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

Proposed Structure for
B.Tech in Biotechnology Engineering (As Per NEP)

(To be implemented w.e.f Academic Year 2024-25)

Department of Biotechnology Engineering
KIT's College of Engineering(Autonomous) Kolhapur

06/06/2024
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Patil
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B.Tech. Biotechnology Engineering

2024-25

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	20	
									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	10	
									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 TotalCredit:23**			

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

SEMESTERIV

Sr. No.	**Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs./ Week**	**Credits**	**Evaluation Scheme**			
									Component	Marks		
										Max	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	10	
									ESE(OE)	25	10	

8	PC	UBTPC0432	Genetic Engineering Laboratory	0	0	2	2	1	ISE	25	10	
									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	Miniprojector	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 TotalCredit:23**			

Multi-Disciplinary Minor-I(Data Analytics)		**Multidisciplinary 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	Min for Passing	
1	PC	UBTPC0501	Bioreaction Engineering	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
2	PC	UBTPC0502	Mass Transfer	2	0	0	2	2	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
3	PC	UBTPC0503	Fermentation Technology	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
									ISE1	10		

4	PEC	UBTPE05**	Elective I	3	0	0	3	3	MSE	30		40
									ISE2	10		
									ESE	50	20	
5	OE	UILOE0527	Open Elective I	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									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	10	
									ESE(OE)	25	10	
8	VSEC	UBTVS0532	Fermentation Technology Laboratory	0	0	2	2	1	ISE	25	10	
									ESE (POE)	25	10	
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 TotalCredit:22**			

Multi-Disciplinary Minor-I(Data Analytics)		**Multidisciplinary 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)

Open Elective-I	
UILOE0527	Leadership and Corporate Strategy (OE- I)

SEMESTER VI

Sr. No.	Category	Course Code	Course Name	L	T	P	Hrs./ Week	Credits	Evaluation Scheme	
										Marks

										Max	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	UILOE0628	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	10	
									ESE (POE)	25	10	
8	PC	UBTPC0632	Bioprocess Equipment Design Laboratory	0	0	2	2	1	ISE	25	10	
									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 TotalCredit:24**			

Multi-Disciplinary Minor-I(Data Analytics)	**Multidisciplinary 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)	

Open Elective-II	
UILOE0628	Social Entrepreneurship (OE- II)

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		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
2	PC	UBTPC0702	Good Manufacturing Practices	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
3	PC	UBTPC0703	Process Engineering Costing and Plant design	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
4	PEC	UBTPE07**	Program Elective III	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
5	OE	UILOE0723	Open Elective III	2	0	0	2	2	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
6	PC	UBTPC0731	Analytical Techniques Laboratory	0	0	2	2	1	ISE	25	10	
									OE	25	10	
7	PC	UBTPC0732	Professional Certification	0	0	2	2	1	ISE	50	20	
8	PM	UBTIL0771	Project I	0	0	8	8	4	ISE	50	20	

									ESE(OE)	50	20	
9	MM	UBTMM07**	Multidisciplinary Minor	3	0	0	3	3	ESE	100	40	
			Total:				**29**	**23**	**Total Marks: 800 TotalCredit:23**			

Multi Disciplinary Minor-I(Data Analytics)		**Multidisciplinary 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)

Open Elective-III	
UILOE0723	Healthcare and Technology (OE- III)

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		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
2	PEC	UBTPE08**	Program Elective V	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
3	RM	UBTIL0871	Project–II	0	0	8	8	4	ISE	50	20	
									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 TotalCredit: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)

MultiDisciplinary Minor– IDataanalytics

Sr. No.	Category	CourseCode	CourseName	L	T	P	Hrs./ Week	Credits
1	MM-I	UBTMM0341	Computationalstatistics	2	0	0	2	2
2	MM-I	UBTMM0441	PythonandRlanguagefor data science	3	0	0	3	3
3	MM-I	UBTMM0541	Fundamentals ofdatascience	3	0	0	3	3
4	MM-I	UBTMM0641	DataMining	3	0	0	3	3
5	MM-I	UBTMM0741	DataVisualizationand 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

Emergingminor-IBioinformatics

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 TotalCredit: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: Regulatory Approval 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	Marks 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	Marks 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**			

Title of the Course: Bioreaction Engineering **Course Code: UBTPC0501**	**L**	**T**	**P**	**Credit**
	3	**-**		**3**

Course Pre-Requisite: Basics of Fluid Mechanics, Mass and Energy Balances, Unit Operations

Course Description: This course is designed to study enzyme and cell culture reaction kinetics in batch, fed batch and continuous modes of reactor operations including their non-ideal behavior.

Course Objectives:

1. To explain the reaction yields and reaction rates.
2. To develop enzyme and cell culture kinetics.
3. To analyze enzymes and cell culture reactions in different modes of bioreactors.
4. To illustrate the concept of non-ideality and multiple reactor systems.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Taxonomy	
		level	Descriptor
CO1	Explain the concept of reaction kinetics.	2	Understanding
CO2	Analyze enzyme and cell culture kinetics for different modes of bioreactors.	4	Analyzing
CO3	Illustrate the concept of non-ideality and residence time distribution.	2	Understanding

CO4	Evaluate the performance of ideal batch, fed-batch and continuous modes of bioreactors.	5	Evaluating

CO-PO-PSO Mapping:

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

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 with60 -70% weightage for course content (normally the last three modules) covered after MSE.

Unit 1: General Reaction kinetics for biological systems: Reaction thermodynamics, reaction yields, reaction rates, reaction Kinetics, Effect of temperature on reaction rates, zero order kinetics, first order kinetics, Problems based on it.	**6 Hrs.**
Unit 2: Enzyme and Cell culture reaction kinetics for biological systems: Michaelis Menten Kinetics, Kinetics of enzyme deactivation, cell growth kinetics, production kinetics in cell culture, kinetics of substrate uptake in cell culture in absence of product formation, kinetics of substrate up take in cell culture with product formation,	**8 Hrs.**
Unit 3: Ideal Batch operation of enzyme and cell culture bioreactors: Batch operation of mixed reactors, Mathematical expressions of enzyme reactions, Mathematical expressions of cell culture reactions for biomass formation, substrate consumption, product formation and total time for batch reaction cycle, Problems based on it	**8 Hrs.**
Unit 4: Ideal Fed Batch operation of cell culture bioreactors: Mathematical expressions of cell culture reactions for biomass formation, substrate consumption, product formation and total time for fed batch reaction cycle. Problems based on it	**8 Hrs.**
Unit 5: Ideal Continuous operation of enzyme and cell culture bioreactors: Mathematical expressions of enzyme reactions & cell culture reactions, substrate consumption, product formation, comparison between major modes of reactor operations- Problems based on it.	**7 Hrs.**
Unit 6: Non - Ideality: Concept of non-ideality, Reasons for Non-Ideality, Conversion in nonideal flow reactors, Residence Time Distribution (RTD) function, Residence Time Distribution measurement: pulse and step input method, Study- F, C and E curves.	**8 Hrs.**

Textbooks & References:

1. Chemical Reaction Engineering- Levenspile, O. (Wiley)
2. Bioprocess Engineering Principles – Doran Pauline M. (Elsevier Pub.)
3. Chemical Engineering Kinetics- Smith, J. ((McGraw Hill, New York)
4. Reaction Kinetics for Chemical Engineers- Walas, S.M. (McGraw Hill, New York).
5. Elements of Chemical Reaction Engineering- Scott. H. Fogler, (EES publication).
6. Biochemical Engineering Fundamentals- Bailey and Ollis, (McGraw Hill, New York)
7. Bioreaction Engineering-Schergeri, K. (John Wiley)
8. Bioprocess Engineering: Basic Concepts – Shuler M.L., Kargi F. (Prentice Hall of India)
9. Process Biotechnology Fundamentals, Mukhopadhaya, S.N. (Viva Books Pvt. Ltd.)
10. Biochemical Engineering- Blanch H.W. and Clark, D. S. (CRC Press)

Title of the Course: Mass Transfer **Course Code: UBTPC0502**	**L**	**T**	**P**	**Credit**
	2	**-**		2

Course Pre-Requisite: Basic Concepts of Fluid Mechanics, Heat Transfer

Course Description: The objective of this course is to provide biotechnology engineering students with the basic principles of mass transfer

Course Objectives:

1. To explain molecular diffusion, Fick's law and role of convective and diffusive mass transfer in bioprocessing
2. To analyze separation methods like distillation, extraction and drying.
3. To solve case studies on separation processes.

Course Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Taxonomy	
		level	Descriptor
CO1	Explain role of convective and diffusive mass transfer in bioprocessing	2	Understanding
CO2	Explain the role of mass transfer in unit operations such as distillation and extraction	2	Understanding
CO3	Illustrate the role of mass transfer in unit operations such as crystallization and drying	2	Understanding

CO4	Analyze the case studies on mass transfer based unit operations such as distillation, extraction, crystallization and drying.	4	Analyzing

CO-PO-PSO Mapping:

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

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 the last three modules) covered after MSE.

Unit 1: Mass transfer in Bioreactors Diffusion, Role of diffusion in mass transfer, molecular diffusion, Fick's law of diffusion, Diffusivity, Molecular diffusion in gases, liquids and diffusion in solids, Mass transfer coefficient, Mechanism of mass transfer. Film theory, Convective mass transfer, Oxygen Transfer in Fermenters, Determination of KLa, Factors affecting KLa values, the balance between oxygen supply and demand, Classification of reactors based on agitation and aeration regime	**7 Hrs.**
Unit 2: Distillation Vapor –liquid equilibrium, Raoult's law, Dalton's law, Relative volatility, Simple distillation, Flash distillation, Continuous rectification-binary systems, Analysis of fractionating column by McCabe-Thiele method, Reflux ratio, azeotropic and extractive distillation	**8 Hrs.**
Unit 3: Extraction Partition coefficient basis of extraction, Type of extraction processes, Type of equipment's, scale up, Special extraction types (Aqueous two-phase extraction, Supercritical fluid Extraction, Reverse Micellar Extraction)	**7 Hrs.**
Unit 4: Crystallization and Drying Mechanism and methods of crystallization, Principles of drying, Phase equilibria, Cross circulation drying, through circulation drying, drying of suspended particles, Freeze drying, Drying equipment's - dryers for solids and pastes, dryers for solution and slurries, Selection of drying equipment	**8 Hrs.**

Textbooks and references:

1. Robert E. Treybal,"Mass Transfer Operations",Third Edition, McGrawHill, 1980.
2. McCabe&Smith,"UnitOperationofChemicalEngineering",5thEditionMcGraw Hill, KogakushaLtd. 1998.
3. Bioprocess Engineering Principles by Pauline M.Doran – Academic Press.
4. Bioseparation - Shivshanker B. (Prentice Hall of India)
5. C. J Geankolis, Transport Processes and unit operations, 3rdEdition, PrenticeHall, India, 1993
6. Richardson &Coulson, "Chemical Engineering", Vol. 2, PergamonPress, 1970.
7. B.K Datta, Principles of mass transfer & separation process.
8. Product recovery in bioprocess technology – Biotol Series (Butterworth-Heinemann Ltd.)

Title of the Course: Fermentation Technology **Course Code: UBTPC0503**	**L**	**T**	**P**	**Credit**
	3	-		3
Course Pre-Requisite: Microbiology, Cell and Molecular Biology, Biochemistry, Fluid Mechanics, Heat Transfer				
Course Description: This course explains the upstream processing part of a fermentation process. It covers the general aspects of isolation of producer strains, media requirements, media preparations and sterilization, inoculum development and details of fermentation process and final harvest of broth. It also highlights the operational aspects and control systems in of different types of fermentation vessels.				

