Kolhapur Institute of Technology's College of Engineering, Kolhapur

Teaching and Evaluation scheme

For

Final Year B. Tech. Programme in Biotechnology Engineering Semester-VII

Course Code	Course Name	Hr/Week			Credits		Evaluation Scheme			
							Component	Marks		
		L	T	P				Max	Min for passing	
UBIO0701	Bioprocess Modeling and Simulation	4	1	-	5		ISE-I	10		
							MSE	30		
							ISE-II	10		
							ESE	50	20	40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
UBIO0702	Good Manufacturing Practices	4	-	-	4		ISE-I	10		
							MSE	30		40
							ISE-II	10		
							ESE	50	20	
UBIO0703	Process Engineering Costing and Plant Design	4	-	-	4		ISE-I	10		
							MSE	30		40
							ISE-II	10		
							ESE	50	20	
UOEL07**	Open elective -II	4	-	-	4		ISE-I	10		
							MSE	30		40
							ISE-II	10		
							ESE	50	20	
UBIO0751	Project Work Phase – I	-	-	4	2		ISE	50	20	40
							ESE	50	20	
UBIO0731	Bioprocess Modeling and Simulation (Lab)	-	-	2	1		ISE	50	20	
							ESE	50	20	
UBIO0761	^Professional certifications	-	-	2	-		Audit Course-V	*	*	
Total		**16**	**1**	**8**	**20**		**Total Contact hours / Week : 25**			

Open Elective II-Theory		Offered by Department
Course Code	**Course Name**	
UOEL0701	Bioinformatics	Biotechnology Engineering
UOEL0702	Biosensors	Biotechnology Engineering

Title of the Course: Bioprocess Modeling and Simulation	**L**	**T**	**P**	**Credit**
Course Code:UBIO0701	**4**	**0**	**0**	**4**

Course Pre-Requisite: Knowledge of different modes of reactor operations and their kinetics, solving of ODE, unit operations and basic mathematical calculations

Course Description: It describes the basic knowledge of various models, skills for model building, application of numerical methods, simulation techniques and successive usage of it in bioprocess and cellular level modeling.

Course Objectives:

1. To explain basics of modeling and simulations
2. To apply numerical methods and their usage in process modeling
3. To demonstrate dynamics of different fermentation modes
4. To solve various case studies of industrially important processes

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	Explain basics of modeling and simulations	II	Understanding
CO2	Applying numerical methods and their usage in process modeling	III	Apply
CO3	Demonstrate dynamics of different fermentation modes	II	Understanding
CO4	Solve various case studies of industrially important processes	III	Apply

CO-PO Mapping:

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3													
CO2	3	2													
CO3	3	1	1	2	2										
CO4	3	3	2	2								3	1	1	

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 with 60-70% weightage for course content (normally last three modules) covered after MSE.	
Course Contents:	
Unit 1:Fundamentals of Modeling and Simulation Introduction of modeling and simulation, scope and applications of modeling and simulation in biotechnology, model building process, Use of fundamental laws: Continuity equation, energy equation, equation of motion, transport equation, equation of state, phase and chemical equilibrium, chemical kinetics, Process simulation, Scope of process simulation, Formulation of problem, Process simulation approaches for steady state simulation, Strategies, Process simulator, Structure of process simulator, Simulation tools	10 Hrs.
Unit 2:Analytical and Numerical Methods Newton's Method, Milne-Simpson Method, Euler method, Runge-Kutta method, Henn's Method, Polygon Method, Adams-Bashforth-Moulton Method	7 Hrs.
Unit 3: Model Classification Types of Models with one case study each –Physical theory based versus empirical models, Steady state versus unsteady state models, linear versus non-linear models, Unstructured versus structured models, Segregated versus non-segregated models, Lumped versus distributed models, Deterministic versus stochastic models	7 Hrs.
Unit 4:Modeling of Bioprocess Systems Gravity flow tank and variations, Stirred tank heater, Batch fermentation and its variations (normal, substrate inhibited, product inhibited), Continuous / chemostat fermentations and its variations (normal, fed-back control, multistage), Fed batch bioreactor, Plug flow bioreactor, Bubble column bioreactor, Packed bed bioreactor, Fluidized bed reactor, Heat exchanger	12 Hrs.
Unit 5:Modeling of Bioprocess Case Studies Modeling of fermentation processes (lactic acid, antibiotic, ethanol), Modeling for activated sludge process, Modeling for anaerobic digestion	6 Hrs.
Unit 6: Modeling at Cellular Level Introduction to Biochemical Networks, Metabolic flux analysis, Elementary mode analysis, Modeling of gene regulation and Genetic switches	6 Hrs.
Textbooks: 1. Process Modelling Simulation and Control for Chemical Engineers- W L Luyben (McGraw-Hill). 2. 'Bioprocess Engineering Principles' P M Doran, Elsevier Science & Technology Books, May 1995. **3.** 'Bioreaction Engineering Principles' J Nielsen, J Villadsen, G Lidén, Springer Books, 2003.	
References: 1. 'Bioprocess Engineering: Basic Concepts' M L Shuler, F Kargi,2 illustrated, Prentice Hall,	

2. Modeling and Control of fermentation Processes-J R Leigh (Peter Peregrinus).
3. Biochemical Engg Fundamentals- J.E. Bailey and D F Ollis (McGraw Hill).
4. Biological reaction engineering: Dynamic modeling fundamentals with simulation Examples- J E Prenosil, E Heinzle, J Ingham, I J Dunn (Science).

Unit wise Measurable students Learning Outcomes:

1. Student will learn basic fundamentals of modeling and simulation
2. Students will acquire knowledge about various analytical and numerical methods
3. Student will learn different types modeling methods
4. Student will be able to do modeling and simulation of important bioprocess systems
5. Students will learn various bioprocess case studies along with modeling and simulation
6. Students will have knowledge about biochemical networks, switches and their modeling

Title of the Course: Good Manufacturing Practices	L	T	P	Credit
Course Code:UBIO0702	4	-	-	4

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

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

Course Objectives:

1. To summarize Good Manufacturing Practices in industry
2. To apply how GMPs are integrated into Formal Management Systems for industry
3. To analyse the concept of validation, elements of validation in industry
4. To evaluate the requirement of regulatory guidelines for industry

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	summarize Good Manufacturing Practices in industry	II	Understand
CO2	Apply how GMPs are integrated into Formal Management Systems for industry	III	Apply
CO3	Analyze the concept of validation, elements of validation in industry	IV	Analyse
CO4	Evaluate the requirement of regulatory guidelines for industry	V	Evaluate

CO-PO Mapping:

CO\PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1		2			1	3	3	3	1	2	3	3			3
CO2			2			3		2	3		2	2			3
CO3								3				2			3
CO4								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.

