of Next Generation Sequencing (NGS).
2. To learn experimental design, library preparation, and data generation in NGS workflows.
3. To develop skills in NGS data analysis, including quality control, alignment, and variant detection.
4. To interpret sequencing results for applications in genomics, transcriptomics, and personalized medicine.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy Descriptor**
CO1	Explain the principles, platforms, and methodologies of Next Generation Sequencing (NGS).	Cognitive (Understanding) L2
CO2	Illustrate experimental design, library preparation, and data generation in NGS workflows.	Cognitive (Understanding) L2
CO3	Explain steps involved in NGS data analysis, including quality control, alignment, and variant detection.	Cognitive (Understanding) L2
CO4	Make use of sequencing results for applications in genomics, transcriptomics, and personalized medicine.	Cognitive (Applying) L3

CO-PO-PSO Mapping:

CO	**POs**											**PSOs**		
s	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	**2**	**1**												
2	**2**	**1**	**2**	**2**	**3**							**2**		
3	**2**	**1**												
4	**2**	**3**	**2**	**2**	**3**							**3**		

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE-1 and ISE-2:** Assessment is based on Assignment/Declared Test/Quiz/Seminar/Group Discussions etc.
- **MSE:** Assessment is based on 50% of course content (Normally first three modules).

ESE: Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.	
Course contents :	
Unit 1: Introduction to Next Generation Sequencing Evolution of sequencing technologies from Sanger to next-generation approaches, fundamental principles, workflow, and major applications in genomics and transcriptomics. Advantages and Disadvantages of NGS.	6 Hrs.
Unit 2: NGS Platforms and Technologies Sequencing platforms such as Illumina, Ion Torrent, PacBio, and Oxford Nanopore. Sequencing chemistry, read lengths, throughput, accuracy, and comparison of Next Generation Sequencing techniques.	7 Hrs.
Unit 3: Library Preparation and Experimental Design DNA and RNA extraction, quantification, fragmentation, adapter ligation, and indexing methods, importance of sequencing depth, coverage, experimental design for reliable results.(case study)	7 Hrs.
Unit 4: Data Generation and Quality Control Base calling, raw data formats like FASTQ and BAM, and the use of tools such as FastQC for quality assessment. Trimming, filtering, and preprocessing of sequencing reads to prepare high-quality data for analysis.	7 Hrs.
Unit 5: Sequence Alignment and Variant Analysis Reference-based alignment and de novo assembly using tools like BWA and Bowtie. Variant calling, SNP and INDEL detection, annotation using GATK or SAM tools, and visualization of genomic data.	8 Hrs.
Unit 6: Applications of NGS Transcriptome (RNA) sequencing, Exome sequencing, Genome Annotation, Using NGS to detect sequence variants, ChIP-sequence, biological theories on ChIP sequence analysis, Understanding the non – coding genome, Disease gene identification, DNA fragment evaluation, Peak identification, two condition comparison, Saturation analysis, Motif finding and related theories, Personalized medicine	7 Hrs.
Textbooks: 1. Genomes 4 by Brown, T. A. (Garland Science) 2. Introduction to Genomics (3rd Edition) by Lesk, Arthur M. (Oxford University Press) 3. Bioinformatics and Functional Genomics (3rd Edition) by Pevsner, Jonathan (Wiley-Blackwell)	
Reference Books: 1. Next Generation Sequencing: Advances, Applications and Challenges edited by Kulski, J. K. (InTechOpen) 2. Bioinformatics: Sequence and Genome Analysis by Mount, David W. (Cold Spring Harbor Laboratory Press) 3. Discovering Genomics, Proteomics and Bioinformatics by Campbell, A. M. and Heyer, L. J. (Benjamin Cummings)	

Class: Final Year B.Tech. Biotechnology **Title of the Course:** Drug Development Process (Program Elective V) **Course Code:** UBTPE0814	**L**	**T**	**P**	**Credit**
	03 hours per week	-	-	3

Course Pre-Requisite: Students shall have the basic knowledge of Microbiology, Biochemistry, Human Biology and Diseases, Bioinformatics

Course Description: This course explains drug life cycle from discovery up to market through the phases of pre-clinical and clinical trials with their regulatory aspects in brief.