Course Objectives:

1. To understand the microbial fermentations in terms of microbiological aspects of improvements of strains, nutritional requirements , media design and formulations
2. To correlate the sterilization basics and aseptic operations in fermentation process
3. To appreciate the working and design fundamentals of bioreactors and to know the basics of controls in the fermentation process with broth harvest

Course Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Taxonomy	
		Level	Descriptor
CO1	Recall microbiological basics of isolation, genetic improvements and culturing	1	Evaluating
CO2	Relate the nutritional requirements of microorganisms for media preparations, optimizations and sterilization from small to large scale	2	Understanding
CO3	Illustrate the working and scale up aspects of bioreactors based on applications	2	Understanding
CO4	Explain the basic controls in the fermentation process and broth harvest	2	Understanding

CO-PO-PSO Mapping:

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

ESE: Assessment is based on 100% course content with 60 -70% weightage for course content (normally the last three units) covered after MSE.

Unit 1: Microbiological Basics in Fermentation Bioprocessing and types, Meaning of Fermentation, The range of fermentation processes and their hosts, The chronological development of fermentation industry, Basics of isolation, improvement and preservation of industrially important microorganisms, Microbial repositories and procurement protocols	**7 Hrs.**

Unit 2: Media Optimization and Sterilization Media components and criteria of their choices (Energy sources, Carbon sources, Nitrogen sources, Buffers, Oxygen requirements, Antifoams), Medium optimization (one factor at a time method, statistical methods), Medium sterilization, The design and scale up of batch sterilization processes (Death kinetics, Del factor derivations), The design of continuous sterilization processes (Del factor and nutrient quality criterion), Filter sterilization (Design of depth filter for aseptic air inoculation)	**9 Hrs.**
Unit 3: Inocula Development and Fermentation Process The development of inocula for bacterial, fungal, algal processes, The aseptic inoculation of plant fermenters, Fermentation process (Quantifying cell concentration, Quantifying substrates and products), In-process quality control, Concept of Quality by Design (Basic terminologies - Process characterization, Critical quality attributes, Critical process parameters)	**6 Hrs.**
Unit 4: Design and Working Aspects of Bioreactors Classification of bioreactors, Working aspects of stirred tank reactor, Bubble column reactor, Air lift reactor, Packed bed reactor, Fluidized bed reactor, Wave bioreactor, Single use/Disposable bioreactor, Perfusion technology, Reactor peripherals and accessories, Selection and design fundamentals of a typical bioreactor, Scale up aspects of Bioreactor (Constant power per unit volume, Constant K_La, Constant impeller tip speed)	**11 Hrs.**
Unit 5: Fermentation Process Control Components of basic control loop, Sensors (Temperature, Pressure, Microbial biomass, Flow rate, Dissolved oxygen, pH, Rate of stirring) , Actuators, Controllers and control actions (ON-OFF, Proportional and PID) Typical fermentation control loops (Temperature, pH, D.O., air flow rate, agitation, pressure and antifoam) Loop versus Sequence control, Advances in controls	**8 Hrs.**
Unit 6: Broth Harvesting Characterization of fermentation broth, Broth pretreatments (Coagulation, flocculation, cell disruption for intracellular products)	**4 Hrs.**

Textbooks and Reference Books:

1. Principles of Fermentation Technology – Stanbury P.F., Whitaker A, Hall S. J. (Aditya Books)
2. Fermentation Microbiology and Biotechnology – El-Mansi E.M.T. ,Bryce C.F.A, Demain A.L., Allman A.R. (CRC Press)
3. Biochemical Engineering and Biotechnology – Ghasem D. Najafpour (Elsevier)
4. Bioprocess Engineering Principles – Doran Pauline M. (Elsevier Pub.)
5. Process Biotechnology fundamentals – Mokhopadhyay S. N. (Anshan Publishers)
6. Biochemical Engineering – Aiba S., HumphreyA.E. , Millis N. F. (Academic Press)
7. Introduction to Biochemical Engineering - Rao D.G. (Tata McGraw-Hill)
8. Fundamentals of Biochemical engineering -Rajiv Dutta (Springer Pub., Ann Books India)
9. Bioprocess Engineering: Basic Concepts – Shuler M.L., Kargi F. (Prentice Hall of India)

Title of the Course: Cell Culture Technology	**L**	**T**	**P**	**Credit**

Course Code: UBTPE0511	**3**	**-**		**3**

Course Pre-Requisite: Students admitted for this course will be expected to have sufficient background knowledge of Cell biology and general biology.

Course Description:

The course covers central topics in Animal biotechnology. The focus is on IVF, Animal cell culture, Cell & Tissue Engineering. Furthermore, attempts to manipulate the animal cells are described.

Course Objectives:

1. To illustrate animal cell physiology and complexity and cell cycle concept
2. To prepare(setup) laboratory for cell culture, media preparation and sterilization
3. To identify, dissociate and study physiology and testing cell lines.
4. To illustrate genetic engineering in cell lines for tissue engineering.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Taxonomy	
		Level	Descriptor
CO1	Illustrate the animal cell and tissue physiology	2	Understanding
CO2	Explain the laboratory setup and process of cell culturing	2	Understanding
CO3	Examine the characteristics of cell lines.	3	Applying
CO4	Analyze genetic engineering methods for cell and tissue engineering.	4	Analyzing

CO-PO-PSO Mapping:

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

Assessments:

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 units)
ESE: Assessment is based on 100% course content with 60 -70% weightage for course content (normally the last three units) covered after MSE.

Unit 1:---Introduction & biology of cultured cells Introduction of Cell Culture Technology, Philosophy and complexity in cell culture, To grow the cell outside the body, Cell cycle concept, dividing cells	**6 Hrs.**
Unit 2:---Equipment, aseptic techniques, safety protocols Cell Culturing methods -Batch, Fed Batch and Perfusion, Pros and cons of each culture method, Layout(s) & design(s) of cell culture facility, Precautions during designing the lab layout,State of the art facility in cell culture lab, specialized facility in cell culture lab	**7 Hrs.**
Unit 3:---Culture media development & sterilization Cell Culture media composition and importance of each component in adherent and non adherent cell lines. Interaction of cell and glass/polycarbonate surface, Poly D lysine deposition, Surface chemical analysis, Cell growth process, Cell surface interface.	**10 Hrs.**
Unit 4:---Cell dissociation and testing of cell line Introduction of define system, Mechanical dissociation of animal tissue, Rules for mechanical dissociation of tissue, Cell separation & In vitro myelination cell culture, Contamination, cryo-preservation & cyto-toxicity, Fluorescent assisted cell sorting	**6 Hrs.**
Unit 5:---Genetic material into the cell and Cell morphology analysis (DNA, RNA RNP complex into the cell) Lentiviral based transduction, Retroviral based transduction, Lipofection and Electroporation. MTT assay for measuring metabolic activity, Basics of Flow cytometry and its applications for analysis of physical and chemical characteristics of the cell. Miniaturized small scale high-throughput systems used in early-stage cell culture development. Examples: AMBR System, Tube Spins, Erlenmeyer flasks etc.	**10 Hrs.**
Unit 6:---Protein Over-Expression and Gene Knock-out Different strategies for protein expression and its analysis using Flow cytometry and Western blot, CRISPR based Knock-out of specific genes and ways to assess the knock-outs.	**6 Hrs.**

References and Textbooks:

1) Culture of Animal Cells by R Ian Freshney.
2) Animal Cell Culture by John R.W. (Masters Oxford University Press)
3) Introduction to Cell and Tissue Culture by Jennie P. Mather and Penelope E.Roberts (Plenum Press, New York and London)
4) Cell culture technology: Recent advances and future prospects (Euroscicon Meeting Reports Book 1) by Bruserud, Øystein and Astrid Englezou.
5) Vertebrate Cell Culture II and Enzyme Technology: Volume 39 (Advances in Biochemical Engineering/ Biotechnology) by A.F. Bückmann and G. Carrea
6) Animal Cell Culture and Technology (The Basics) (Garland Science)) by Michael Butler

Title of the Course: Biological Thermodynamics (PE-I) **Course Code: UBTPE0512**	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**
Course Pre-Requisite: Basics of unit and conversions, Basics of Thermodynamics at 10+2 Level				

Course Description: The objective of this course is to provide biotechnology engineering students with the basic principles of thermodynamics to apply in Bioenergetics, metabolic activities, cellular respiration, growth and development processes, membrane transport systems, enzymatic reactions and much more.

Course Objectives:

1. To explain the basic concepts of thermodynamics like heat, enthalpy, internal energy, work, energy and power.
2. To utilize the basic concepts for deriving different laws.
3. To examine different relationships between fundamental properties.
4. To evaluate energy requirements for different biochemical processes

Course Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Taxonomy	
		level	Descriptor
CO1	Explain the basic concepts of thermodynamics like heat, enthalpy, internal energy, work	1	Understanding
CO2	Apply the basic concepts for deriving mathematical expressions for thermodynamic laws.	3	Applying
CO3	Examine different relationships between fundamental properties.	5	Analyzing
CO4	Evaluate energy requirements for different biochemical processes.	5	Evaluating

CO-PO-PSO Mapping:

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

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 with60 -70% weightage for course content (normally the last three modules) covered after MSE.

Course Contents:

Unit 1: Introduction and basic concepts: Scope and limitations of thermodynamics, Force, pressure and energy, Equilibrium state and the phase rule, Temperature and Zeroth law of thermodynamics, Heat reservoirs and heat engines, reversible and irreversible processes.	**7 Hrs**
Unit 2: First Law of thermodynamics and P-V-T behavior: General Statements for first law of thermodynamics, Internal Energy, first law for non-flow process, Enthalpy, first law for flow process, Heat Capacity, Equation of state and concept of ideal gas, processes involving ideal gases- constant volume, constant pressure, constant temperature processes, polytropic process	**8 Hrs**
Unit 3: Second Law of Thermodynamics: Limitations of first law of Thermodynamics- direction of change, General statements of the second law of thermodynamics, Entropy-concept, The CARNOT principle, Entropy –A state function, statistical explanation for entropy, Third law of thermodynamics.	**8 Hrs**
Unit 4: Thermodynamic properties of pure fluids: Classification of thermodynamic properties, Work function (Helmholtz Free Energy), Gibbs Free energy, Fundamental property relations, Maxwell's relations and its applications.	**7 Hrs**
Unit 5: Gibbs free energy theory: Equilibrium, Reversible processes, Equilibrium constant, Effect of temperature on Keq, Chemical coupling, Redox reactions.	**7 Hrs**
Unit 6: Gibbs free energy-applications: Applications of thermodynamics in metabolic reactions, Macromolecular interactions, Membrane transport, Molecular pharmacology, DNA, Enzyme Substrate interactions, Substrate Cycling, Protein solubility, Protein stability, Protein dynamics	**8 Hrs**
Textbooks & References: 1. Biological Thermodynamics – D.T. Haynie (Cambridge University Press) 2. A textbook of Chemical Engineering Thermodynamics – K. V. Narayanan (Prentice Hall of India) 3. Introduction to Chemical Engineering Thermodynamics – Smith, Van Ness, Abbott (TMH) 4. Chemical, Biochemical and Engineering Thermodynamics – Stanley I. and Sandler (Wiley India Edition) 5. Chemical engineering thermodynamics – Y.V.C. Rao (New Age international)	

Title of the Course: Business Communication and Value Science (Practical) **Course Code: UBTAE0501**	**L**	**T**	**P**	**Credit**
			2	1
Course Pre-Requisite: Basics of Communication Skills, LSRW Skills, Grammar etc.				

Course Description: This course will help students to develop their personality by learning professional skills including soft skills, presentation skills, understanding emotional intelligence, hone motivation, enhance leadership to raise their employability quotient.

