STRUCTURE

H. B. Technological Institute, Kanpur-02(U.P.)

B. Tech Chemical Technology (BIOCHEMICAL ENGINEERING)

Structure & Evaluation Scheme

(Recommended By B.O.S)

(w.e.f. 2009-10)

Year I Semester I Branch: Chemical Technology (Biochemical Engineering)

S.No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			ESE		
			L	T	P	CT	TA	Total			
Theory											
1	HMA-101	Mathematics I	3	1	0	30	20	50	100	150	4
2	HPH-101/HCY-101	Physics / Chemistry	3	1	0	30	20	50	100	150	4
3	HEE-101/HET-101	Electrical Engg./Electronics Engg.	3	1	0	30	20	50	100	150	4
4	HME-101/HCS-101	Engg. Mechanics/ Concepts of Computer and C Programming	3	1	0	30	20	50	100	150	4
5	HHU-101/HCE-101	Professional Communication/Engineering Graphics	3	1	0	30	20	50	100	150	4
6	HHU-102/HCE-102	Remedial English/Environment and Ecology	2	0	0				50	50	Audit
Practical/Training/Project											
7	HPH-151/HCY-151	Physics Lab/ Chemistry Lab	0	0	3	10	10	20	30	50	1

8	HHU-152/HCS-151	Language Lab / Computer Lab	0	0	3	10	10	20	30	50	1
9	HEE-151/HME-151	Electrical Engg.Lab/Workshop Practice	0	1	3	30	20	50	50	100	2
10	HGP-101	GP						50		50	

Year I Semester II Branch: Chemical Technology (Biochemical Engineering)

S.No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			ESE		
			L	T	P	CT	TA	Total			
Theory											
1	HMA-201	Mathematics II	3	1	0	30	20	50	100	150	4
2	HPH-201/HCY-201	Physics / Chemistry	3	1	0	30	20	50	100	150	4
3	HEE-201/HET-201	Electrical Engg./Electronics Engg.	3	1	0	30	20	50	100	150	4
4	HME-201/HCS-201	Engg. Mechanics/ Concepts of Computer and C Programming	3	1	0	30	20	50	100	150	4
5	HHU-201/HCE-201	Professional Communication/Engineering Graphics	3	1	0	30	20	50	100	150	4
6	HHU-202/HCE-202	Remedial English/Environment and Ecology	2	0	0				50	50	Audit
Practical/Training/Project											
7	HPH-251/HCY-	Physics Lab/ Chemistry Lab	0	0	3	10	10	20	30	50	1

	251										
8	HHU-251/HCS-251	Language Lab / Computer Lab	0	0	3	10	10	20	30	50	1
9	HEE-251/HWS-251	Electrical Engg.Lab/Workshop Practice	0	1	3	30	20	50	50	100	2
10	HGP-201	GP						50		50	

Year II Semester III Branch: Chemical Technology (Biochemical Engineering)

S.No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			ESE		
			L	T	P	CT	TA	Total			
Theory											
1	HMA-401	Computer oriented numerical method	3	1	0	30	20	50	100	150	4
2	HCH-406	Fluid Flow and Solid Handling	3	1	0	30	20	50	100	150	4
3	HCH-407	Chemical Engineering Thermodynamics	3	1	0	30	20	50	100	150	4
4	HCH-408	Instrumentation and Process Control	3	1	0	30	20	50	100	150	4
5	HBE-401	Biochemistry	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
7	HMA-451	Numerical Techniques Lab	0	0	3	15	10	25	25	50	
8	HCH-458	Instrumentation and Process Control	0	0	3	15	10	25	25	50	
9	HBE-451	Biochemistry Lab	0	0	6	30	20	50	50	100	
10	HGP-401	G.P.						50		50	

Year II Semester IV Branch: Chemical Technology (Biochemical Engineering)

S.No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			ESE		
			L	T	P	CT	TA	Total			
Theory											
1	HMA-401	Numerical Methods and Computer Programming	3	1	0	30	20	50	100	150	4
2	HCH-401	Fluid Flow and Solid Handling	3	1	0	30	20	50	100	150	4
3	HCH-402	Chemical Engineering Thermodynamics	3	1	0	30	20	50	100	150	4
4	HCH-403	Instrumentation and Process Control	3	1	0	30	20	50	100	150	4
5	HBE-401	Biochemistry	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
7	HMA-451	Numerical Methods and Computer Programming Lab	0	0	3	15	10	25	25	50	
8	HCH-451	Instrumentation and Process Control	0	0	3	15	10	25	25	50	
9	HBE-451	Biochemistry Lab	0	0	6	30	20	50	50	100	
10	HGP-401	G.P.						50		50	