Course Learning Objectives:

1. To understand the drug discovery process
2. To appreciate the life cycle of drug from discovery to market
3. To get the insights on pre-clinical (animal) and clinical (human) drug trails
4. To know the basics of regulatory affairs with their agencies

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy Descriptor**
CO1	Explain the drug development from the discovery to post market surveillance	Cognitive (Understanding) L2
CO2	Summarize pre-clinical research stages in the drug development	Cognitive (Understanding) L2
CO3	Summarize clinical research stages in the drug development	Cognitive (Understanding) L2
CO4	Recall the regulatory agencies and their affairs	Cognitive (Remembering) L1

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	1	1			3	2			1	1	2	1	2
2	3	1	1	1		3	3					3		3
3	3	1	1	1		3	3			1	1	2	1	3
4						3	3							3

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE-1 and ISE-2:** Assessment is based on Assignment/Declared Test/Quiz/Seminar/Group Discussions etc.
- **MSE:** Assessment is based on 50% of course content (Normally first three modules).

ESE: Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.

Course contents :

Unit 1: Drug Discovery and Development Diseases and disorders in human system with their mechanisms, Relevant Approaches to address diseases and disorders (pre-disease medication and post disease medication),	08 Hrs.

Diseases and Drug databases, Drug discovery process (The age of botanicals, Milestones in biotechnology, Societal and Governmental Impacts) Classical targets in drug discovery, Modern drug discovery process	
Unit 2: Drug Design and Screening Systems General approach of drug designing, Medicinal chemistry (structure activity and property relationships, drug like guidelines), The role of *in silico* tools, In vitro drug screening systems (The basic terms – Response curves, IC50, EC50 Agonists, Antagonists etc., Different assay types), High throughput screening	08 Hrs.
Unit 3: *In vitro* ADME and *in vivo* Pharmacokinetics Absorption, Distribution, Metabolism and Elimination pathways, *In vitro* ADME model systems, *In vivo* pharmacokinetics , Pharmacodynamics	08 Hrs.
Unit 4: Preclinical Research Animal models of disease states, Sources and validity of animal models, Species selection, Safety and toxicology (Sources of toxicity , Acute versus chronic toxicity , Cytotoxicity , Carcinogenicity, Genotoxicity, Teratogenicity and Mutagenicity) Animal ethics, Overview of 21 CFR Part 58 : Good Laboratory Practice for Nonclinical Laboratory Studies	08 Hrs.
Unit 5: Clinical Research Introduction to clinical trials, Clinical trials phase studies (Phase 1 to 4 trials), Designing clinical trials, ICH-GCP guidelines, Clinical research glossary, Investigational New Drug (IND) application, CTA , 21 CFR Part 312	08 Hrs.
Unit 6: Regulatory Aspects Overview of regulatory framework, Role of ICH, WHO and FDA, Common Technical Document (CTD), New Drug Application (NDA) Process, Drug dossier submissions, Good Documentation Practices, Data integrity principles (ALCOA++), 21 CFR 11	08 Hrs.

Text Books :

1. Basic Principles of Drug Discovery and Development by Benjamin E. Blass (Academic Press)
2. Drug Discovery and Clinical Research by SK Gupta and Sushma Srivastava (ICRI Pub.)