Course Objectives:

1. Analyze personal strengths and areas for development
2. Understand the importance of life skills for holistic personality development
3. Develop employability skills through various essential employability criteria
4. Apply public speaking in real life scenarios
5. Understand the implications of cross-cultural communication

Course Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Taxonomy	
		level	Descriptor
CO1	Analyze personal strengths and areas for development	4	Analyzing
CO2	Understand the importance of life skills for holistic personality development	2	Understanding
CO3	Develop employability skills through various essential employability criteria	5	Creating
CO4	Apply public speaking in real life scenarios	3	Applying
CO5	Understand the implications of cross-cultural communication	2	Understanding

CO-PO-PSO Mapping:

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

Assessments: Teacher Assessment:

Assessment	**Weightage**	**Remark**
In Semester Evaluation 1 (ISE1)- (25 marks)	100%	ISE: ISE is based on practical performance/ Quiz/ Presentation/ Group Discussion/ Interview/Assignments/Demonstration, etc.

Experiment No. 1 - Self-awareness: Identifying self, personality traits, qualities, strengths and weaknesses. Create your SWOT , SWOT vs. TOWS, The balancing act- Ted talk on biomimicry. SWOT along with various aspects of self to fit the challenging professional world.	**2 Hrs.**
Experiment No. 2- Soft skills and ethics: Introduction, importance of Soft skills. Checklist on Soft Skills, Action Plan for improvement. Participants will read a case study and list down the soft skills.	**2 Hrs.**

Experiment No. 3 - Assertive communication and Positive Attitude: Positive and assertive communication with self and others to overcome challenges and build up mutual relationship and rapport.• Checklist on Positive self-talk, Positive Attitude and Self-Esteem, Goal setting, right attitude • Assertiveness Self-assessment Test: https://www.psychologytoday.com/intl/tests/personality/assertiveness-test	**2 Hrs.**
Experiment No. 4 - Employability quotient 1: Employment Correspondence- Participants are trained to draft Resume, CV and Application Letter in an ideal format to foster better employability. E-mail etiquettes.	**2 Hrs.**
Experiment No. 5 - Employability quotient 2: Employment skills- Open discussion on the topic, "Employers' expectations and the need for new skillset for the changing workforce trends." The focus is on raising learning and adaptability through employment perspective. A detailed checklist is provided to the participants to macth their skills and employer's expectations.	**2 Hrs.**
Experiment No. 6 - Employability quotient 3: Group Dynamics: Participants will be engaged in Group discussion activity to harness effective Communication skills, self-confidence, assertive self-expression, team work and constructive exchange of ideas and thoughts.	**2 Hrs.**
Experiment No. 7 - Employability quatient 4: Interview Skills and Techniques: Participants will face mock interview rounds followed by discussion on interview etiquettes.	**2 Hrs.**
Experiment No. 8 - Presentations techniques: Participants will prepare and deliver a short presentation on various soft skills or non-verbal communication. The focus is on body language, voice modulation, engagement with audience.	**2 Hrs.**
Experiment No. 9 - Emotional intelligence: Strategies to hone EI. A short video/movie clip showing manifestations of EI. Extemporaneous speeches on topics related to workplace scenarios followed by peer feedback.	**2 Hrs.**
Experiment No. 10 - Motivation and leadership: Participants are given few Case studies/ video samples to understand motivation. Participants will talk about their favourite leader and motivation through their life.	**2 Hrs.**
Experiment No. 11 - Cross- cultural communication: Techniques to facilitate cross-cultural communication. Participants will be provided a set of case scenarios to analyse cross-cultural communication. Participants will attempt a quiz based on different cultures.	**2 Hrs.**
Experiment No. 12 - Storytelling for business: Participants create and present a story and learn to connect with an audience and convey complex ideas through storytelling.	**2 Hrs.**
Essential Reading:	
1. Assertiveness Step by Step: Dr Windy Dryden & Daniel Constantinou, London: Sheldon, Pg 23-34	
2. Emotional Intelligence, Why it can matter more than IQ: Daniel Goleman, Bloomsbury Publishing	
3. Leadership: Theory and Practice: Peter G. Northouse, Sage, 2021	
4. A Theory of Human Motivation: Abraham H. Maslow, 1943	
5. Communication Skills: Meenakshi Raman & Sangeeta Sharma, Oxford University Press, 2013	
Online Resources:	
1. Ted Talk: How to Speak So That Others Want to Listen- https://www.youtube.com/watch?v=eIho2S0ZahI1	
2. TEDx talk by Adam Galinsky: How to speak up for yourself- https://www.ted.com/talks/adam_galinsky_how_to_speak_up_for_yourself?language=en	
3. https://www.youtube.com/watch?v=FFjGGZecO04	
4. https://news.stanford.edu/2005/06/14/jobs-061505/ (Steve Jobs: Connecting the dots)	

Title of the Course: Bioreaction Engineering Laboratory **Course Code: UBTPC0531**	**L**	**T**	**P**	**Credit**
	-	**-**	**2**	**1**

Course Pre-Requisite: Biochemistry, Microbiology, Fermentation Technology

Course Description: This course includes practical studies based on research in reaction engineering.

Course Objectives:
1. To interpret the order of reactions by experimental and graphical methods
2. To analyze enzyme catalyzed bioreactions

Course Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Taxonomy	
		level	Descriptor
CO1	Examine the order of reaction	2	Understanding
CO2	Examine biochemical reaction kinetics.	4	Analyzing
CO3	Assess the performance of different types of reactors.	5	Evaluating

CO-PO-PSO Mapping:

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

Assessments: Teacher Assessment:
In Semester Evaluation (ISE) and End Semester Examination (ESE-OE) 25 marks each will be taken.

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

ISE are based on practical performance/ Quiz/Internal oral etc.
ESE-OE –Assessment based on external oral examination

Experiment No. 1: Determination of value reaction rate constant for First Order Reaction Aim and Objectives: To determine value of reaction rate constant for first order of reaction by experimental analysis	**2 Hrs**
Experiment No. 2: Determination of value reaction rate constant for pseudo first Order Reaction Aim and Objectives: To determine value of reaction rate constant for pseudo first order of reaction by experimental analysis	**2 Hrs**
Experiment No. 3: Determination of value reaction rate constant for second Order Reaction Aim and Objectives: To determine value of reaction rate constant for second order of reaction by experimental analysis	**2 Hrs**
Experiment No. 4: Determination of Order of Reaction by Graphical Method Aim and Objectives: To study graphical method for determining order of reaction	**2 Hrs**
Experiment No. 5: Standard Curve for Reducing Sugar Estimation Aim and Objectives: To get a standard curve for reducing sugar estimation by DNSA method	**2 Hrs**

Experiment No. 6: Enzyme Assay (any enzyme and substrate may be chosen e.g., alpha amylase and starch respectively) Aim and Objectives: To study assay of enzyme to know the activity of enzyme	**2 Hrs.**
Experiment No. 7: Effect of Temperature and Ph on Enzyme Activity Aim and Objectives: To find optimum temperature of enzyme at fixed pH and fixed substrate concentration. To find optimum pH of enzyme at fixed temperature and fixed substrate concentration.	**2 Hrs.**
Experiment No. 8: Effect of Substrate Concentration of Enzyme Activity Aim and Objectives: To perform enzyme reaction at varying concentration of substrate at fixed temperature and pH (preferably at optimum conditions)	**2 Hrs.**
Experiment No. 9: Free Versus Immobilized Enzymes Aim and Objectives: To compare performance of free vs immobilized enzyme and calculate enzyme activity recovery	**2 Hrs.**
Experiment No. 10: Deactivation Kinetics of Enzyme Aim and Objectives: To perform deactivation kinetics	**2 Hrs.**
Experiment No. 11: Study the performance of different types of reactors Aim and Objectives: Assess the performance of different types of reactors.	**2 Hrs.**
Textbook and References: 1. Process Biotechnology fundamentals – Mokhopadhyay S. N. (Anshan Publishers) 2. Biochemical Engineering – Aiba S., HumphreyA.E. , Millis N. F. (Academic Press) 3. Introduction to Biochemical Engineering - Rao D.G. (Tata McGraw-Hill) 4. Fundamentals of Biochemical engineering -Rajiv Dutta (SpringerPub., Ann Books India)	

Title of the Course: Fermentation Technology Laboratory **Course Code: UBTVS0532**	**L** **-**	**T** **-**	**P** **2**	**Credit** **1**
Course Pre-Requisite: Microbiology, Cell and Molecular Biology, Biochemistry, Fluid Mechanics, Heat Transfer				
Course Description: This course provides hands-on experience on the aspects of isolation of producers, lab scale fermentations with the in-process analyses aspects with case studies.				
Course Objectives: 1. To understand isolation methods for producer microbial strains 2. To run a complete fermentation process from media making, sterilization to inoculation 3. To know in-process analyses in the fermentation process				

Course Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Taxonomy	
		Level	Descriptor
CO1	Demonstrate microbiological work basics and biomass, substrate and product calculations	2	Understanding
CO2	Apply knowledge of upstream processing techniques for lab scale fermentation	3	Applying

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	2	3	1	3	3	1	1	2	3	3
2	3	3	3	3	2	3	1	3	3	1	1	2	3	3

Assessments:

One component of In Semester Evaluation (ISE) and one component of End Semester Evaluation (Practical and Oral Examination).

Assessment Component	Marks
ISE	25
ESE (POE)	25

ISE is based on weekly performance, journal reports and quizzes etc.

Experiment No. 1:Isolation of Producers Aim and Objectives: To isolate enzyme producer from natural sources like soil or industrial wastes	**2 Hrs.**
Experiment No. 2:Pretreatment, preparation of fermentation media and estimation of carbohydrates and proteins from fermentation media Aim and Objectives: To pretreat the complex media sources and to estimate the carbohydrate and proteins in the media to help in the formulation	**2 Hrs.**
Experiment No. 3:Study of growth kinetics of the organism Aim and Objectives: To calculate the specific growth rate of the microorganism under study in batch culture.	**2 Hrs.**
Experiment No. 4:Study of substrate utilization and product formation kinetics in fermentation Aim and Objectives: To calculate the specific substrate consumption and product formation rate of the microorganism under study in batch culture	**2 Hrs.**
Experiment No. 5: Calculation of different rates and yield coefficients in fermentation Aim and Objectives: To calculate yield and yield coefficient in batch culture	**2 Hrs.**
Experiment No. 6: Preparation and use of laboratory scale fermenter and its accessories Aim and Objectives: To learn handling and use of laboratory scale fermenter and its accessories	**2 Hrs.**
Experiment No. 7: Production of ethanol/alcoholic beverage Aim and Objectives: To monitor and characterize the fermentation process at flask or fermenter level.	**2 Hrs.**
Experiment No. 8: Production of organic acid Aim and Objectives: To monitor and characterize the fermentation process at flask or fermenter level.	**2 Hrs.**

Experiment No. 9: Production of antibiotics Aim and Objectives: To monitor and characterize the fermentation process at flask or fermenter level.	**2 Hrs.**
Experiment No. 10: Production of enzyme Aim and Objectives: To monitor and characterize the fermentation process at flask or fermenter level.	**2 Hrs.**
Experiment No. 11: Production of biofertilizers/ biopesticides Aim and Objectives: To monitor and characterize the fermentation process at flask or fermenter level.	**2 Hrs.**
Experiment No. 12: Production of single cell proteins Aim and Objectives: To monitor and characterize the fermentation process at flask or fermenter level.	**2 Hrs.**

Textbooks and Reference Books :

1. Principles of Fermentation Technology – Stanbury P.F., Whitaker A, Hall S. J. (Aditya Books)
2. Fermentation Microbiology and Biotechnology – El-Mansi E.M.T. ,Bryce C.F.A, Demain
   A.L., Allman A.R. (CRC Press)
3. Biochemical Engineering and Biotechnology – Ghasem D. Najafpour (Elsevier)
4. Bioprocess Engineering Principles – Doran Pauline M. (Elsevier Pub.)
5. Process Biotechnology fundamentals – Mokhopadhyay S. N. (Anshan Publishers)
6. Biochemical Engineering – Aiba S., HumphreyA.E. , Millis N. F. (Academic Press)
7. Introduction to Biochemical Engineering - Rao D.G. (Tata McGraw-Hill)
8. Fundamentals of Biochemical engineering -Rajiv Dutta (Springer Pub., Ann Books India)
9. Bioprocess Engineering: Basic Concepts – Shuler M.L., Kargi F. (Prentice Hall of India)

Title of the Course: Bioinformatics Laboratory **Course Code: UBTPC0533**	**L**	**T**	**P**	**Credit**
			2	1

Course Pre-Requisite: Biochemistry, Molecular Biology, Genetic Engineering, Chemistry, Mathematics and Computer Literacy

Course Description:

This course introduces students to the resources to access scientific data and bioinformatics tools, explains the retrieval of sequences from various databases. It helps compare the different software tools to assess the sequence similarities and software for evolutionary studies. This course deals with tools used in protein visualization.