Course Contents:	
Unit 1:-An Introduction To Pharmaceutical GMP Introduction, guideline on GMP for pharmaceutical products, good practices-production, laboratory.	8 Hrs.
Unit 2:- Quality Standards and QA, QC in Pharmaceutical Industries Quality standards-advantages. Concept, role and importance of quality control, quality assurance- functions and advantages. Quality management in pharmaceutical industry. Customer requirement of quality.	8 Hrs.
Unit 3:-Pharmaceutical Validation Introduction of validation, types, scope and importance of validation. Limitations of validation, organization of validation. Elements of validation-IQ, OQ,PQ and DQ.Cleaning validation, process validation and validation of analytical procedures as per ICH guideline .	8 Hrs.
Unit 4:-Regulatory Affairs: Introduction to regulatory affairs. Necessity of regulatory affairs. Types of different applications- DMF, NDA, and ANDA. Types of DMF. Different regulatory agencies and their functions.	8 Hrs.
Unit 5:-Intellectual Property Rights: Types of intellectual property-patents, trademark, copyright and related right. Types of Patent Application- ordinary, PCT, conventional.	8 Hrs.
Unit 6:-Biosafety: Introduction- Introduction to biological safety guideline. Bio-safety levels. Containments to biohazards. Role of institutional Bio-safety committee-RCGM, GEAC. Recommended Bio-safety levels for infectious agents and infected animal.	8 Hrs.

Textbooks:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, (Universal Law Publishing Co.)
2. Genetic Patent Law & Strategy, KankanalaC .Manupatra Informatics Solutions Pvt.Ltd.,.
3. Patents, Subbaram, N.R. (Syndicate)
4. 4.Basic Biotechnology b Ignacimuthu, S.(Tata McGraw-Hill)
5. Genetically yours by Lim, H.A. (World Scientific)

References:

1. Biotechnologies and Development(UNESCO Publications)
2. cGMP for Pharmaceuticals-Manohar Potdar (Pharma Med Press)
3. Validation of Active Pharmaceutical Ingredients-Ira Berry(CRC Press)
4. Quality Assurance and Quality Management in Pharmaceutical Industry-Y. Anjaneyulu
5. Quality assurance in Analytical Chemistry, B.W. Wenclawiak., M.Koch.E. Hajicostas,

Unit wise Measurable students Learning Outcomes:

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

Title of the Course: Process Engineering Costing and Plant Design **Course Code: UBIO0703**	**L**	**T**	**P**	**Credit**
	4	**1**	**0**	**5**

Course Pre-Requisite: Industrial work flow , Bioprocess Equipment Design , Drawing**,** Costing basics

Course Description:

First section of this course explains the basics of plant design and managing project from their inception to erection, commissioning and final runs. Second section explains the industrial cash flow with detailing about total capital investment, profits and loss calculation and interests, taxes and many commerce calculations required to run the business.

Course Learning Objectives:

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

Course Outcomes:

CO	**After the completion of the course the student should be able to -**	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Explain basic fundamentals of Flow sheet synthesis, development and general plant designing procedures	II	Understand
CO2	Analyze different costing strategies and cost estimation methods.	IV	Analyze
CO3	Compare different Interest and profitability methods.	V	Evaluate
CO4	Determine interest, taxes, fixed charges for different practical situations	V	Evaluate

CO-PO Mapping:

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	3	3		3					2			3	3
CO2	2	3	2	2							3		2		2
CO3	2	3	2	2		2					3		2		
CO4	2	3	2	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 with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1: General Plant Design Considerations Pre-project objectives, Project classification, Plant location, Plant Layout, Health and Safety , Loss Prevention, Environmental Protection, Plant operation and control, patent consideration	10 Hrs.
Unit 2: Flow Sheet Synthesis and Development Process Information, Input/output structure, Functions diagrams, Operations diagram, process flow sheet, use of software's in process design	6 Hrs.
Unit 3:Design and Costing Strategy Optimum design, material selection and costing, equipment design and costing and design reports. Comprehensive case studies	8 Hrs.
Unit 4: Analysis of Cost Estimation Industrial Cash flow, Factors affecting investment and production cost, Capital Investment, estimation of capital investment, cost indexes, cost components in capital investment, methods for estimating capital investment, estimation of total product cost, gross profit, net profit and cash flow	10 Hrs.
Unit 5:Interest, Time Value of Money, Taxes and fixed charges Interest, cost of capital, time value of money, cash flow patterns, Income taxes, fixed charges	6 Hrs.
Unit 6: Profitability, Alternative Investments and Replacements Profitability standards, methods for calculating profitability, alternative investments, replacements, practical factors in alternative investment and replacements analysis.	8 Hrs.

Textbooks:

1. Plant Design & Economics for Chemical Engineers- M. S. Peters , K. D. Timmerhaus, R.E. West (McGraw Hill) Fifth edition
2. Chemical Engineering Design, Coulson & Richardson's Volume 6 – R.K. Sinnott
3. Contemporary Engineering Economics – Chan S. Park (Perason Pretice Hall)

References:

1. Bioseparation Science and Engineering – Harrison R.G., Todd P., Rudge S.R., Petrides D.P.(Oxford University Press)
2. Principles of Fermentation Technology – Stanbury P.F., Whitaker A, Hall S. J.(Aditya Books)
3. Biochemical Engineering Fundamentals, Bailey & Ollis. (McGraw Hill Book Co.)
4. Conceptual Design of Chemical Processes, Douglas, James M., (McGraw-Hill, International Editions)
5. A Guide to chemical Engg. Process Design & Economics" Gael D .Ulrich, (JohnWiley & Sons)
6. Chemical Project Economics, Mahajani, V.V., (Macmillan Indian Ltd.)
7. Systematic Methods of Chemical Process Design, Biegler, L.T., I.E. Grossmann andA.W. Westerberg, (Prentice Hall ,Pearson Education)
8. Chemical Process: Design and Integration, Smith, R., (John Wiley and Sons, West Sussex, UK)
9. Chemical Engineers Handbook 5th ed R.H. Perry& C.H. Chilton, (McGraw-HillBook Company).

Unit wise Measurable students Learning Outcomes:

At the end of the Unit Students will be able to -

1. Student will learn fundamentals of general plant design
2. Students will acquire knowledge about flow sheet development
3. Student will design and analyze costing strategy
4. Student will be able to analyze cost
5. Students will learn basics of investments
6. Students will have knowledge about profitability

Title of the Course: Bioinformatics	L	T	P	Credit
Course Code: UOEL701	4	-	-	4

Course Pre-Requisite: Biochemistry, molecular biology, chemistry, and mathematics and computer language.

Course Description: Bioinformatics is integration of biology, chemistry, and mathematics and computer science. This subject provides information of various biological databases and tools available for life science field.

Course Objectives:

1. To Overview of living system, fundamental understanding of biomolecules and genetic information
2. To describe the understanding of databases of Bioinformatics and also discuss the differences between various databases.
3. To demonstrate tools of bioinformatics like BLAST, FASTA, Genbank etc to access various sequences for study.
4. To apply the tools and methods used in the course eg: to address the issues related to molecular interactions, evolutionary studies

Course Learning Outcomes:

CO	After the completion of the course the student should beable to	Bloom's Cognitive	
		Level	Descriptor
CO1	Overview of living system, fundamental understanding of biomolecules and genetic information	I	Understanding
CO2	Describe the understanding of databases of Bioinformatics and also discuss the differences between various databases.	II	Comprehension
CO3	Demonstrate tools of bioinformatics like BLAST, FASTA, Genbank etc to access various sequences for study	III	Apply
CO4	Apply the tools and methods used in the course eg: to address the issues related to molecular interactions, evolutionary studies.	III	Identify

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3											
CO2	3				3							
CO3	3	2	3									
CO4	3	3	3		3	1						

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.