Year III Semester V Branch: Chemical Technology (Biochemical Engineering)

S.No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			ESE		
			L	T	P	CT	TA	Total			
Theory											
1	HME-501	Elements of Mechanical Engineering	3	1	0	30	20	50	100	150	4
2	HCH-501	Heat Transfer Operations	3	1	0	30	20	50	100	150	4
3	HCH-502	Mass Transfer Operations	3	1	0	30	20	50	100	150	4
4	HBE-501	Concepts in Biochemical Engineering	3	1	0	30	20	50	100	150	4
5	HBE-502	Molecular Biology and Genetic Engineering	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
6	HBE-551	Biochemical Engineering Lab	0	0	3	15	10	25	25	50	
7	HBE-552	Molecular Biology Lab	0	0	6	30	20	50	50	100	
8	HCH-551	Chemical Engineering Unit Operation Lab	0	0	3	15	10	25	25	50	
9	HGP-501	G.P.						50		50	

Year III Semester VI Branch: Chemical Technology (Biochemical Engineering)

S.No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			ESE		
			L	T	P	CT	TA	Total			
Theory											
1	HME-601	Machine Design	3	1	0	30	20	50	100	150	4
2	HCH-601	Chemical Reaction Engineering	3	1	0	30	20	50	100	150	4
3	HBE-601	Fermentation Technology	3	1	0	30	20	50	100	150	4
4	HBE-602	Waste Treatment	3	1	0	30	20	50	100	150	4
5	HBE-603	Bioprocess Engineering	3	1	0	30	20	50	100	150	4

Practical/Training/Project											
6	HBE-651	Fermentation Lab	0	0	6	30	20	50	50	100	
7	HBE-652	Waste Treatment Lab	0	0	3	15	10	25	25	50	
8	HBE-653	Seminar	0	0	3			50		50	
9	HGP-601	G.P.						50		50	

Year IV Semester VII Branch: Chemical Technology (Biochemical Engineering)

S.No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			ESE		
			L	T	P	CT	TA	Total			
Theory											
1	HCH-701	Equipment Design	3	1	0	30	20	50	100	150	4
2	HBE-701	Enzyme Engineering and Technology	3	1	0	30	20	50	100	150	4
3	HBE-702	Bioreactor Design and Analysis	3	1	0	30	20	50	100	150	4
4	HBE-703	Down Stream Processing	3	1	0	30	20	50	100	150	4
5	Open Elective*	Principles of Biochemical Engineering and Biotechnology	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
7	HBE-751	Enzyme Engineering Lab	0	0	6	30	20	50	50	100	
8	HBE-752	Industrial Training Report Presentation	0	0	3			50		50	
9	HBE-753	Project (Dissertation)	0	0	3			50		50	
10	HGP-701	G.P.						50		50	

* To be offered for other departments.

Year IV Semester VIII Branch: Chemical Technology (Biochemical Engineering)

S.No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			ESE		
			L	T	P	CT	TA	Total			
Theory											
1	HHU-801	Industrial Management	3	1	0	30	20	50	100	150	4
2	HCH-801	Process Modeling and Simulation	3	1	0	30	20	50	100	150	4
3	HBE-801	Bioinformatics	3	1	0	30	20	50	100	150	4
4	HBE-802	Food Biotechnology	3	1	0	30	20	50	100	150	4
5	(Branch Elective) HBE-011 HBE-012 HBE-013 HBE-014	 IPR, Biosafety and Regulatory Issues Novel Bioproducts Plant Cell Biotechnology Biosensors	3	1	0	30	20	50	100	150	4
Practical/Training/Project											
7	HBE-851	Project	0	0	12	30	20	50	100	150	
8	HBE-852	Educational Tour						50		50	
9	HGP-801	G.P.						50		50	

H.B.Technological Institute,Kanpur-02 (U.P.)
M.Tech Chemical Technology (Biochemical Engineering)
Structure and Evaluation Scheme (w.e.f. 2010-11)
Recommended by BOS
I Semester