Course Objectives:

6. To understand the basics of tools in bioinformatics.

7. To exploit various software for sequence retrieval and their analysis.

8. To analyze the differences in the sequences and multiple sequence alignment results.

9. To compare different platforms for sequence alignment and evolutionary studies.

10. To select the platforms for performing tasks to address the problems in Biotechnology

Course Outcomes:

CO		Bloom's Taxonomy	
		level	Descriptor
CO1	Make use of software tools for sequences and other biological data retrieval, drug discovery, etc.	3	Apply
CO2	Analyze the results obtained from sequence alignments, homology modelling, docking experiments and protein structure visualization tools.	4	Analyze

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	2	3							3		
2	3	2	1	1	3							2		

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	25

ISE are based on assignment/declared test/quiz/seminar/Group Discussions etc.

Experiment No. 1: ---Retrieving sequence records with NCBI (Entrez), EMBL, PROSITE, SWISSPROT, etc. Aim and Objective: To retrieve nucleotide and protein sequence.	**2 Hrs.**
Experiment No. 2: --- Retrieving scientific data and the clinical trial data from databases like Pubmed, Clinicaltrials, etc. Aim and Objective: To understand and retrieve the scientific, clinical trial data from database sources.	**2 Hrs.**
Experiment No. 3: ---BLAST and FASTA. Aim and Objective: To study pairwise sequence alignment using BLAST and FASTA.	**2 Hrs.**
Experiment No. 4: ---CLUSTAL-W and Omega, MEGA. Aim and Objective: To study multiple sequence alignment.	**2 Hrs.**

Experiment No. 5: ---Primary structure visualization of a protein using Protparam and Protscale. Aim and Objectives: To computes the various physical and chemical parameters of a protein. To perform primary structure analysis of proteins. To introduce a protein analysis software that is available through the ExPASy server.	**2 Hrs.**
Experiment No. 6: --- Retrieving structure of protein from PDB and visualizing the tertiary structure of Protein. Aim and Objective: To retrieve the structure of protein from PDB and work with Rasmol/Pymol for protein structure visualization.	**2 Hrs.**
Experiment No. 7: — Surface Analysis of a protein using CASTp. Aim and Objective: To get a detailed and complete quantitative characterization of surface pockets and interior voids of proteins using CASTp (Computed Atlas of Surface Topography of proteins), To familiarize with the online resource CASTp.	**2 Hrs.**
Experiment No. 8: --- Retrieving details of a drug molecule using various databases: DrugBank, ChEMBL, Pubchem, etc. Aim and Objective: To find the structure and activity of drug molecules from Drug Bank and ChEMBL.	**2 Hrs.**
Experiment No. 9: ---Phylogenetic Analysis using PHYLIP – Rooted and Unrooted trees. Aim and Objective: To find the evolutionary relationships between organisms and to analyse the changes occurring in these organisms during evolution using PHYLIP.	**2 Hrs.**
Experiment No. 10: —Homology Modelling with Swiss model and Homology modeller. Aim and Objective: To Perform Homology modeling for the given protein.	**2 Hrs.**
Experiment No. 11:--- Molecular Docking with iGEMDOCK/SwissDock. Aim and Objective: To perform molecular docking to predict the interaction energy between molecules.	**2 Hrs.**

ences:

Textbook and References

1. Bioinformatics: Theory andPractice, Chikhale N.J., GomasV.S, Himalaya Pub. House.
2. Bioinformatics: A practical guide to the analysis of genes and Proteins, Baxevanis, A. D. and Ouellette, B, F, F, John Wiley and sons, Inc. publications
3. Bioinformatics-sequence and genome analysis, David Mount

Title of the Course: Mini Project III	**L**	**T**	**P**	**Credits**
Course Code: UBTIL0571	**-**	**-**	**2**	**1**

Course Pre-Requisite: All theoretical concepts and practical skills learnt in second year courses

Course Description: Mini Project I includes a group of students working on a problem statement provided with preparation of work plan, execution and submission of a synoptic summary in the form of report.

Course Objectives: 1. To explain the approach to address the problem statement provided using the fundamental understanding of concepts.
2.To develop a plan of work based on aim and objectives finalized.
3.To elaborate the synoptic plan and executed project work effectively using oral and written means.

Course Outcomes:

COs	After the completion of the course the student will be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	To explain the approach to address the problem statement using the fundamental concepts.	2	Understanding
CO2	To develop and execute a plan of work based on objectives finalized.	3	Applying
CO3	To discuss and analyse the result and discussion of the work	3	Applying
CO4	To conclude the synoptic plan and executed project work effectively using oral and written means	3	Applying

CO-PO Mapping:

	POs											**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	3	3	3	3				3	3	3	3		
CO2	1	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3					3			3	3	3	3			
CO4						3			3	3	3			

Assessment Scheme:
One component of In Semester Evaluation (ISE) with 100% weightage

Assessment Component	**Marks**
ISE	25

ISE is based on rubrics based progressive report submission and presentation to supervisors.

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 basic understanding of concepts in various courses, capacity of planning and executing the application of the knowledge. Reporting the outcomes effectively. Projects Areas can be socially related to - Microbiology Biochemistry Cell Biology Molecular Biology Enzyme Technology Immunology Genetic Engineering Bioinformatics Fluid Mechanics Heat Transfer	

Title of the Course: Fundamentals of Data Science(MM-I) Course Code: UBTMM0541	L	T	P	Credit
	3			3

Course Pre-Requisite: Basic knowledge of Mathematics and Programming

Course Description: This course provides an interdisciplinary introduction to Data Science, covering fundamental concepts, techniques, and applications across various domains. Students will learn data preprocessing, statistical analysis, and machine learning methodologies to extract meaningful insights from data.

Course Objectives:

1. Understand the multidisciplinary role of Data Science across various domains.
2. Apply data preprocessing and statistical analysis techniques to real-world datasets.
3. Utilize machine learning models for predictive analytics in different applications.
4. Analyze time series data and apply forecasting models for data-driven predictions.
5. Implement optimization and decision science techniques for solving complex problems.

Course Outcomes:

CO		Bloom's Taxonomy	
		level	Descriptor
CO1	Understand the multidisciplinary role of Data Science across various domains.	2	Understanding
CO2	Apply data preprocessing and statistical analysis techniques to real-world datasets.	4	Apply
CO3	Utilize machine learning models for predictive analytics in different applications.	2	Utilize
CO4	Analyze time series data and apply forecasting models for data-driven predictions.	4	Analyze
CO5	Implement optimization and decision science techniques for solving complex problems.	4	Implement

CO-PO-PSO Mapping:

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

Assessments: Teacher Assessment:

Assessment	Marks	Remark
End Semester Examination (ESE)	100	100% course contents

Unit 1: Introduction to Data Science Definition and Evolution of Data Science, Relationship with AI, Machine Learning and Big Data. Data Science Applications in: Engineering: Predictive Maintenance, IoT Data Analytics, Healthcare: Genomics, Medical Imaging, Disease Prediction, Finance: Fraud Detection, Risk Analysis, Stock Market Prediction	**6 Hrs.**

Unit 2: Data Handling and Preprocessing Types of Data: Structured, Unstructured, Semi-structured, Data Collection, Cleaning, and Transformation , Handling Missing Data and Outliers, Feature Engineering and Dimensionality Reduction, Large-Scale Data Processing and Storage Technologies	**8 Hrs.**
Unit 3: Advanced Statistical Analysis for Data Science Review of Basic Statistical Concepts, Probability Distributions and Their Applications, Hypothesis Testing (t-test, ANOVA, Chi-Square Test), Regression Analysis (Linear, Logistic, Multiple)	**8 Hrs.**
Unit 4: Machine Learning Fundamentals Overview of Machine Learning Algorithms, Supervised Learning: Decision Trees, Random Forests, SVM Unsupervised Learning: K-Means, Hierarchical Clustering	**8 Hrs.**
Unit 5: Time Series Analysis and Forecasting Introduction to Time Series Data, Components of Time Series: Trend, Seasonality, Cyclic, and Irregular Variations Time Series Analysis Techniques: Moving Averages, Exponential Smoothing, ARIMA (AutoRegressive Integrated Moving Average) Model	**8 Hrs.**
Unit 6: Optimization and Decision Science Introduction to Optimization Techniques, Linear Programming and Non-Linear Programming Genetic Algorithms and Evolutionary Computing	**8 Hrs.**

Textbooks and references:

Textbook and References

1. Joel Grus – Data Science from Scratch: First Principles with Python, 2nd Edition, O'Reilly Media, 2019

2. Sebastian Raschka & Vahid Mirjalili – Python Machine Learning, 3rd Edition, Packt Publishing, 2019.

3. Hyndman, Rob J., & Athanasopoulos, George – Forecasting: Principles and Practice, 3rd Edition, OTexts, 2021.

4. Mokhtar S. Bazaraa, Hanif D. Sherali, & C. M. Shetty – Nonlinear Programming: Theory and Algorithms, 3rd Edition, Wiley, 2006.

5. Trevor Hastie, Robert Tibshirani, & Jerome Friedman – The Elements of Statistical Learning: Data Mining,

Title of the Course:	Taxation and Audit (MM-II)	L	T	P	Credit
Course Code:	UBTMM0542	3	-	-	3

Course Pre-Requisite:

1. Fundamentals of Financial Accounting
2. Cost and Management accounting

Course Description:

The course is designed to provide in-depth study of taxation and auditing principles, concepts, and practices as it applies mainly to business and investors. Further, it will provide the student with a working knowledge of taxation and auditing procedures and techniques, standards, ethics and legal environment, statistical tools, computations as well as reports.

Course Learning Objectives:

The major purpose of this course is:

1. to acquaint themselves about the concept and principles of taxation, auditing, processes and assurance standards;
2. to prepare students to understand the nature and objectives of taxation and audit;
3. to make them appreciate the general practices so as to confirm the successful management and leadership of profit- and not-for profit organizations in a changing environment;
4. to provide a range of knowledge, skills, attitudes and problem-solving abilities to enable the student respond to the need for successful management and leadership.