Course Contents:

Unit 1: Introduction to Biotechnology General biology, Introduction to Biomolecule, Cell: Basic structure and function Flow of genetic information.	10 Hrs.
Unit 2: Introduction to Bioinformatics History, importance, opportunities and challenges of Bioinformatics	4 Hrs.
Unit 3: Introduction and Importance to Databases Primary sequence databases, Secondary sequence databases, Composite sequence databases, Structural (Protein) databases, Bibliographic databases, Taxonomic Databases, Derived database -SCOP, CATH, PROSITE, PRINTS, BLOCKS, Pfam **Importance of Databases** NCBI (Entrez),EBI,CIB, DDBJ, Genbank, EMBL,SWISSPROT, PDB, PROSITE, PIR, TREMBL, KEGG	10 Hrs.
Unit 4: Sequence Alignment Introduction of sequence alignment-local and Global alignments, Types of Sequence alignment – Pairwise and Multiple sequence alignment (Clustal-W), Alignment algorithms (Needleman- Wunsch algorithm and Smith-Waterman algorithm), Scoring matrices, Statistical significance of sequence alignment.	8 Hrs
Unit 5: FASTA, BLAST, MATRICES AND MOLECULAR PHYLOGENETICS FASTA, BLAST and its types, PAM and BLOSUM Matrices, Phylogenetics: Distance based methods, Bootstrappig, Jackkniffing (subtree reliability evaluation)..	8 Hrs.
	8 Hrs.

Unit 6: Applications of Bioinformatics: Human genome project**,** Chemo-informatics, Health-informatics, Fingerprinting, face recognition.	

Textbooks:

1. Introduction to bioinformatics – T.K. Attwood and Parry-Smith D.J.
2. Bioinformatics: sequence and genome analysis by David Mount, cold springer harbour press, 2004.
3. Bioinformatics: Methods and Applications- Rastogi S. C., N. Mendiratta., P Rastogi.
4. Fundamentals of Molecular Evolution by D. Graur and W-H Li, 2nd Edition, Sinauer Associates.

References:

1. Developing Bioinformatics computer skills – Gibas C and Jambeck P
2. Baxevanis, A. D. and Ouellette, B, F, F.: Bioinformatics: A practical guide to the analysis of genes and Proteins. 2nd Ed..2002. John wiley and ons, Inc. publications, New York.
3. Eidhammer, IngeJonassen, William R. Taylor: protein Bioinformatics. 2003 John Wiley and Sons L

Unit wise Measurable students Learning Outcomes:

1. Students will able to overview of living system, fundamental understanding of biomolecules and genetic information
2. Students will able to describe the understanding of databases of Bioinformatics and also discuss the differences between various databases.
3. Students will able to demonstrate tools of bioinformatics like BLAST, FASTA, Genbank etc to access various sequences for study.
4. Students will be able to apply the tools and methods used in the course eg: to address the issues related to molecular interactions, evolutionary studies

Title of the Course: Biosensors	**L**	**T**	**P**	**Credit**

Course Code:UOEL0702	4	-	-	4

Course Pre-Requisite:

1) The students should have a basic knowledge of Microbiology, Biochemistry, Physics, Chemistry and Computer language.

Course Description: This course helps to understand the use of biomolecues as recognition elements for detection of a particular analyte and the use of biological elements such as proteins in place of silicon chips.

Course Objectives:

1. To list the basic terminologies and recognize the importance of Biosensor
2. To explain the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications
3. To Remember and understand the concepts, types, working and practical applications of important biosensors.

Course Learning Outcomes:

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

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	List the basic terminologies and recognize the importance of Biosensor	Cognitive	List
CO2	Explain the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications	Cognitive	Explain
CO3	Remember and understand the concepts, types, working and practical applications of important biosensors.	Cognitive	Remember

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	**3**											
CO2	**3**				**3**							
CO3	**3**	**2**	**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.

Course Contents:

Unit 1: INTRODUCTION Biosensors- Advantages and limitations, various components of biosensors Biocatalysis based biosensors, Bioaffinity based biosensors & Microorganisms based biosensors, Biologically active material and analyte. Types of membranes used in biosensor constructions	8-- **Hrs.**
Unit 2 : TRANSDUCERS IN BIOSENSORS Various types of transducers; principles and applications - Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor, Impedimetric, Chemiluminiscene - based Biosensors	8-- **Hrs.**
Unit 3: BIOSENSORS - PHYSIOLOGICAL RECEPTORS - J RECEPTORS Chemoreceptors, Baroreceptors, Touch receptors, Biosensors - Working Principle and Types, Applications.	6-- **Hrs.**
Unit 4: APPLICATION AND USES OF BIOSENSORS Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary,agriculture and food Low cost - biosensor for industrial processes for online monitoring; biosensors for environmental monitoring. Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors in industry, healthcare, food and environment.	8-- **Hrs.**
Unit 5: BIOELECTRONICS Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly.	8-- **Hrs.**
Unit 6 : DESIGN FOR A BIOMOLECULAR PHOTONIC COMPUTER: Assembly of photonic biomolecular memory store; Information processing; Commercial prospects for biomolecular computing systems.	8-- **Hrs.**

Textbooks:

1. Brian R Eggins - Biosensors an Introduction , First edition, John Wiley & Sons Publishers, 1996.
2. Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, First edition, Marcel Dekker,Inc, 1991.
3. Donald G. Buerk - Biosensors Theory and Applications, First EditionTechnomic Publishing. Co, Inc, 1993.

References:

1. Elizabeth A Hall - Biosensors, First Edition, Open University, Milton Keynes, 1990.
2. Graham Ramsay - Commercial Biosensors, First edition, John Wiley & Sons,Inc. 1998.
3. Tran Minh Canh - Sensor Physics & Technology - Biosensors, First Edition, Champan & Hall, 1993.

Unit wise Measurable students Learning Outcomes:

1. Students will be able to understand the basic terminologies and recognize the importance of Biosensor
2. Students will be able to understand the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications
3. Students will be able to understand the concepts, types, working and practical applications of important biosensors.

Title of the Course: Project Phase -I	**L**	**T**	**P**	**Credit**
Course Code: UBIO0751	**-**	**-**	**4**	**2**

Course Pre-Requisite:

All Theoretical And Practical Skills Learnt Till Previous Semester

Course Description:

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

Course Objectives:

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

Course Learning Outcomes:

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

CO-PO Mapping:

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO1		3		3		2	2	1				3	3		
CO2		3													
CO3			3						1				1		
CO4				1					3	3	2				

Assessments :

One component of In Semester Evaluation (ISE) and EndSemester Examination (ESE) having 50% and 50% weights respectively.

Assessment	**Marks**
ISE	50
ESE	50

ISE is based on the rubrics based progressive report submission and presentationto respective supervisors.

ESE is based on presentation of synopsis to expert panel.

Each project batch should consist of maximum 3 project groups having maximum 9 students.

Description:

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

The Project Work Phase - I consists of following phases**:**

1. Surveying the contemporary knowledge, work and issues in the related field of interest for identification of problem
2. Collection of literature and reviewing
3. Presenting a plan of work to attain aim and objectives

Projects Areas can be -

1. Processes based project: Product manufacturing, Waste treatments etc.
2. Equipment based Project: Detailed design and fabrication, prototype development etc.
3. Industrial problems: Any problem or project directly related to existing plants for modification of process or equipment or regarding pollution control and energy conservation.

Students may undergo studies such as study of the selection of the process, computation of material and energy balances, process design, and detailed design of one of the main equipments; cost estimation, economic analysis etc.