S. No.	Course Code	Subject	Periods			Evaluation Scheme					Subject Total
			L	T	P	Sessionals				Examination	
						CT	Attendance	TA	Total		
1	PCH-103	Advance Mathematics and Statistical Design of Experiments	3	1	0	30	10	10	50	100	150
2	PBE-101	Bioreactor Design and Analysis	3	1	0	30	10	10	50	100	150
3	PBE-102	Structural and Molecular Biology	3	1	0	30	10	10	50	100	150
4	Elective-I PBE-103 PBE-104 PBE-105 PMA-101	Bioinformatics Analytical Methods in Bioprocesses Biochemical Engineering* Engineering Mathematics**	3	1	0	30	10	10	50	100	150
		Total	12	4	0				200	400	600

***Only for students other than Biochemical Engg. And Biotechnology background**
**** Only for students of M.Sc. (Chemistry) Biology background.**

II Semester

S. No.	Course Code	Subject	Periods			Evaluation Scheme					Subject Total
			L	T	P	Sessionals				Examination	
						CT	Attendance	TA	Total		
1	PBE-201	Bioseparation and Downstream Processing	3	1	0	30	10	10	50	100	150
2	PBE-202	Bioprocess Technology	3	1	0	30	10	10	50	100	150
3	PBE-203	Environmental Biotechnology	3	1	0	30	10	10	50	100	150
4	Elective-II PBE-204 PBE-205 PBE-206	 Plant Biotechnology Animal Cell Culture & Tissue Engineering Biomedical Instrumentation	3	1	0	20	10	10	40	60	100
5	PBE-207	Critical Review of Research Publications on one Relevant Topic	0	4	-	-	-	-	50		50
		Total	12	8	0				240	360	600

III Semester

S. No.	Course Code	Subject	Periods			Evaluation Scheme					Subject Total
			L	T	P	Sessionals				Examination	
						CT	Attendance	TA	Total		
1	PCH-301	Modeling & Simulation of	3	1	0	30	10	10	50	100	150

		Chemical Engineering Systems									
2	Elective-III PBE-301 PBE-302 PBE-303	Bio-Process Plant Design Bioenterpreneurship and Regulatory Issues Bioenergy	3	1	0	30	10	10	50	100	150
3	PBE-304	Project Dissertation*	-	8	-	-	-	-	50	-	50
4	PBE-305	Seminar	-	-	2	-	-	-	100	-	100
		Total	6	10	2				250	200	450

*Dissertation to continue in fourth semester.

IV Semester

S. No.	Course Code	Subject	Periods			Evaluation Scheme					Subject Total
			L	T	P	Sessionals				Examination	
						CT	Attendance	TA	Total		
1	PBE-401	Research Project	-	-	18	-	-	-	150	200	350
		Total	-	-	18				150	200	350

Grand Total: 2000

H. B. Technological Institute, Kanpur-02(U.P.)

B. Tech Chemical Technology (Biochemical Engineering)

Existing Detailed Syllabus of Departmental Subjects

(Theory/Practical)

HBE-301 MICROBIOLOGY

L :	T:	P
3	1	0

Microbiology and its scope, microscopy. Classification, morphology and physiology of bacteria, yeast, molds, algae and virus.

Microbial growth kinetics, growth curve, diauxic growth factors influencing growth, continuous and synchronous culture, microbial nutrition and reproduction.

Pure culture techniques – microbial culture media, isolation, identification and maintenance of cultures, characteristics of pure culture, enumeration techniques.

Physical and chemical methods of control of microorganisms, immune response, antigen-antibody interaction. Microbial defense mechanisms under adverse conditions.

Microbial ecology, incidences of microorganisms in soil, water, air, food and sewage, food spoilage organisms, food borne infections and poisoning organisms.

References:

1. "Microbiology" by M.J. Pelczar, Jr. E.C.S. Chan and N.R. Krieg, 5th Ed. , TMH Book Company.
2. "Foundation in Microbiology", Kathleen Talaro & Arthur Talaro, W.C.B. Wm. C. Brown Publishers (1994).

HBE-351 MICROBIOLOGY LAB

L :	T :	P
0	0	6

1-2. Microscopy: Use & care of microscope, examination of prepared slides and wet mounts of bacteria, yeast, molds. Microbial identification & examination of food samples. Other biomaterials of bacteria yeast and molds.