Course Outcomes:

COs	After the completion of the course the student will be able to	Bloom's Cognitive level	Descriptor
CO1	Demonstrate an understanding of the nature and scope of taxation and auditing.	2	Understanding
CO2	Identify the regulatory framework of taxation and auditing and related services.	3	Applying
CO3	Analyze the stages of an audit and methods of gathering audit evidences.	4	Analyzing

CO4	Perceive the knowledge about Computation of Income, Submission of Income Tax Return, Advance Tax, and Tax deducted at Source, Tax Collection Authorities under the Income Tax Act, 1961.	5	Evaluating

Teacher Assessment:

Assessment	**Weightage (Marks)**
End Semester Evaluation (ESE)	100

Course Contents:

Unit 1: Introduction of Income Tax: Meaning, features and contribution to public revenue, Important definitions - income, gross total income, computation of gross total income, total income, previous year and assessment year, agriculture income, exempted income, carry forward and set off of losses, clubbing of income, Deductions from gross total income, Determination and tax incidence of residential status.	**8 Hrs**
Unit 2: Computation and taxable income from 'Salary' head, Computation of taxable income from 'House Property' head. Computation of taxable income from 'Business or Profession' head.	**6 Hrs**
Unit 3: Capital Gains: Short term and Long term, exemption from capital gains, computation of capital gains/loss, Computation of taxable income under the head "Income from other sources".	**6 Hrs**
Unit 4: Introduction: Meaning and Objectives of Auditing. Types of Audit, Internal Audit, Audit Process: Audit Programme, Audit and book, working papers and evidence, Preparation before commencing of Audit.	**6 Hrs**
Unit 5: Internal Check System: Routine Checking, Internal Check andTest Checking, Internal Control and Audit Procedure. Vouching, Verification of Assets and Liabilities.	**6 Hrs**
Unit 6: Company audit: Appointment of auditor, Powers, Duties and Liabilities. Divisible Profits and Dividend. Auditor's report: Cleaned and Qualified report. Investigation: Objectives, Difference between audit and investigations, Process of Investigation, Special audit of Banking Companies, Educational, Non Profit Institutions and Insurance Companies.	**8 Hrs**

Textbook and References

1. Alvin A. Arens et al: Auditing and assurance services, an integrated approach, 12th edition, Pearson Prentice Hall, New Jersey (2008).
2. Chandra Mahesh and Shukla D.C.: Income Tax Law and Practice; Pragati Publications, New Delhi.
3. Dinker Pagare• Income Tax Law and Practice: Sultan Chand & Sons, New Delhi.
4. Girish Ahuja and Ravi Gupta: Systematic approach to income tax: Sahitya Bhawan Publications, New Delhi.

Title of the Course: Bioseparations **Course Code: UBTPC0601**	**L**	**T**	**P**	**Credit**
	3	**-**		**3**
Course Pre-Requisite: Biochemistry, Fluid Mechanics, Mechanical Operations, Bioprocess Calculations, Heat and Mass Transfer, Biological Thermodynamics				

Course Description: This course emphasizes the downstream purification processes of products which is a continuation of the course on Fermentation Technology. The first unit describes the biomass removal methods such as centrifugation and filtration followed by bulk impurity isolation operations such as precipitation, adsorption and fine purification operations such as chromatography and membrane separations. The last unit briefs about finishing and formulation steps after purification.

Course Objectives:

1. To understand the overall stages of bioseparations for different bio-products purifications
2. To understand solid liquid separations for biomass isolations, bulk impurity isolation and fine purification operations for the bio-product
3. To know about the finishing, filling and formulations of the products

Course Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Taxonomy	
		Level	Descriptor
CO1	Explain process design of filtration and centrifugation	2	Understanding
CO2	Choose the bulk isolation operation	3	Applying
CO3	Examine the type of fine purification methods	4	Applying
CO4	Summarize the finishing, formulations and filling processes	2	Understanding

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	2									3	
2	3	3	1	3								3	3	
3	3	3	1	3								3	3	
4	2		3			1							2	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 units)
ESE: Assessment is based on 100% course content with60 -70% weightage for course content (normally last three units) covered after MSE.

Unit 1: Filtration and Centrifugation Conventional filtration versus depth filtration, Basic theory of filtration, Types of filtration processes, Types of filtration equipment, Process time and filter area calculations, Scale up Theory of sedimentation, Equipment for sedimentation, Relative centrifugal field, Types of centrifugation, Types of centrifuges, Performance equation of centrifuges, Sigma factor based scale up	**10 Hrs.**
Unit 2: Precipitation Chemistry of dissolution versus precipitation, Difference between crystallization and precipitation, Types of precipitation (using salts, using organic solvents, using acid/alkali, using electrolytes, using non ionic polymers), Precipitation Equipment, Precipitation yield calculations	**5 Hrs.**
Unit 3: Adsorption Chemistry of adsorption, Nature of adsorbents, Batch adsorption, Adsorption isotherms (Linear, Freundlich, Langmuir) and their use, Continuous adsorption (Adsorption in CSTR, Adsorption in fixed beds/ Frontal adsorption and its use)	**7 Hrs.**
Unit 4: Chromatography Planar chromatography (paper and thin layer) , Column chromatography Basic terms (Partition coefficient, Capacity factor, Retention time, relative retention, resolution, theoretical plates) , Principles and case studies on Normal phase chromatography, Ion exchange chromatography, Adsorption chromatography, Reverse phase chromatography, Hydrophobic interaction chromatography, Affinity chromatography, Gel-filtration chromatography) Analytical chromatography versus preparative chromatography	**11 Hrs.**
Unit 5: Membrane separations Classification of membranes processes (micro-filtration, ultra-filtration, diafiltration, nano-filtration, reverse osmosis) and their modes (TFF v/s NFF), Structure and preparation of membranes, Types of membrane modules, Effects of parameters on flux, Important practical concepts (Concentration polarization, fouling, mass flux, permeate flux (LMH), retention/ rejection coefficient, sieving coefficient, pressure drop , transmembrane pressure, concentration factor, NWP, NMWCO), time and area calculations, Membrane system scale up	**8 Hrs.**
Unit 6: Finishing, Formulations and Filling Finishing operations for drug substance (Buffer exchange, Concentration adjustments for liquid forms, Crystallization/Drying/Lyophilization for solid forms) , Different Formulations of API, Sterile filtration and filling of final drug substance, Packaging	**4 Hrs.**

Textbooks and Reference Books :

1. Bioseparations - Belter P.A., Cussler E.L., Hu Wei-Shou (Wiley Publication)
2. Bioseparations - Shivshanker B. (Prentice Hall of India)
3. Bioseparation Science and Engineering – Harrison R.G., Todd P., Rudge S.R., Petrides D.P.
   (Oxford University Press)
4. Product recovery in bioprocess technology – Biotol Series (Butterworth-Heinemann Ltd.)
5. Protein Purification: Principles and Practice - Scopes Robert K. (Springer – Verlag Pub.)
6. Separation processes in Biotechnology –Asenjo J.A. (Taylor and Francis Group)
7. Separation and Purification Techniques in Biotechnology – Dechow F.J. (Noyes Pub.)
8. Transport Processes and Separation Process Principles - Geankoplis Christie John (Prentice Hall of India)
9. Unit Operation of Chemical Engineering - McCabe W. L., Smith J., Harriot P.(McGraw-Hill Pub.)
10. Downstream Processing in Biotechnology – Anuj Kumar Rana (Global Vision Pub.)

Title of the Course: Process Calculations **Course Code: UBTPC0602**	**L**	**T**	**P**	**Credit**
	3	**-**		**3**

Course Pre-Requisite: Basics of mathematics units and conversions, heat and mass transfer.

Course Description: The course will cover concepts ranging from basics such as units and dimensions, stoichiometry to the simultaneous application of material and energy balances with and without occurrence of biochemical reaction.

Course Objectives:

1. To explain the general theory of material balance.
2. To discuss the basic principles of mass and energy balances for reactions with and without reaction.
3. To compute mass and energy balance on various processes with and without reaction.
4. To explain the general theory of unsteady state material and energy balances

Course Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Taxonomy	
		level	Descriptor
CO1	Recall different units and conversions in bioprocess calculations.	2	Understanding
CO2	Apply material balance fundamentals for different unit processes.	3	Applying
CO3	Apply energy balance for different unit processes	3	Applying
CO4	Analyze material and energy balance for unsteady state processes	5	Analyzing

CO-PO-PSO Mapping:

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

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 with60 -70% weightage for course content (normally last three modules) covered after MSE.

Unit 1: Introduction to Engineering Calculations Units and Conversions, Density, Specific Gravity; specific volume , Mole Concept, chemical composition, Pressure, Temperature, std. Conditions, physical and chemical data, stoichiometry, atomic mass, molar mass, Equivalent mass, Normality, Molarity, Molality.	**7 Hrs.**
Unit 2: Material Balances without Biochemical Reaction Material balances, Thermodynamic Preliminaries, Law of Conservation of Mass, Procedure for Material-Balance Calculations, Material-Balance for industrially important operations continuous filtration, batch mixing, extraction, drying	**7 Hrs.**
Unit 3: Material Balances with Biochemical Reaction Definition of terms involved, guidelines for solving problems, Material-Balance for industrially important operations: continuous acetic acid fermentation, Xanthan gum production, Material Balances with Recycle, By-Pass and Purge Streams, Stoichiometry of Growth and Product Formation	**8 Hrs.**
Unit 4: Energy Balance without reaction Basic Energy Concepts, General Energy-Balance Equations, Enthalpy Calculation Procedures, Enthalpy Change in Non-Reactive Processes, Procedure for Energy-Balance Calculations without Reaction, Energy-Balance for industrially important operations: Continuous waterheater, cooling in downstream processing	**7 Hrs.**
Unit 5: Energy Balance with reaction Enthalpy Change Due to Reaction, Heat of Reaction For Processes With Biomass Production, Energy-Balance Equation For Cell Culture, Energy-Balance for industrially important operations: Continuous ethanol fermentation, Citric acid production.	**8 Hrs.**
Unit 6: Unsteady state material and energy Balance Unsteady-State Material-Balance Equations, Unsteady-State Energy-Balance Equations, Unsteady-State Mass Balance for industrially important operations: CSTR, Unsteady-State Energy Balance for industrially important operations: solvent heater	**8 Hrs.**

Textbooks and references:

1. Bioprocess Engineering Principles-, Pauline Doran. (Academic Press).
2. Stoichiometry -Bhat B.I and S.M.Vora .(Tata McGraw Hill).
3. Basic Principles and Calculations in Chemical Engineering David .Himmelblau. (Prentice Hall of India Pvt Ltd).
4. Bioprocess Engineering: Basic Concepts Michael Shuler and FikretKargi. (Prentice Hall), Kogakusha Ltd. 1998.
5. Chemical Process Principles -A.Hougen, K.M.Watson and R.A.Ragatz. (John Wiley and Asia Publishing Co.).
6. Elementary Principles of Chemical Processes. Richard Felder and Ronald W.Rausseau. (John Wiley & Sons)

Title of the Course: Bioprocess Equipment Design **Course Code: UBTPC0603**	**L**	**T**	**P**	**Credit**
	2	**-**		**2**

Course Pre-Requisite: Unit Operations, Fermentation Technology, Fluid Mechanics

Course Description: The objective of this course is to provide biotechnology engineering students the basic principles of equipment design.

Course Objectives:

1. To explain the codes and standards for the mechanical design of equipment.
2. To analyze design procedures for commonly used process equipment.
3. To design different bioprocess equipment.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Taxonomy	
		level	Descriptor
CO1	Explain the codes and standards for the mechanical design of Bioprocess equipment.	2	Understanding
CO2	Explain the need of understanding design parameters.	2	Understanding
CO3	Illustrate design procedures for bioprocess equipment	4	Analyzing
CO4	Estimate the design parameters for bioprocess equipment	5	Evaluating

CO-PO-PSO Mapping:

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

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 two modules)
ESE: Assessment is based on 100% course content with 60 -70% weightage for course content (normally the last two modules) covered after MSE.