Suggested fields for project work -

1. Fermentation based: Microbial fermentation, Animal cell fermentation, Plant cell FermentationCombitorial chemistry: Enzymatic processes
2. Microbial/enzymatic treatment of domestic and industrial waste water treatment.
3. Modeling and Simulation: Microbial fermentation, Waste water treatment, modeling genetic regulation (genetic switches, signal transduction, mixed cascadic systems), Insilco microorganisms (metabolic flux analysis, elementary mode analysis of metabolic fluxes),Insilco mammalian/animal organs, Virtual patients (analysis by top to bottom and bottom top analysis)
4. Bioinformatics: Sequence homology, clustering of genes, parametric analysis for homology and catalytic activity of enzyme, microarray data analysis.
5. Immunological studies: Modeling and experimental verification of antigen antibody interactions (steady state and dynamic modeling).
6. Metabolic Engineering and Genetic Engg. (modeling and experimental aspects of metabolic flux analysis for inhibitor development and planning for genetic mutation/deletion/strain improvement)
7. Toxicological studies: Effect of synthetic and plant extracted active compounds on eukaryotic organisms (Yeast and animal cells).
8. Extraction and purification techniques: Solvent/supercritical extraction of biologically active compounds from plants and herbs, Chromatographic purification.
9. Nutritional analysis of local food components and linear programming for balance diet design for Kolhapur region.
10. Techniques development for the preservation of farmer's products (fruits and vegetables)and scale-up of exiting techniques such as ozonation , γ-rays preservation; Optimization of long term preservation of milk by supercritical carbon dioxide.
11. Food industry: Optimization/Modification of microbial processes of food industry, nutritional enrichment of food products.
12. Production of Bioinsecticides and pesticides

13. Insect cell differentiation and development.
14. Tran differentiation of stem cells.
15. Reproductive biotechnology: Artificial reproductive technology.
16. Trace proteins studies.
17. Biotransformation.
18. Tracer techniques for establishment of metabolic pathways.
19. Microbial desalting of sea water.
20. Microbial leaching of metals from ores.
21. Linear programming for dose design.
22. Environmental Biotechnology: Hospital waste treatment.
23. Leather tanning by natural products.

Title of the Course: Bioprocess Modeling and Simulation (Lab)	L	T	P	Credit
Course Code:UBIO0732	-	-	2	1

Course Pre-Requisite: Knowledge of different growth kinetics, solving of ODE, unit operations, basic programming skills and basic mathematical calculations

Course Description: Course describes modeling and simulation of various operational modes of reactors and their variations due to effect of substrates and products.

Course Objectives:

1. To construct model equations for biological systems grown under various growth and cultivation conditions.
2. To develop skills in solving the model equations and estimating the parameter values by use of basic programing language/tool.
3. To explain application of model in bioprocess development.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Taxonomy	
		Level	Descriptor
CO1	Construct the designing of model equations for different fermentation runs	VI	Create
CO2	Develop skills in solving the model equations and estimating the parameter values by use of basic programing language/tool.	III	Apply
CO3	Explain application of model in bioprocess development.	II	Understand

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2								2	3	
CO2	3	3	3	2	3								2	3	
CO3	1														

Assessments:

Teacher Assessment:

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

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Course Contents:	
Experiment No. 1:Introduction to various programs/tools to solve model equations and to estimate model parameters **Aim and Objectives:** To learn basic programs / tools which are prerequisite for solving and simulating the bioprocess problems. **Outcomes:** Student will acquire skills about programs / tools which are being used for solving linear or non-linear model ODE equations. **Theoretical Background:** Various programs/tools consists different mathematical algorithms which easily solves the linear or non-linear systems of equations. The basic orientation enhances the basic understanding and appropriate uses of programs/tools.	2 Hrs.
Experiment No. 2:Modeling and Simulation of Batch Bioreactor **Aim and Objectives:** To model and simulate dynamics of batch bioreactor which is the basic mode of cultivation of organisms. **Outcomes:** Students will be able to solve the growth kinetic equations of batch fermentation through computational programs / tools. **Theoretical Background:** The batch bioreactor consists lag, exponential, deceleration and stationary phases. These phase mainly consequences of nutritional availability and hence specific growth rate varies. Modeling of these dynamics provides the better predictability of batch kinetics.	2 Hrs.
Experiment No. 3:Modeling and Simulation of Continuous Bioreactor **Aim and Objectives:** To simulate the steady state values of continuous bioreactor under different model inputs. **Outcomes:** Students will acquire the knowledge about steady state and they will be able to predict it on varying input values. **Theoretical Background:** Continuous bioreactor is operated at steady state condition where all the variable of the system will be constant. The small variation in input values or condition drives the steady state to another point. Prediction of a specific steady state condition is prerequisite for maintaining quality of the product.	2 Hrs.
Experiment No. 4:Modeling and Simulation of fed-batch Bioreactor **Aim and Objectives:** To predict dynamics of state variables of fed-batch bioreactor with respect to time and input. **Outcomes:** Students will learn techniques of formulating and solving of non-linear equations for fed-batch reactor. **Theoretical Background:** Fed-batch is a fermentation method where substrates are fed intermittently to prolong the growth and product formation activities. Biomass, substrates and products are continuously diluted due to addition of fresh media and hence dynamics of fed-batch changes with fresh media flow rate and time.	2 Hrs.
Experiment No. 5: Performance analysis of packed bed bioreactor **Aim and Objectives:** To study and analyze the packed bed bioreactor which is one of the major fermentation strategy used for continuous product formation from immobilized cells / enzymes. **Outcomes:** Student will acquire the knowledge about modeling of immobilized catalyst and its effect on product formation.	2 Hrs.

Theoretical Background: The cells or enzymes are immobilized with a suitable matrix that forms the bed in the bioreactor. The porous structure of matrix offers way to cells/enzyme for supply of nutrients/substrates and removal its products. Matrix acts as a protective environment for cells/enzymes from local shear forces. This system has gained considerable interest for the commercial production of biopharmaceutical products from mammalian cells.	
Experiment No. 6:Performance Analysis of Feed-Back Continuous Bioreactor **Aim and Objectives:** To learn the advantages of feed-back control over normal continuous bioreactor operation **Outcomes:** Students will be able to design and simulated the feed-back control loop for continuous bioreactor **Theoretical Background:** A continuous bioreactor is maintained higher than that can attain in normal run by incorporating two way of biomass feedback system: (i) Internal feedback and (ii) External feedback. This system contains enhanced steady state biomass concentration in comparison to $Yx/s*(S_R-s)$ due reduced concentration of biomass to allowed in effluent stream. This is more useful process in effluent treatment and anaerobic fermentation.	2 Hrs.
Experiment No. 7:Performance Analysis of Multi-Stage Continuous Bioreactor **Aim and Objectives:** To separate organism growth phases in two or more reactors under continuous mode strategy. **Outcomes:** Students will learn the multi-stage chemostat modeling and simulation as these operations are used for enhanced productivity. **Theoretical Background:** Two continuous bioreactors are connected in series and allowed to maintain their steady state conditions. The dilution rate of both the bioreactor may be same or different depending on required residential time. This system can be used in utilization of multiple carbon sources and/or in the production of secondary metabolites.	2 Hrs.
Experiment No. 8:Modelingand Simulation of Substrate Inhibited Batch Bioreactor **Aim and Objectives:** To model and simulate the effect of substrate concentration on specific growth rate of organism in batch bioreactor. **Outcomes:** Students will acquire physical meaning of substrate inhibition constant and its use in simulation of substrate inhibited batch bioreactor **Theoretical Background:** The higher concentrations of substrate in the medium inhibit the organism growth and growth rate depends on substrate concentration. The inhibition pattern of microbial growth is analogous to enzyme inhibition and it may follow either noncompetitive preferably or competitive substrate inhibition Growth kinetics of batch reactor varies significantly under the influence of substrate inhibition.	2 Hrs.
Experiment No. 9:Modeling And Simulation of Product Inhibited Batch Reactor **Aim and Objectives:** To study and simulate the variation in batch dynamics due to product toxicity to cells. **Outcomes:** Students will be able to model and simulate the batch bioreactor with incorporation of product inhibition constant.	2 Hrs.