Reference Books :

3. Principles and Practice of Clinical Research by John I. Gallin and Frederick P. Ognibene (Academic Press)
4. Biopharmaceutical Drug Design and Development by Susanna Wu-Pong (Humana Press)
5. Practical Guide to Clinical Data Management by Susanne Prokscha (CRC Press)
6. Understanding Biopharmaceuticals: Manufacturing and Regulatory Issues by Grindley, Jill E. Ogden (CRC Press)
7. Pharmaceutical Biotechnology, 2nd Ed. By Crommelin D.J.A. , Sindelar R. D , Bernd Meibohm (Springer)
8. Pharmaceutical Biotechnology by Gary Walsh (Wiley)
9. Pharmaceutical Biotechnology by O. Kayser, R. H. Muller (Wiley - VCH)
10. Handbook of Pharmaceutical Biotechnology by Jay P Rho, Stan G Louie (Haworth Press)

Title of the Course: Project Phase II Course Code: UBTIL0871	L	T	P	Credit
	-	-	8	2

Course Pre-Requisite: All theoretical and practical skills learnt till previous semester

Course Description: Project phase-II includes a group of students working on a problem statement identification, carrying out literature review, preparing work plan and submit a synoptic summary in the form of report.

Course Objectives:

1. To utilize the knowledge and practical skill sets learnt in the laboratory and field for attainment of objectives.
2. To interpret the observations and results obtained in the project study.
3. To compile the work done on a research project in a team resulting in a thesis and possible publications in journals, conference proceedings.

Course Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Taxonomy	
		level	Descriptor
CO1	Utilize the knowledge and practical skill sets learnt in the laboratory and field for attainment of objectives.	3	Apply
CO2	Interpret the observations and results obtained in the project study.	5	Evaluate
CO3	Compile the work done on a research project in a team resulting in thesis and possible publications in journals, conference proceedings.	6	Create

CO-PO-PSO Mapping:

COs	POs											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
1	3	3	3	3	3	3	3	3	3	3	3	3	3	
2	3	3	3	3	3		3	3	3	3	3	3	3	
3					3		3	3	3	3	3	3		

Assessments:

Two components of In Semester Evaluation (ISE), one End Semester Examination (ESE) having 50% and 50% weights respectively.

Assessment	Marks
ISE	50
ESE (OE)	50

ISE is based on the rubrics based progressive report submission and presentation to respective supervisors. ESE is based on presentation of synopsis to expert panel.

Description: The objective of the project phase II is to make use of the knowledge gained by the student at various stages of the degree course. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the course. This also judges the ability of student to work in a team with respect to team building, leadership skill set development etc. The Project Work Phase - II consists of following phases 1. Actual hands-on work in the laboratory 2. Analyzing, interpreting the observations and results, drawing conclusions 3. Compiling the results, making conclusions and remarks 4. Presenting the work in a team to expert panel.

Class: Final Year B.Tech. Biotechnology **Title of the Course:** Internship **Course Code:** UBTIL0872	**L**	**T**	**P**	**Credit**
	-	-	**12 hours per week**	**6**

Course Pre-Requisite: Students shall have the knowledge all theoretical concepts and practical skills learnt till previous semester

Course Description: Internship is a mandatory component in the curriculum to enhance the skills and expose students to the respective fields of engineering. It includes either industrial or research organizational hands on training. In this head of passing, students are required to search for a minimum 3 months to maximum 6 months internship, make a formal application by sharing CV and fetch the internship in their domain of interest. The institutional Training and Placement Cell with departmental coordination also will assist in the process. The process will be conducted as per the Internship Policy of the Institute.

Course Learning Objectives:

1. To gain technical hands-on and people skills
2. To develop professional competencies in the field
3. To appreciate professional practices which are useful for career growth

Course Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy Descriptor**
CO1	Apply academic knowledge to gain hands-on experience	Cognitive (Applying) L3
CO2	Develop communication, team work and collaboration to achieve common goals	Cognitive (Evaluating) L5
CO3	Demonstrate professional values and ethical standards	Cognitive (Understanding) L2
CO4	Develop job skills and attitude to constitute a professional identity	Cognitive (Evaluating) L5

CO-PO-PSO Mapping:

COs	**POs**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	3	3	3	3	3				3	3	3	3	3
2								3	3	3	3			
3							3	3	3	3	3			3
4						3					3			3

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	75
ISE-2	75

- **ISE-1 and ISE-2:** Assessment is based on progress presentations and report submissions