Unit 1: Design preliminaries: Design codes, Mechanical Properties of Materials, design pressure, design temperature, design stress and factor of safety, corrosion allowance, Weld joint efficiency factor, Design Loadings.	**7 Hrs.**
Unit 2: Design of pressure vessels: Classification of pressure vessels, Pressure Vessel Codes & Standards, selection of material, Design of Shell & its components, process hazards and safety measures in equipment design.	**8 Hrs.**
Unit 3: Design of Reactor: Introduction, classification of reaction vessels, heating system: jackets and coils, types of agitators, Design of agitator system components	**7 Hrs.**
Unit 4: Design of Heat Exchanger: Introduction, types of heat exchanger, design of shell & tube heat exchanger- shell, tube, tube sheet, baffles.	**8 Hrs.**

Textbooks & References:

1. Introduction to chemical equipment design B. C. Bhattacharya-.CBS Publisher and distributor, Pvt.Ltd.
2. Joshi's Process equipment design, V.V. Mahajani and S.B. Umarji, Trinity Press, ISBN: 9789351380191
3. Chemical Engg. Design, Vol. 2 & 6 Coulson J. M. and Richardson J. F (Pergaman Press)
4. Process Design of Equipment, Dr. S.D. Dawande, 1st Edition, (Central Techno Publication)
5. Fundamentals of Equipment Design, A. K. Koker, (Gulf Publication)
6. Process Heat Transfer, D.Q. Kern, (Tata McGraw Hill Company, New York).

Title of the Course: Plant Biotechnology (PE- II) Course Code: UBTPE0611	L	T	P	Credit
	3		-	3

Course Pre-Requisite: Basics of Plant Tissue Culture, molecular Biology and Genetic engineering

Course Description:

This course deals with DNA isolation and transfer to plants and animals and production of transgenic animals and plants

Course Learning Objectives:

1. To impart knowledge on production of transgenic plants
2. To make the students understand the concepts and applications
3. To **e**xplain economic and regulatory considerations of plant genetic engineering
4. To

Course Outcomes:

CO		Bloom's Taxonomy	
		level	Descriptor
CO1	Illustrate plant tissue culture and plant DNA transformation processes	2	Understanding
CO2	Explain the preparation of transgenic plants	2	Understanding
CO3	Explain economic considerations of plant genetic engineering	2	Understanding
CO4	Explain regulatory considerations of plant genetic engineering	2	Understanding

CO-PO-PSO Mapping:

COs	POs											PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2											3		2
2	2											3		3
3	2		1			3	3	3				**3**		3
4	2											**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 the last three modules) covered after MSE.

Unit 1 Plant Genomes and Plant Tissue Culture Introduction-gene structure and gene expression-regulation, implication for plant transformation,-Protein targeting, heterologous promoters, genome size and organization, Arabidopsis and new technologies. Plant tissue culture plasticity and totipotency, culture environment, growth regulators, media regulators, culture types, plant regeneration.	**8 Hrs.**
Unit 2 Plant Transformation Techniques Introduction- Agrobacterium mediated gene transfer –Ti-plasmid-process of T-DNA transfer and integration, transformation in plant, Direct gene transfer methods. Binary vectors- basic features of vectors-optimization-clean gene technology.	7 **Hrs.**
Unit 3 Transgenic Plants-Herbicide and Pest Resistance Herbicide resistance-use of herbicide in modern agriculture-strategies for engineering herbicide-Resistance environment impact, pest resistance-nature and scale of insect / pest damage to crop-GM strategies-Bt approach to insect resistance-copy nature strategy-insect resistant crops and food safety.	7 **Hrs.**
Unit 4 Plant Disease Resistance and Stress Tolerance Introduction-plant-pathogen interactions-natural disease resistance pathways-biotechnological -Approaches to disease resistance. Plant viruses-types-entry and replication-transgenic approach-PDR Stress tolerance-abiotic stress-water deficit stress and various approaches for tolerance.	**10 Hrs.**
Unit 5 Molecular Farming And Gm Crops Future Prospects - I Introduction-carbohydrates and lipids production-molecular farming of proteins-economic considerations for molecular farming. Recent case studies based on Molecular Farming.	**7 Hrs.**
Unit 6 Molecular Farming And Gm Crops Future Prospects -II GM crops-current status-concerns about GM crops- regulations of GM crops and products-Greener genetic engineering. Recent case studies based on Plant Biotechnology.	**6 Hrs.**

Textbooks and references:

Textbooks and references:

1) Plant Biotechnology-The genetic manipulation of plants. Adrian Slater, NigelW.Scott and MarkR. Fowler. Oxford university press, pg-341.
2) Plant Cell Culture Protocols, Robert P. Adams, Humana Press, 2015.
3) Plant Biotechnology: Principles and Applications, P. S. Srivastava, Springer, 2021.
4) Plant Tissue Culture: Methods and Applications, S. K. Gupta and S. K. Jain, Wiley, 2017.
5) Plant Cell Culture: Essential Methods, Sarah Robinson and Karen A. Michael., Wiley-Blackwell, 2018.
6) Handbook of Plant Cell Culture, S. M. Jain, P. K. Gupta and R. L. J. A. S. S., Springer, 2014.

Title of the Course: Bioprocesses	L	T	P	Credit
Course Code: UBTPE0612	3	-	-	3

Course Pre-Requisite: Microbiology, biochemistry, Metabolic pathway, Fermentation technology, Bioseparations, Equipment design

Course Description: Production of each bio-product to be discussed with respect to History, microorganisms used, biosynthetic pathway, upstream process details, recovery and discussion of flow sheet

Course Learning Objectives:

To explain various strains, their improvements and upstream processing for different bioproducts
To illustrate downstream processing for different bioproducts
To construct process flow sheet for industrial production

Course Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Taxonomy	
		Level	Descriptor
CO1	Explain the host strain improvements with their impact on bioprocesses	2	Understanding
CO2	Illustrate upstream processing for different bioproducts	2	Understanding
CO3	Illustrate downstream processing for different bioproducts	2	Understanding
CO 4	Construct process flow sheet for industrial production	3	Applying

CO-PO-PSO Mapping:

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

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester 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 with60-70% weightage for course content (normally last three modules) covered after MSE.

UNIT: 1 PRODUCTION OF INDUSTRIAL CHEMICALS Fermentative production of Organic acids: --Lactic acid, Citric acid, Acetic acid, Gallic acid Production of Organic solvents:-Ethanol, Acetone-Butanol, Glycerol	**7 Hrs**
UNIT: 2 HEALTH CARE PRODUCTS Fermentative production of antibiotics: Penicillin, Streptomycin Steroid fermentation: Biotransformation	**6 Hrs**
UNIT: 3 PRODUCTION OF INDUSTRIAL BIOCHEMICALS Production of Enzymes: Lipases, α–Amylases, Glucose isomerases, Proteases Production of Biosurfactants: Xanthan	**9 Hrs**
UNIT: 4 PRODUCTION OF FINE CHEMICALS Fermentative production of Amino Acid:L-glutamic acid, L-Phenylalanine, L- lysine, L- tryptophan Fermentative production of Vitamins: Vitamin B12, Vitamin C, Riboflavin. Production of pigments: Anthocyanins	**9 Hrs**
UNIT: 5 PRODUCTION OF FOOD AND BEVERAGES Production of Single Cell Protein (SCP), Production of baker's yeast Alcoholic beverages: Beer, Wine, Whisky	**7 Hrs**
UNIT: 6 PRODUCTION OF AGRICULTURAL PRODUCTS Production of Bio fertilizers and Bio pesticides, Biogas production from municipal sewage	**7 Hrs**

Text and Reference books:

1 Comprehensive Biotechnology: Vol 3- M. M. Young. (Pergamon Press, Oxford)
2. A textbook of Industrial Microbiology: second edition- Wulf Crueger & Anneliese Cruger (Panima Publishing Corporation)
3 Biotechnology- KeshavTrehan (New Age International Pvt. Ltd)
4. Process Biotechnology Fundamentals- S.N. Mukhopadhyay, I. Campbell, F.G. Priest (Viva Books Ltd)
5. Industrial microbiology – Prescott & Dunn (Agrobios)
6. Microbiology for Sanitary Engineers – McKinney, Ross. E. (McGraw-Hill)
7. Safety in Microbiology- D.A. Shapton and R.G Board (Academic Press, London)
8. Modern Concepts of Biotechnology- H.D. Kumar (Vikas Publishing house Pvt. Ltd)
Process Biotechnology fundamentals – Mokhopadhyay S. N. (Anshan Publishers)

Title of the Course: Biotech Industry: Practices and Entrepreneurship **Course Code: UBTEM0601**	**L**	**T**	**P**	**Credit**
	2	**-**		**2**

Course Prerequisite: Industrial Organization and Management

Course Description: The objective of this course is to provide biotechnology engineering students with knowledge of the industrial environment and entrepreneurial opportunities.

Course Objectives:

1. To make the students learn the principles of Bio business management.
2. To motivate the students to explore various entrepreneurial opportunities.
3. To enable the students, understand the concepts of marketing management as a part of practices in industries.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Taxonomy	
		level	Descriptor
CO1	Explain different internal and external factors affecting bio-business.	2	Understanding
CO2	Explain the importance of entrepreneurship	2	Understanding
CO3	Summarize different supports provided by the government to start small scale industries.	2	Understanding
CO4	Illustrate the need to understand marketing management principles to achieve best practices in biotech industries.	4	Analyzing

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		1	
2								3	3	3	3		1	
3								3	3	3	3		1	
4								3	3	3	3		1	

Assessments: Teacher Assessment:

ESE: Assessment is based on 100% course content

Assessment	**Marks**
ESE	50

Unit 1: Bio-business Environment - Introduction to bio-business, Indian context of bio-business, internal environment, external environment- micro environment and macro environment, Globalization.	**7 Hrs.**
Unit 2: Entrepreneurship: concept of entrepreneurship, Functions of an entrepreneur, types of entrepreneurships, qualities required to become entrepreneur, types of entrepreneurs, factors conducive for promoting entrepreneurship, reasons of entrepreneurial failure.	**8 Hrs.**
Unit 3: Entrepreneurship Development: Introduction, objectives, entrepreneurship development training, stages in EDP training, Small Scale Industries- definition, procedure to start small scale industry.	**7 Hrs.**
Unit 4: Marketing Management: Definition, marketing concepts, selling concept, marketing research procedure, market research approaches, **Advertising** - definition, objectives, benefits, drawbacks of advertising, advertising mediums.	**8 Hrs.**

Textbooks and References:

1. Industrial and business Management, M.T. Telsang, (S. Chand and Co. New Delhi)
2. Organizational Mgmt. and Behavior- N. K. Hukkeri, (Electrosted publication. Satara)
3. Management- James A. F. Stoner, R. Edward Freeman, (Prentice Hall of India, New Delhi)
4. Management Today- principles and practice- Burton and Thakur (TATA McGraw Hill Pub. New Delhi)
5. Economics-Benham, F., (Sir Issocpitham and Sons Ltd., London)
6. Principles of Economics- Seth M. L., (L. N. Agarwal Pub., Agra)
7. Essentials of Management, Harold Koontz, Heinz Weihrich. (McGraw-Hill

Title of the Course: Bioseparations Laboratory **Course Code: UBTPC0631**	**L**	**T**	**P**	**Credit**
	-	**-**	**2**	**1**

Course Pre-Requisite: Solution Preparations, Process Calculations

Course Description: Bioseparations laboratory course includes practical based on extraction, precipitation, adsorption, chromatography and membrane separations.

Course Objectives:
To understand the principle and methodology of purification and analysis of the product.

Course Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Taxonomy	
		level	Descriptor
CO1	Demonstrate the chromatographic techniques for the purification of bio-products	2	Understanding
CO2	Analyze different unit operations involved in purification of bio-products	4	Analyzing

CO-PO-PSO Mapping:

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

Assessments:

One component of In Semester Evaluation (ISE) and one component of End Semester Evaluation (Practical and Oral Examination).

Assessment Component	Marks
ISE	25
ESE (POE)	25

ISE is based on weekly performance, journal reports and quizzes etc.