Theoretical Background: High concentrations of product can be inhibitory for microbial growth. Sometimes lower concentration is also inhibitory due toxic nature of product. The inhibition may be competitive or noncompetitive or the un-clear mechanism. The growth rate of organism gradually starts decreasing with increase in product concentration.	

Textbooks:

1. Process Modelling Simulation and Control for Chemical Engineers- W L Luyben (McGraw-Hill).
2. 'Bioprocess Engineering Principles' P M Doran, Elsevier Science & Technology Books, May 1995.
3. 'Bioreaction Engineering Principles' J Nielsen, J Villadsen, G Lidén, Springer Books, 2003.

References:

1. 'Bioprocess Engineering: Basic Concepts' M L Shuler, F Kargi,2 illustrated, Prentice Hall, 2002.
2. Modeling and Control of fermentation Processes-J R Leigh (Peter Peregrinus).
3. Biochemical Engg Fundamentals- J.E. Bailey and D F Ollis (McGraw Hill).
4. Biological reaction engineering: Dynamic modeling fundamentals with simulation Examples- J E Prenosil, E Heinzle, J Ingham, I J Dunn (Science).

Experiment wise Measurable students Learning Outcomes: Student will be able to

1. Learn various programs/tools to solve model equations and to estimate model parameters
2. Do modeling and simulation aspects of batch bioreactor
3. Do modeling and simulation aspects of continuous bioreactor
4. Do modeling and simulation aspects of fed-batch bioreactor
5. Do performance analysis of packed bed bioreactor
6. Do performance analysis of feed-back continuous
7. Do performance analysis of multi-stage continuous bioreactor
8. Do modeling and simulation of substrate inhibited batch bioreactor
9. Do modeling and simulation of product inhibited batch reactor

Title of the Course: Professional Certification Course Code: UBIO0761	L	T	P	Credit
	--	--	2	Audit Course

Course Pre-Requisite:
Basic Technical Knowledge And Soft Skills

Course Description:
The major objective of this course is to help students to get certifications from premier agencies or institutes from India and abroad. It exposes students to renowned faculties at those destinations and in turn helps to widen the connect to outside world. It would also facilitate them to get research and intern opportunities in the field after their graduation.

Course Learning Objectives:
1. To motivate students to fetch certifications from premier agencies or institutes from India and abroad for their career building.

Course Outcomes:

CO	After the completion of the course the student should beable to	Bloom's Taxonomy	
		Level	Descriptor
CO1	Motivate students to fetch certifications from premier agencies or institutes from India and abroad for their career building.	IV	analyze

CO-PO Mapping:

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1										2		3			

Assessments :
Teacher Assessment:
There is no exam component for this Audit Course. Student has to produce minimum 2 certifications from any agencies in the semester to pass the Audit Course.

Kolhapur Institute of Technology's College of Engineering, Kolhapur

Teaching and Evaluation scheme for

Final Year B. Tech. Programme in Biotechnology Engineering Semester-VIII

Course Code	Course Name	Hr/Week			Credits	Evaluation Scheme		
		L	T	P		Component	Marks	
							Max	Min for passing
UBIO08**	Professional Elective -II	3	-	-	3	ISE-I	10	40
						MSE	30	
						ISE-II	10	
						ESE	50	20
UBIO08**	Professional Elective - III	3	-	-	3	ISE-I	10	40
						MSE	30	
						ISE-II	10	
						ESE	50	20
UBIO0851	Project Work Phase-II	-	-	12	6	ISE-I	75	30
						ISE-II	75	30
						ESE	150	60
	$Industrial Training	-	-	-	-	-	-	-
Total		**6**	**0**	**12**	**12**	**Total Contact hours / Week :18**		

$Student should undergo industrial training of 30 days during vacation after Final Year B.Tech. Sem-VII, Evaluation by Presentation of Training at Departmental Level.

Professional Elective II	
Course Code	**Course Name**
UBIO0821	Biopharmaceuticals
UBIO0822	Plant Biotechnology
UBIO0823	Bioprocesses

Professional Elective III	
Course Code	**Course Name**
UBIO0824	Industrial Organization Management and Entrepreneurship
UBIO0825	Environmental Biotechnology
UBIO0826	Food Technology

Title of the Course: Biopharmaceuticals (Professional Elective – II) Course Code:UBIO0821	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite:
All Basics Subjects Of Life Sciences, Chemical Sciences And Engineering Sciences Learnt Till Previous Semester

Course Description: Course emphasizes on case studies of different biopharmaceuticals with reference of to the complete production technology.

Course Objectives:

1. To list down the range of biopharmaceuticals with respect to different classifications.
2. To explain the pathophysiology and mechanism of action of biopharmaceuticals.
3. To apply principles of different unit operations in production technology of biopharmaceuticals.
4. To analyze biopharmaceutical products with respect to regulatory aspects and clinical studies.
5. To evaluate biopharmaceutical product development process.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Taxonomy	
		Level	Descriptor
CO1	List down the range of biopharmaceuticals with respect to different classifications.	I	Remember
CO2	Explain the pathophysiology and mechanism of action of biopharmaceuticals.	II	Understand
CO3	Apply principles of different unit operations in production technology of biopharmaceuticals.	III	Apply
CO4	Analyze biopharmaceutical products with respect to regulatory aspects and clinical studies.	IV	Analyze
CO5	Evaluate biopharmaceutical product development process.	V	Evaluate

CO-PO Mapping:

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	3														
CO2	3												1		
CO3	3	2	3	2										3	
CO4															3
CO5	1	2	3	2		1		1			1	2	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 with60-70% weightage for course content (normally last three modules) covered after MSE.	
Course Contents:	
Unit 1:Drug discovery, development and manufacturing Difference between pharmaceuticals, biologics and biopharmaceuticals, Drug development process, Drug manufacturing process, Biopharmaceutical industry	**6 Hrs.**
Unit 2:Biopharmaceutical product development case study : Monoclonal Antibodies Case studies (any two of industrial products) with reference to pathophysiology, chemical description of drug, expression systems, production and purification technology, biochemical and biophysical analysis, fill finish and formulation, pharmacology, regulatory and quality considerations, clinical studies	**9Hrs.**
Unit 3:Biopharmaceutical product development case study : Hormones Case studies (any two of industrial products like Insulin, Growth hormone, Erythropoietin, Follicle Stimulating Hormone, Luteinizing hormone, Parathyroid etc.)with reference to pathophysiology, chemical description of drug, expression systems, production and purification technology, biochemical and biophysical analysis, fill finish and formulation, pharmacology, regulatory and quality considerations, clinical studies	**9Hrs.**
Unit 4:Biopharmaceutical product development case study : Hematopoietic growth factors, Cytokines Case studies (any two of industrial products like GM-CSF, EGF, IGF, FGF,M-CSF, SCF , G- CSF ,IFNs, ILs etc.) with reference to pathophysiology, chemical description of drug, expression systems, production and purification technology, biochemical and biophysical analysis, fill finish and formulation, pharmacology, regulatory and quality considerations, clinical studies	**10Hrs.**
Unit 5:Biopharmaceutical product development case study : Clotting factors, Enzymes and regulators Case studies (any two of industrial products like Enterokinase / Enteropeptidase , streptokinase, t-PA etc.) with reference to pathophysiology, chemical description of drug, expression systems, production and purification technology, biochemical and biophysical analysis, fill finish and formulation, pharmacology, regulatory and quality considerations, clinical studies	**10 Hrs.**
Unit 6:Nucleic acid therapeutics Oligonucleotidesbiochemistry, Antisense technology; Triplex technology, Aptamer technology, Ribozyme Technology	**4 Hrs.**
Textbooks: 1. Understanding Biopharmaceuticals: Manufacturing and Regulatory Issues by Grindley, Jill E. Ogden (CRC Press) 2. Pharmaceutical Biotechnology, 2nd Ed. By Crommelin D.J.A. , Sindelar R. D ,Bernd Meibohm (Springer) 3. Pharmaceutical Biotechnology by Gary Walsh (Wiley)	
References: 1. Pharmaceutical Biotechnology by O. Kayser, R. H. Muller (Wiley - VCH) 2. Handbook of Pharmaceutical Biotechnology by Jay P Rho, Stan G Louie (Haworth Press.	

Unit wise Measurable students Learning Outcomes:
At the end of Unit Students will be able to –

1. Relate general drug development and manufacturing process to biopharmaceuticals.
2. Comprehend the product development case study on monoclonal antibody products.
3. Comprehend the product development case study on hormone products.
4. Comprehend the product development case study on growth factors and cytokine products.
5. Comprehend the product development case study on clotting factor and enzyme products.
6. Comprehend the use of nucleic acid therapeutic products.

Title of the Course: Plant Biotechnology **(Professional Elective – II)** **Course Code:**UBIO0822	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**

Course Pre-Requisite: Biochemistry, Genetic Engineering

Course Description: This course contains studies on applications of tissue culture and genetic engineering of plants

Course Objectives:

1. To explore the structural complexity and diversity of plants
2. To present an overview of plant tissue culture and genetic manipulation of plants
3. To impart knowledge in principles underlying plant metabolism
4. To understand the modern technologies underlying plant breeding and plant protection
5. To appreciate the use biotechnology is for plant improvement.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	Understand the structural complexity and diversity of plants	II	Understand
CO2	Usethe plant tissue culture and genetic manipulation of plants	I	Use
CO3	To impart knowledge in principles underlying plant metabolism	I	Use
CO4	understand the modern technologies underlying plant breeding and plant protection	II	understand
CO5	Explain how biotechnology is used for plant improvement.	III	Explain

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO1				**3**				**2**	**2**			**2**		**2**	
CO2	**2**	**3**	**3**	**2**		**2**	**3**	**2**	**3**	**2**		**2**	**2**		
CO3		**3**	**2**	**2**			**2**		**3**	**2**		**2**		**2**	
CO4		**2**	**3**	**2**		**2**			**2**			**2**	**2**		
CO5		**3**	**2**	**2**					**2**	**2**		**2**	**2**		

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.

Course Contents:	
Unit 1 From Cells To Plants Evolution of plant diversity - variation in plant populations and species –speciation origins of reproductive isolating mechanisms -species concepts -morphology anatomy and embryology - overview of plant phylogeny -phylogenetic relationships of angiosperms- molecular systematic Culture – regeneration; Somatic hybrid-cybrids.	6Hrs.
UNIT II - Techniques For Genetic Manipulation of Plants 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.	6 Hrs.
Unit III - Metabolic Plant Physiology Overview of photosynthesis.- Light absorption and energy conversion; the reaction center complex; the photosystem - Carbon reactions in C3 plants – Photorespiration - Variations in mechanisms of CO2 fixation- Carbohydrate metabolism- sucrose and starch- cell wall polysaccharides- non-starch storage polysaccharides Nitrogen and sulphur metabolism- Transport processes	6 Hrs.
UNIT IV - Plant Breeding And Plant Protection Plant reproductive systems- germplasm - variation- types and origin - Plant genetic resources for plant breeding- Sexual hybridization and wide crosses- Mutagenesis - Polyploidy- selected breeding objectives- Cultivar release and commercial seed production. Biotic stress factors- plant-pathogen interactions- natural disease resistance pathways- abiotic stress factors - tolerance mechanisms	6 Hrs.
Unit V - Plants As Production Systems Plant tissue culture-plasticity and totipotency, culture environment, growth regulators, media regulators, culture types, plant regeneration - Hairy root cultures - production of secondary metabolites-carbohydrate and lipid production-molecular pharming of proteins - emerging applications for producing fine chemicals, drugs, and alternative fuels.	6 Hrs.
Unit VI Application of Plant Genetic Engineering Herbicide resistance, Insect resistance, Disease resistance, Virus resistance. Abiotic stress tolerance; Drought, Temperature, Salt, Post-harvest losses, Long shelf life of fruits and flowers, Male sterile lines, Transgenic plants as Bio-factories, production of quality oil, Industrial enzymes, Antigens (edible vaccine),provitamins iron proteins in rice, modification of food plants test and application and Genetic manipulation of flower pigmentation	6 Hrs.

Text Books

1. Taiz. L and Zeigler.E, "Plant Physiology," .Panima Publishing Corporation, New Delhi, Third edition. 2003.
2. Salisbury. F.B and Ross.C.W, "Plant Physiology", Wadsworth Publishing Company Fourth edition 1992.
3. Slater. A, Scott.N.W and Fowler.M.R, "Plant Biotechnology - The genetic manipulation of plants", Oxford University press 2008.
4. Robert Wayne Allard John, "Principles of Plant Breeding", Wiley & Sons Second edition 1999.

References

1. Murray.D.R, “Advanced methods in plant breeding and biotechnology” CAB International 1991.
2. Stephanopolous.G.N, Aristidou. A.A and Neilsen.J, “Metabolic engineering- Principles and Methodologies,” Academic Press 1998.
3. Smolke.C, “The metabolic pathway engineering- Tools and applications” - CRC Press 2009.

Unit wise Measurable students Learning Outcomes:

At the end of Unit Students will be able to –

1. Use basic structure and diversity of plants
2. Use basic biotechnological techniques to explore molecular biology of plants
3. Understand how biotechnology has been used to develop knowledge of complex processes that occur in the plant.
4. Discuss the industrial application of plant biotechnology
5. Explain how biotechnology is used for plant improvement.

Title of the Course: BIOPROCESSES	**L**	**T**	**P**	**Credit**
Course Code: UBIO0823	**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 acquaint students with the world of classical and modern fermentations
To explain the role of strain improvement and processes improvements required for economical processes
To describe upstream processes, particularly inoculums built up carried out in industry.
To evaluate the effects of substrates and other growth requirements in industrial operations and process optimization.
To decide suitable sequence of down streaming operations.
To develop flow sheet for various productions.