Experiment No. 1: Single stage and multistage extraction studies Aim and Objectives: To compare the performance of single stage versus multi-stage extraction process	**2 Hrs.**
Experiment No. 2: Phyto-extraction using Soxhlet and vacuum evaporation Aim and Objectives: To extract phyto-constituents by leaching process using Soxhlet apparatus and quantify the product	**2 Hrs.**
Experiment No. 3: Aqueous two-phase extraction Aim and Objectives: To select aqueous two-phase extraction system and calculate partition coefficient	**2 Hrs.**
Experiment No. 4: Isoelectric point precipitation Aim and Objectives: To precipitate casein from milk using Isoelectric point precipitation	**2 Hrs.**
Experiment No. 5: Salt precipitation / Organic solvent precipitation Aim and Objectives: To determine the best salt/organic solvent concentration to precipitate protein maximally	**2 Hrs.**
Experiment No. 6: Study of adsorption isotherm Aim and Objectives: To determine the static binding capacity of the product on given adsorbent matrix	**2 Hrs.**
Experiment No. 7: Study of column adsorption (breakthrough curve) Aim and Objectives: To determine the dynamic binding capacity of the product on given adsorbent matrix	**2 Hrs.**
Experiment No. 8: Ion exchange chromatography Aim and Objectives: To purify the protein of interest by ion exchange chromatography	**2 Hrs.**
Experiment No. 9: Affinity chromatography Aim and Objectives: To purify the protein of interest by affinity chromatography	**2 Hrs.**
Experiment No. 10 : Gel filtration chromatography Aim and Objectives: To purify the protein of interest by gel filtration chromatography	**2 Hrs.**
Experiment No. 12: Reverse phase chromatography Aim and Objectives: To purify the protein of interest by reverse phase chromatography	**2 Hrs.**

Textbooks and Reference Books :

1. Bioseparations - Belter P.A., Cussler E.L., Hu Wei-Shou (Wiley Publication)
2. Bioseparations - Sivsanker B. (Prentice Hall of India)
3. Bioseparation Science and Engineering – Harrison R.G., Todd P., Rudge S.R., Petrides D.P.
(Oxford University Press)
4. Product recovery in bioprocess technology – Biotol Series (Butterworth-Heinemann Ltd.) 5. Protein Purification: Principles and Practice - Scopes Robert K. (Springer – Verlag Pub.)
6. Separation processes in Biotechnology –Asenjo J.A. (Taylor and Francis Group)
7. Separation and Purification Techniques in Biotechnology – Dechow F.J. (Noyes Pub.)
8. Transport Processes and Separation Process Principles - Geankoplis Christie John (Prentice Hall
of India)
9. Unit Operation of Chemical Engineering - McCabe W. L., Smith J., Harriot P.(McGraw- Hill
Pub.)
10. Downstream Processing in Biotechnology – Anuj Kumar Rana (Global Vision Pub.)

Title of the Course: Bioprocess Equipment design Laboratory **Course Code: UBTPC0632**	**L**	**T**	**P**	**Credit**
	-	**-**	**2**	**1**
Course Pre-Requisite: Knowledge of equipment used in Bioprocess Industries				

Course Description: This course contains drawings of equipment symbols, instrument symbols, stream designations, P&IDs, different parts of equipment.

Course Objectives:

1. To show different equipment symbols, instruments symbols, stream designations.
2. To design parts of the reactor and heat exchanger.
3. To develop standard P&IDs based on process requirements.

Course Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Taxonomy	
		level	Descriptor
CO1	Outline different equipment symbols, instruments symbols, stream designations	2	Understanding
CO2	Interpret standard P&IDs based on process requirements	2	Understanding
CO3	Design parts of bioprocess equipment.	4	Analyzing

CO-PO-PSO Mapping:

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

Assessments: Teacher Assessment:

In Semester Evaluation (ISE) and End Semester Examination (ESE-OE) 25 marks each will be taken.

Assessment	Marks
ISE	25
ESE(OE)	25

ISE are based on practical performance/ Quiz/Internal oral etc.
ESE-OE –Assessment based on external oral examination

Experiment No. 1: Equipment Symbols Aim: To Draw Equipment Symbols used in flowsheet synthesis Objective: To understand various Equipment Symbols used in flowsheet synthesis	**2 Hrs**
Experiment No. 2: Instrument Symbols and stream Designation Aim: To Draw Instrument Symbols and learn stream Designations used in flow sheet synthesis. Objectives: To understand various Instrument Symbols and learn stream Designations used in flow sheet synthesis	**2 Hrs**
Experiment No. 3: Piping and Instrumentation Diagram Aim: To Draw and understand the importance of Piping and Instrumentation Diagram used in flowsheet synthesis. Objectives: To understand various Piping and Instrumentation Diagram used in flow sheet synthesis	**2 Hrs**
Experiment No. 4: Types of Agitators Aim: To Draw and understand the importance of different types of agitators used in the bioprocess industry. Objectives: To understand various types of agitators used in the bioprocess industry.	**2 Hrs**

Experiment No. 5: Components of Reaction Vessel Aim: To Draw and understand the importance of Components of Reaction Vessel Objectives: To understand various Components of Reaction Vessel	**2 Hrs**
Experiment No. 6: Components of Shell and Tube Heat Exchanger Aim: To Draw and understand the importance of Components of Shell and Tube Heat Exchanger Objectives: To understand various Components of Shell and Tube Heat Exchanger	**2 Hrs.**
Experiment No. 7: Design of Reaction Vessel Aim: To Draw and understand the importance and calculations for design of Reaction Vessel Objectives: To understand various parts and their dimensions calculations of Reaction Vessel	**2 Hrs.**
Experiment No. 8: Design of Heat Exchanger Aim: To Draw and understand the importance and calculations for design of Heat Exchanger Objectives: To understand various parts and their dimensions calculations of Heat Exchanger	**2 Hrs.**

References:

1. Process Design of Equipment ,Dr. S.D. Dawande, 1st Edition, (Central Techno Publication)
2. Fundamentals of Equipment Design, A. K. Koker, (Gulf Publication)
3. Process Heat Transfer, D.Q. Kern (Tata Mc-Graw Hill Company, New York).
4. Applied Process Design for Chemical and Petrochemical Plants, E.E. Ludwig, Vol. I, II, III,3rd edition London, 1994 (Gulf Publication)
5. Plant Design and Economics for Chemical Engineers M.S. Peters & K.D. Timmer Haus", 5th edition, (McGraw Hill International Book Co)

Title of the Course: Effluent Treatment Lab	L	T	P	Credit
Course Code: UBTPC0633	-	-	2	1

Course Pre-Requisite:
Biochemistry, Microbiology, Fermentation technology

Course Description:
This includes theoretical understanding of waste management and waste treatment.

Course Learning Objectives:

1. To examine physical and chemical quality of drinking water and effluent
2. To examine biological quality of drinking water and effluent

Course Outcomes:

CO's	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Examine physical and chemical quality of drinking water and effluent	4	Analysing
CO2	Examine biological quality of drinking water and effluent	4	Analysing

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
CO1	2			2		3	3				3			3
CO2	2			2		3	3				3			3

Assessment Scheme:
Two components of In Semester Evaluation (ISE)

Assessment	Marks
ISE	25

Course Contents:

Experiment No. 1: BOD test Aim and Objectives: To perform BOD test.	**5 Days**
Experiment No. 2: COD test Aim and Objectives: To perform COD test.	**2 Hrs**
Experiment No. 3: MPN test Aim and Objectives: To perform MPN test.	**2 Hrs**
Experiment No. 4: Confirmed test**.** Aim and Objectives: To perform Confirmed test.	**2 Hrs**
Experiment No. 5: Completed test (IMViC) Aim and Objectives: To perform Completed test.	**2 Hrs**
Experiment No. 6: Alkalinity test Aim and Objectives**:** To perform Alkalinity test.	**2 Hrs**
Experiment No. 7: Phosphorus test Aim and Objectives: To perform Phosphorus test.	**2 Hrs**
Experiment No. 8: TKN test Aim and Objectives: To perform TKN test.	**2 Hrs**
Experiment No. 9: Acidity test Aim and Objectives: To perform Acidity test.	**2 Hrs**

Experiment No. 10: Determine Solids in waste. Aim and Objectives: Determine Solids in waste.	**2 Hrs**
Experiment No. 11: Membrane filtration technique Aim and Objectives: Perform Membrane filtration technique for isolation of MO in effluent	**2 Hrs**
Experiment No. 12: Total plate count Aim and Objectives: Perform Total plate count for isolation of MO in effluent	**2 Hrs**

Reference books:

1. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003.
2. E.W. Rice, R.B. Baird, A.D. Eaton, L.S. Clesceri, "Standard Methods for the Examination of Water and Wastewater", 22nd Edition
3. Microbiological Examination Methods of Food and Water: A Laboratory Manual neusely da Silva et. al. CRC Press; 1 edition
4. Waste Water TreatmentM N Rao and A K Datta OXFORD & IBH PUBLISHING1 January 2020 ; 3 edition
5. WASTEWATER TREATMENT: Concepts and Design Approach

G. L. KARIA, R.A. CHRISTIAN PHI Learning Pvt. Ltd., 02-Apr-2013PHI publication ; 2nd Edition

6. Manual of Water Supply and Treatment (3rd ed)- Ministry of Urban Development, New Delhi, 1991

Title of the Course: Co -Curricular Activities-I/ II/ III/ IV **Course No.: UUBTCC0634**	**L**	**T**	**P**	**Credits**
	---	**---**	**2**	**1**

Course Pre-Requisite:

None: This course is open to all second-year engineering students interested in enhancing their personal and professional development through co-curricular activities.

Course Description:

Co-Curricular activities are an integral part of curriculum which provides educational activities to the students and thereby help in broadening their experiences. Co-Curricular activities can be defined as the activities that enhance and enrich the regular curriculum during the normal college hours. All Co-Curricular activities are organized with specific purpose which may according to the nature and form of activities. This course introduces students to a variety of co-curricular activities aimed at enhancing their professional and personal development within the field of engineering and technology. Through practical projects, competitions, workshops, and community engagement, students will develop teamwork,
leadership, communication, and technical skills essential for success in their careers.

Course Learning Objectives (CLOs):

1. To encourage students to showcase their intellectual and independent thinking skills.
2. To imbibe a sense of confidence and managerial capabilities among students.
3. To promote the ability to work in team, organize and analyse available resources.
4. To build responsiveness among students about the social and cultural responsibilities.

Course Outcomes (COs):

At the end of the course students will be able to:

CO1:	**Demonstrate** the ability to critically analyse information and apply independent judgment in decision-making within the context of the activity.
CO2:	**Apply** principles of management and organizational skills to plan, coordinate, and execute tasks related to the co-curricular activity.
CO3:	**Collaborate** effectively with peers to achieve common goals and objectives within the co-curricular activity.
CO4:	**Reflect** on their roles and responsibilities as members of a diverse community, fostering empathy and inclusivity.

Assessments:

Assessment	Marks
ISE	50

ISE: Assessment is based on the student's participation in various Co-Curricular Activities and Guidelines given in "Rules for Assigning Activity Points: Activity – Event Grade Point Scheme" Policy Document.

Course Guidelines:

1. Students are entitled to gain academic knowledge in this fast-paced environment, but it is also necessary for them to develop their personalities in both internal and external situations.
2. Co-curricular activities help students grow and develop their personalities. These activities contribute to a student's total personality development.
3. Not every student is intellectually inclined. Similarly, not all pupils are interested in co-curricular activities. Therefore, there is a need to provide a solid balance of co-curricular and extra-curricular activities in order to achieve the course learning objectives.
4. It primarily refers to intellectual, physical, emotional, and social growth that can be attained by a careful mix of academic, co-curricular, and extra-curricular activities.
5. So, keeping the course learning objectives the "Rules for Assigning Activity Points: Activity – Event Grade Point Scheme" Policy Document is proposed.