Course Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Taxonomy	
		Level	Descriptor
CO1	acquaint students with the world of classical and modern fermentations	II	Understand
CO2	explain the role of strain improvement and processes improvements required for economical processes	IV	Analyze
CO3	describe upstream processes, particularly inoculums built up carried out in industry	III	Apply
CO4	evaluate the effects of substrates and other growth requirements in industrial operations and process optimization	V	Evaluate
CO5	Decide suitable sequence of down streaming operations.	V	Evaluate
CO6	Develop flow sheet for various productions.	VI	Create

CO-PO-PSO Mapping:

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3														
CO2	3	2		2			2	1			1		3		1
CO3		2		3									2	3	1
CO4	2	2		3							1		2	3	1
CO5		2		3		3	3				1		2	3	1
CO6			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	**6 hrs**
UNIT: 2 HEALTH CARE PRODUCTS Fermentative production of antibiotics: Penicillin, Streptomycin Steroid fermentation: Biotransformation	**4 hrs**
UNIT: 3 PRODUCTION OF INDUSTRIAL BIOCHEMICALS Production of Enzymes: Lipases, α–Amylases, Glucose isomerases, Proteases Production of Biosurfactants: Xanthan	**8 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	**8 hrs**
UNIT: 5 PRODUCTION OF FOOD AND BEVERAGES Production of Single Cell Protein (SCP), Production of baker's yeast Alcoholic beverages: Beer, Wine, Whisky	**5 hrs**
UNIT: 6 PRODUCTION OF AGRICULTURAL PRODUCTS Production of Bio fertilizers and Bio pesticides, Biogas production from municipal sewage	**5 hrs**

UNIT LEARNING OBJECTIVE:- **1.** Evaluate various raw materials, identify and select strategies for strain and process improvement, Design down streaming processes for a particular product and develop flow sheets for Organic acids and Organic solvents **2.** Evaluate various raw materials, identify and select strategies for strain and process improvement, Design down streaming processes for a particular product and develop flow sheets for of Penicillin, Streptomycin and Steroid Biotransformation **3.** Evaluate various raw materials, identify and select strategies for strain and process improvement, Design down streaming processes for a particular product and develop flow sheets for Enzymes and Biosurfactants 4. Evaluate various raw materials, identify and select strategies for strain and process improvement, Design down streaming processes for a particular product and develop flow sheets of Amino Acids. Vitamins, Pigments 5. Evaluate various raw materials, identify and select strategies for strain and process improvement, Design down streaming processes for a particular product and develop flow sheets for Single Cell Protein (SCP), Baker's yeast and Alcoholic beverages **6.** Evaluate various raw materials, identify and select strategies for strain and process improvement, Design down streaming processes for a particular product and develop flow sheets for Biofertilizers , Bio pesticides and Biogas	
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) 9. Process Biotechnology fundamentals – Mokhopadhyay S. N. (Anshan Publishers)	

Title of the Course: Industrial Organization Management and Entrepreneurship (Professional Elective –III) **Course Code:**UBIO0824	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**

Course Pre-Requisite: Fundamentals of Management and Industrial Operations

Course Description: This course contains study of different domains of Management and basic functions of Management.

Course Objectives:

1. To Define concept and different functions of management.
2. To Apply management concept in different domains.
3. To Explain concept and Need of Entrepreneurship.
4. To Examine **Entrepreneurship Development stages**

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	**Bloom's Taxonomy**	
		level	**Descriptor**
CO1	Define concept and different functions of management	II	Understand
CO2	Apply management concept in different domains.	III	Apply
CO3	Explain concept and Need of Entrepreneurship.	V	Evaluate
CO4	Examine Entrepreneurship Development stages	IV	Analyze

CO-PO Mapping:

CO\PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO1								3	3	3	3	3	2		
CO2								3	3	3	3	3	2		
CO3								2	2	3	2	3	2		
CO4								2	2	3	2	3	2		

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.

Course Contents:	
Unit: 1 Principles of Management and Business Environment: Management- Meaning and importance, levels of management. Business Environment- Introduction, internal environment, external environment	6Hrs.
Unit: 2 Functions of Management: Planning- meaning and importance, process of planning, Decision making-Meaning, Importance, Types, process Organizing- definition and concept, need and significance, Formal and Informal organization. Communication – definition and concept, importance, steps in communication, types, barriers to communication, ways of overcoming the barriers in communication Motivation – concept, importance, techniques Leadership styles: definition and concept, importance, qualities of good leadership. Controlling- definition and concept, importance, process, control techniques.	6 Hrs.
Unit 3: Personnel Management-staffing: Definition, Importance, sources of recruitment, recruitment procedure, Training and development	6Hrs.
Unit 4: Materials Management: Definition, objectives, duties of material manager, importance, Purchasing- definition, objectives, vendor selection and rating. Inventory control- definition, importance, components, types of inventories	6 Hrs.
Unit5: Marketing Management: Definition, marketing concepts, selling concept, marketing research procedure, market research approaches, Advertising - definition, objectives, benefits, Drawbacks of advertising, advertising media's.	6 Hrs.
Unit 6: Entrepreneurship Development Definition and concept, Modern concept of an entrepreneur, qualities required to become entrepreneur, factors conductive for promoting entrepreneurship, reasons of entrepreneurial failure Entrepreneurship Development: objectives, EDP training	6 Hrs.
References: 1. Industrial and business Management, M.T. Telsang, (S. Chand and Co. New Delhi) 2. Organizational Mgmt. and Behaviour- N. K. Hukeri, (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. Essentials of Management, Harold Koontz, Heinz Weihrich.(McGraw-Hill	
Unit wise Measurable students Learning Outcomes: **At the end of Unit Students will be able to –** 1. Understand **Principles of Management and Business Environment** 2. Understand Functions of Management. 3. Acquire knowledge of Personnel Management. 4. Acquire general understanding Materials Management. 5. Acquire an awareness of Entrepreneurship development.	

Title of the Course: Environmental Biotechnology (Professional Elective –III) Course Code: UBIO0825	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite: Environmental Sciences, Unit Operations

Course Description: This course contains the study of different microorganisms and techniques required for biodegradation, bioremediation, biofuels production and various environmental laws.

Course Objectives:

After completing the course students are able to,

1. Contribute to the global environmental problems by identifying the appropriate waste treatment to the relevant problems
2. Develop engineering solutions to the social, economic and environmental problems.

Course Learning Outcomes:

1. To Explain the microbial diversity, isolation techniques and environmental genomics.
2. To Utilize microbial population for management of agricultural soil air pollution
3. To Compare different biofuel technologies
4. To Develop bioremediation technological solutions for environmental issues
5. To Evaluate environmental laws and policies for the global environmental problems.

CO	After the completion of the course the student should beable to	Bloom's Taxonomy	
		Level	Descriptor
CO1	Explain the microbial diversity, isolation techniques and environmental genomics.	II	Understand
CO2	Utilize microbial population for management of agricultural soil air pollution	III	Apply
CO3	Compare different biofuels technologies	IV	Analyze
CO4	Develop bioremediation technological solutions for environmental issues	III	Apply
CO5	Evaluate environmental laws and policies for the global environmental problems.	V	Evaluate

CO-PO Mapping:

CO\PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	1		2				3								
CO2	1	2	3			3	3								
CO3	2		3			3	3						3	3	2
CO4	2	2	3	2		3	3				2		3	3	2
CO5			3			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.