6. Student participation is assessed and reflected in the final activity performance report in order to get most students involved in extra-curricular activities (Group A) and co-curricular activities (Group B) as shown in Table 1 in the Policy Document.
7. All undergraduate students must choose at least ONE activity/event from each group i.e. (Group A and B).
8. Students shall choose one activity/ event from Group A and One from Group B that take place on- campus or off-campus.
9. Freedom shall be given to the students to take part in more than one activity under the group.
10. Students are expected to actively participate in activities, participate in contests, and earn grade points.
11. One student in each group must earn up to 50 grades in one semester so that they can achieve up to 100 grades in one year.
12. Grades for each semester are awarded based on the points achieved by the student, as shown in Table 2 in the Policy Document.

Course Structure: ***(Refer Rules for Assigning Activity Points: Activity – Event Grade Point Scheme)***

Sr. No.	Initiatives	Criteria, Activities and Assignments
1	Introduction to Co-Curricular Activities	Orientation, Induction, Course Overview
2	National Initiatives Participation	Participation, Achievement Levels and Assigned Activity Points in NCC, NSS, Unnat Bharat/ Unnat Maharashtra Abhiyan, Ek Bharat Shreshtha Bharat (EBSB)
3	Sports and Games Participation	Participation, Achievement Levels and Assigned Activity Points in Sports and Games
4	Cultural Activities Participation	Participation, Achievement Levels and Assigned Activity Points in Music, Performing Arts, Literary Arts

5	Professional Self Initiatives	Participation, Achievement Levels and Assigned Activity Points in 1. Technical Events/Quiz/Paper Contest/Project Contest / Model Making etc. 2. MOOC/ NPTEL/ SWAYAM/ Coursera etc. 3. Competitions/ Events Conducted by Professional Societies (ISTE, IEI, CSI, IEEE, IETE, SAE, ISRO-IIRS, SWE, ISHRAE, ASM, ISNT etc.) 4. Attending Full time Conference/ Seminars/ Exhibitions/ Workshop/ STTP Conducted at IITs/ NITs/ Reputed Institutes/ Universities 5. Attending Full time Conference/ Seminars/ Exhibitions/ Workshop/ STTP Conducted at KITCoEK 6. Paper Presentation in National/ International Conference of High Repute 7. Poster Presentation in National/ International Conference of High Repute 8. Paper Publication in National/ International Journal of High Repute 9. Industrial Training/ Internship (at least for 04 Weeks) 10. Participation in Institute Level Student Clubs
6	Entrepreneurship and Innovation	Participation, Achievement Levels and Assigned Activity Points in 1. Prototype Developed and Tested 2. Awards for Products Developed 3. Innovative Technologies Developed and Used by Industries 4. Got Funding from Government/ Industry for Innovative Ideas 5. Patent-Filed/ Published/ Approved/ Licensed 6. Social Innovation

7	Leadership & Management of Clubs/ Activities	Participation, Achievement Levels and Assigned Activity Points in 1. Elected Student Representative of Student Council (University Representative, General Secretary, Cultural, Sports, NSS Secretary, Ladies Representative, Academic Toppers, Invitee Members) 2. Office Bearer of Professional Society Chapter (ISTE, IEI, CSI, IEEE, IETE, SAE, ISRO-IIRS, SWE, ISHRAE, ASM, ISNT etc.) 3. Office Bearer of Institute Level Student Club (Developer Student Club, Gaganvedhi, Walk With World, Team Mavericks, Cultural Club, Aura, Amateur Write Club, Rotaract Club of KIT Sunshine, Women Development and Gender Equality Cell, Shourya, Lead India etc.) 4. Office Bearer of Departmental Student Association 5. Office Bearer of ECell, Digital Content Lab etc. 6. Student Ambassador for Mayura AICTE IDEA Lab/ NIDHI iTBI etc. 7. Editorial Board Member of Annual Magazine 8. Editorial Board Member of E-Newsletter 9. Member of Governance Committee/ Statutory Committee
8	Culminating Event and Reflection	Final Presentations, Course Reflection, Documentation, Assessment and Evaluation

Participation Levels:

1. Level: I College Level Events
2. Level: II District/ Central/ Zonal Level Events
3. Level: III State Level Events
4. Level: IV National Level Events
5. Level: V International Level Events

Approval Documents:

1. Certificate
2. Letter from Authorities
3. Appreciation recognition letter
4. Documentary evidence
5. Legal Proof

Grading Scheme:

Grade Range	Grade	Academic Performance
90-100	O	Outstanding

71 to 90	A+	Excellent
68-71	A	Very Good
65-68	B+	Good
60-65	B	Average
55-60	C	Below Average
50-55	D	Marginal
< 50	F1	Fail due to Poor Performance

Title of the Course: Mini Project IV **Course Code: UBTIL0671**	**L**	**T**	**P**	**Credits**
	-	**-**	**2**	**1**

Course Pre-Requisite: All theoretical concepts and practical skills learnt in second year courses

Course Description: Mini Project I includes a group of students working on a problem statement provided with preparation of work plan, execution and submission of a synoptic summary in the form of report.

Course Objectives: 1. To explain the approach to address the problem statement provided using the fundamental understanding of concepts.
2.To develop a plan of work based on aim and objectives finalized.
3.To elaborate the synoptic plan and executed project work effectively using oral and written means.

Course Outcomes:

COs	After the completion of the course the student will be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	To explain the approach to address the problem statement using the fundamental concepts.	2	Understanding
CO2	To develop and execute a plan of work based on objectives finalized.	3	Applying
CO3	To discuss and analyse the result and discussion of the work	3	Applying
CO4	To conclude the synoptic plan and executed project work effectively using oral and written means	3	Applying

CO-PO Mapping:

	POs											**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	3	1	3			1			3	3	3		
CO2		3	2			1			2	3	3	3		
CO3	3	3	3	3	1			1	3	3	3	3		3
CO4	3	3	3	3	1			1	3	3	3	3		3

Assessment Scheme:

One component of In Semester Evaluation (ISE) with 100% weightage

Assessment Component	Marks
ISE	25

ISE is based on rubrics based progressive report submission and presentation to supervisors.

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 basic understanding of concepts in various courses, capacity of planning and executing the application of the knowledge. Reporting the outcomes effectively. Projects Areas can be problems related to - Microbiology Biochemistry Cell Biology Molecular Biology Enzyme Technology Immunology Genetic Engineering Bioinformatics Fluid Mechanics Heat Transfer	

Title of the Course: Data Mining (MM-I) **Course Code: UBTMM0641**	**L**	**T**	**P**	**Credit**
	3			3

Course Pre-Requisite: Basic knowledge of Mathematics and Programming, Computational Statistics, Fundamentals of Data Science

Course Description: This course introduces data mining techniques and their applications in extracting meaningful patterns and insights from large datasets. The emphasis will be on association rule mining, anomaly detection, graph mining, text mining, and scalable data mining techniques relevant to biotechnology, healthcare, and bioinformatics applications

Course Objectives: After the completion of the course the student will be able to -

Course Outcomes:

CO		Bloom's Taxonomy	
		level	Descriptor
CO1	Explain the fundamental concepts of data mining and its applications in healthcare and bioinformatics.	2	Understand
CO2	Apply association rule mining and anomaly detection techniques to extract meaningful insights from datasets.	4	Apply
CO3	Analyze text mining and graph mining techniques in bioinformatics and healthcare analytics.	4	Analyze
CO4	Infer the role of scalable data mining techniques in handling large-scale datasets	2	Understand

CO-PO-PSO Mapping:

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

4	2	2		3	3	2				2	3			

Assessments: Teacher Assessment:

Assessment	Marks
End Semester Examination (ESE)	100

ESE: Assessment is based on 100% course content with 100% weightage for course content .

Unit 1: Introduction to Data Mining Definition, Need, and Challenges of Data Mining, Data Mining vs. Machine Learning, Types of Data and Data Mining Tasks, Overview of Data Mining Applications in Bioinformatics and Healthcare	**6 Hrs.**
Unit 2: Association Rule Mining Market Basket Analysis and Bioinformatics Applications, Apriori Algorithm and FP-Growth Algorithm Evaluation of Association Rules (Support, Confidence, Lift)	**8 Hrs.**
Unit 3: Anomaly Detection Techniques Outlier Detection Methods: Statistical, Distance-Based, and Density-Based Approaches, Isolation Forest, Local Outlier Factor (LOF), and Autoencoders, Applications in Fraud Detection and Medical Diagnosis	**8 Hrs.**
Unit 4: Graph Mining Graph Representation of Data (Nodes, Edges, Adjacency Matrices), PageRank Algorithm, Community Detection, and Link Prediction, Applications in Bioinformatics: Protein-Protein Interaction Networks, Gene Regulatory Networks	**8 Hrs.**
Unit 5: Text Mining and Natural Language Processing Text Representation: Bag-of-Words, TF-IDF, Word Embeddings, Named Entity Recognition (NER), Sentiment Analysis, Topic Modeling (LDA), Applications in Healthcare: Clinical Report Analysis, Literature Mining	**7 Hrs.**
Unit 6: Scalable Data Mining and Big Data Analytics Introduction to Big Data and Distributed Data Mining, MapReduce and Hadoop for Data Mining, Introduction to Spark MLlib for Large-Scale Machine Learning, Applications in Large-Scale Biomedical Data Analytics	**8 Hrs.**

Textbooks and references:

Textbooks and references:

1. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Morgan Kaufmann, 3rd Edition, 2011.
2. Charu C. Aggarwal, "Data Mining: The Textbook", Springer, 2015.

Title of the Course:	**Financial Management (MM-II)**	**L**	**T**	**P**	**Credit**
Course Code:	**UBTM0642**	**3**		**-**	**3**

Course Pre-Requisite: Basic knowledge of Financial Accounting

Course Description: The course is designed to provide working level knowledge of financial and working capital management using various analytical methods

Course Learning Objectives:
To understand scope and objectives of financial management
To read and analyze financial statements
To carry out decision making in a business based on financial management

Course Outcomes:

COs	After the completion of the course the student will be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Explain the objectives of financial management	2	Understanding
CO2	Interpret the financial statements	3	Applying
CO3	Evaluate various financial management techniques in decision making of any business	4	Analyzing

Assessments :
ESE consists of 100 Marks question paper with equal weightage to each unit of the course

Course Contents:

Unit 1: Introduction, Scope and Objectives of Financial Management Functions and Decisions of Financial Management, Profit and Wealth Maximization, Reading the Financial Statements	**6 Hrs**
Unit 2: Ratio Analysis Introduction, Significance and Limitations of Ratio Analysis, Types of Ratios, Calculations of Financial Ratios and Practical Usage	**6 Hrs**
Unit 3: Working Capital Management Estimation and Financing, Inventory Management, Receivables Management, Cash Management	**6 Hrs**
Unit 4: Capital Budgeting Concept and Overview, Capital Budgeting Process, Project Classification, Techniques of Capital Budgeting, Investment Criteria	**8 Hrs**
Unit 5: Cost of Capital Need and Sources of Finances for Business Entity, Capital Structure (Planning and designing based on EBIT and EPS/MPS approach), Factors affecting Capital Structure, Computation of Cost of Capital	**8 Hrs**
Unit 6: Leverage Analysis Concept of Leverage in Finance, Types and Calculations of Leverages	**6 Hrs**

Books:

1. Financial Management by Dr. R.P. Rustagi (Taxmann Publications)
2. Financial Management by V.K. Bhalla (S.Chand Publishing)
3. Financial Management by Prasanna Chandra (Tata McGraw Hill Publications)
4. Financial services in India by V.A. Avadhani (Himalaya Publishing House)
5. Financial Services by M.Y Khan (McGraw Hill Publications)