Course Contents:

Unit 1: Microbial Biodiversity Microbial diversity on earth: extent and importance, level of bacterial diversity, isolation strategies, fungal biodiversity: isolation and identification, Environmental genomics: Degradative plasmids, release of genetically engineered microbes in the environment.	5 Hrs.
Unit 2:Management of Agricultural Soils and Air Pollution Biofertilizer: introduction history, production of nitrogen fixing organisms *Rhizobium, Azotobacter*, Growth hormones (Gibberlic acid, Indole acetic acid) Bioinsecticides: Introduction, production of *Bacillus thuringenesis*, *Trichoderma* Treatment technologies, Bio-filters and Bio-scrubbers for decontamination of polluted air	8 Hrs.
Unit 3: Biofuels Energy crops, Plant derived fuels (Biodiesel), Bioethanol, Microbial Fuel Cell	5 Hrs.
Unit 4: Bioremediation -Fundamentals Definition, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation.	5 Hrs.
Unit 5: Bioremediation - Applications Microbial leaching: Extraction of metals from ores; Recovery of metals from solutions; Microbes in petroleum extraction Biodegradation of xenobiotic compounds: Organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, poly aromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution, Concept of Bioaccumulation and Biomagnifications, Phytoremediation Technology	9 Hrs.

Unit 6: Environmental Laws and Policies	4 Hrs.

Textbooks:

1. General Microbiology, H.G. Schlegel, 7th Ed.(Cambridge University Press)
2. Manual on Solid Waste Management (CPHEEO, Govt. of India).
3. Microbial Ecology: Fundamentals and Applications- Atlas Bartha, 4th Ed.(Dorling Kinderley , India Pvt. Ltd).

References:

1. Manual of Industrial Microbiology and Biotechnology-Arnold Demain and Julian Davies, II Ed. (ASM Press Washington)
2. Wastewater Engineering treatment and reuse- Metcalf Eddy (Wiley Publications)
3. Introductory Practical Microbiology- JayababuMudili (Alpha Science International Limited).

Unit wise Measurable students Learning Outcomes:

At the end of the Unit Students will be able to -

1. identify microbial diversity, their genetic manipulation and containment
2. explain treatment technologies for management of soil and air pollution
3. learn the production technology for biofuels
4. learn bioremediation fundamentals
5. explain applications of bioremediationtechnology
6. understand environmental laws and policies

Title of the Course: FOOD TECHNOLOGY (Professional Elective –III) Course Code:UBIO0825	L	T	P	Credit
	4	-	-	4

Course Pre-Requisite: Biochemistry, bioprocesses

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

Course Objectives:

1. To summarize the students about chemical, biochemical and microbiological characteristics of foods.
2. To explain the principles and techniques of biotechnology in the production, processing and marketing of high quality food and dairy products in a global context.
3. To learn and apply engineering principles and concepts in handling, storing, processing, packaging and distributing food and related products

Course Learning Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Cognitive Level	Bloom's Cognitive Descriptor
CO1	Summarize the students about chemical, biochemical and microbiological characteristics of foods.	2	Understanding
CO2	Explain the principles and techniques of biotechnology in the production, processing and marketing of high quality food and dairy products in a global context.	2	Understanding
CO3	Learn and apply engineering principles and concepts in handling, storing, processing, packaging and distributing food and related products	3	Apply

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3											
CO2							2	1				
CO3	3	2										

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.

Course Contents:	
Unit: 1 Introduction World food demand and Indian scenario, constituents of food (Water, Carbohydrates, Fats and oils, Proteins), quality and nutritive aspects. Food additives. Introduction to FSSAI standards. Deteriorative factors and their control, preliminary processing methods and preservation operation. Introduction to Food Safety Management System (FSMS) and HACCP	**8Hrs.**
Unit: 2 Production and utilization of food products Milk and Milk products: Fluid Milk and some of its derivatives, Ice cream and related frozen desserts, Cheese and their varieties, reduced fat dairy products, Essential micro-organisms and Fermented milk products. Meat, Poultry and Eggs: Meat and meat products, Poultry, Eggs Sea Foods: Fish procurement, Marine fish, Shellfish, Fish byproducts, Contaminants in Fish Spoilage micro-organisms, treatment and disposal of food processing wastes	**8 Hrs.**
Unit: 3 Food Microbiology i. Microbiology in food and factors affecting their growth. ii. Preservation of food iii. Food Spoilage iv. Food poisoning and food borne diseases v. Sanitation of food plants vi. Bacteriology of water-Sampling, inspection	**8 Hrs.**
Unit 4:Improved technology for food processing i. Enzymes in bakery and cereal products ii. Enzymes in fruit juice production iii. Enzymes in cheese making and beverage production.	**8 Hrs.**
Unit 5:Analysis of major food ingredients i. Analysis of preservatives-natural and synthetic ii. Food colors. iii. Food flavor enhancing agents. iv. Chemical measurements Detection and measurement-heavy metals, fungal Toxins, bacteria-toxins, herbicides, Pesticides, toxins	**8 Hrs.**
Unit 6: Downstream processing in food industries and packaging Electro dialysis Systems, Reverse Osmosis System, Types of Reverse- Osmosis and Ultra filtration, Drying Processes & Dehydration Systems, Dehydration System Design, Sedimentation and Centrifugation **Packaging**: Introduction, Food Protection, Product contaminants, Product communication and product convenience, Mass transfer in packaging material, packaging material and product shelf life, Food canning technology, Heat sterilization of canned food.	**8 hrs**
References: 1) F Food Science: 5th Edition-Potter, Norman N. (CBS Publishers & Distributors) 2) Fennema's Food Chemistry, Fourth Edition Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema 3) Food Processing Technology: Principles and Practice by P J Fellows, Wood Head Publishing Limited. 4) Processing Fruits: science and Technology by Diane M. Barrette, Laszlo Somogyi,	

Hosahalli Ramaswamy
5) Fundamental s of Food Engineering by Stanley Charm.
6) Introduction to Food Engineering - R. Paul Singh, Dennis
7) Heid, J. L.and Joslyn,M. A. ,Fundamental s of Food
8) Processing Operation, The AVIPublishing Co;Westport
9) Heldman, D. R., Food Process Engineering,TheAVI Publishing Co; Westport ,1975.
10) Hal l, C. W; Farall, A. W.& Rippen, A. L ;Encyclopedia of Food Engineering, Van Nostrand-Reinhold.
11) Food Process Engineering-Heldman D. R. (AVI Publishing Co)
12) Food Processing and preservation- B. Sivsankar PHI Learning Pvt. Ltd.

Unit wise Measurable students Learning Outcomes:
At the end of Unit Students will be able to –

1. To summarize the students about chemical, biochemical and microbiological characteristics of foods.
2. To explain the principles and techniques of biotechnology in the production, processing and marketing of high quality food and dairy products in a global context.
3. To learn and apply engineering principles and concepts in handling, storing, processing, packaging and distributing food and related products

Title of the Course: Project Phase -II **Course Code:** UBIO0851	**L** -	**T** -	**P** 12	**Credit** 6

Course Pre-Requisite:
All Theoretical And Practical Skills Learnt Till Previous Semester

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

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

Course Learning Outcomes:

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

CO-PO Mapping:

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO1			3	3	2				2				3		
CO2				3											
CO3					1			3	3	3	1				

Assessments :
Two components of In Semester Evaluation (ISE) and EndSemester Examination (ESE) having 50% and 50% weights respectively.

Assessment	**Marks**
ISE - I	75
ISE - II	75
ESE	150

ISE is based on the rubrics based progressive report submission and presentationto respective supervisors.
ESE is based on presentation of synopsis to expert panel.
Each project batch should consist of maximum 3 project groups having maximum 9 students.

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