3. Micrometry: Measurement of microbial cells.

4. Staining techniques: Simple staining, Gram staining, Endospore staining, Capsule staining.

5-7. Enumeration techniques: Microscopic count using haemocytometer, Viable cell count (By pour plate method) Turbidity measurement as direct expression of growth.

8-9. Culture techniques: Culture media preparation, Cultivation of microorganisms.

10. Isolation of microorganisms by streak plate method.

11. Isolation by serial dilution method, maintenance & preservation.

12. Influence of antimicrobial agent on growth effect of UV radiation & heat on microbial growth.

13. Microbiological examination of water: Coliform & Salmonella counts.

14. Microbiological assay of a growth factor.

References:

1. "Microbes in action". A laboratory manual of Microbiology, H.W. Seeley Jr. and Paul J. Van Demark, D.B. Taraporevala Sons & Co. Pvt. Ltd.

2. "Methods in Microbiology", Ed. J.R. Norris and D.W. Ribbons, Vol. 3 A, Academic Press, London & New York.

HBE-401: BIOCHEMISTRY

L : T: P
3 : 1 : 0

Structure and function of biomolecules; carbohydrates, proteins, lipids, nucleic acids, vitamins and coenzymes.

Structure and function of enzymes, mechanism of enzymatic catalysis and enzyme kinetics.

Biological membranes and transport across them. Bioenergetics. Major anabolic and catabolic pathways of carbohydrate metabolism and their regulation; glycolysis, TCA cycle, pentose phosphate pathway, galactose metabolism, electron transport and oxidative phosphorylation, gluconeogenesis. Typical metabolic pathways of microbes; Entner-Duodoroff pathway, glyoxylate cycle, phosphoketolate pathway. Lipid metabolism; transport and oxidation of fatty acids in animal tissues, glycerol metabolism, biosynthesis of fatty acids and triacylglycerol.

Nucleic acid metabolism; mechanism and biosynthesis of DNA and RNA, reverse transcription.

Protein metabolism; out lines of amino acid metabolism and their significance. Protein biosynthesis, inhibitors of protein synthesis, transport of proteins and signal peptides.

References:

1. "Principles of Biochemistry", A.L. Lehninger, D.L. Neston, N.M. Cox, CBS Publishers & Distributors.
2. "Biochemistry", Lubert Stryer, W.H. Freemen & Co. , New York.
3. "General Biochemistry", J.H. Weil, New Age International (PLD).

HBE-451 : BIOCHEMISTRY LAB

L : T: P
0 : 0 : 6

1 Estimation of carbohydrates.

2. Estimation of proteins.

3. Estimation of nucleic acids:

4. Isoelectric precipitation.

5. Separation of amino acids by paper chromatography.

6. Separation of sugars by paper chromatography.

7. Extraction of Lipids.

8. Thin layer Chromatography.

9. Gel Electrophoresis.

10-11. Assay of enzyme activity and enzyme kinetics.

12. Identification and estimation of an intermediate of EMP pathway.

13. Cell fractionation.

References:

1. "An Introduction to Practical Biochemistry", David T. Plummer, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

HBE-501 CONCEPTS IN BIOCHEMICAL ENGINEERING

L : T: P
3 : 1 : 0

Definition and scope of biochemical engineering. Different biochemical unit operations and processes.
Principles of basic and engineering sciences applicable to bioprocesses.
End-products of metabolism: Primary and secondary metabolites, such as enzymes, amino acids, organic acids, solvents, nucleotides and antibiotics. Anaerobic metabolic end products and partial oxidation and its end products.
Stoichiometry and kinetics of cell growth and product formation. Overall growth stoichiometry, elemental and available electron material balance for growth, heat generation and yield concepts etc.
Metabolic pathway synthesis of small molecules through key crossroads and branch points in metabolism.
Solid and submerged fermentation processes.
Design of experiments for bioprocess development.
Commercial aspects of Biotechnological processes. New challenges and future prospects in industrial bioprocess.

HBE – 502: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

L : T : P
3 : 1 : 0

Development of Molecular Biology. Nucleic acids forms, structure and functions. Gene: Its concept and inheritance.

Regulation of transcription and translation. Protein structure, folding and refolding.

Controlling of Prokaryotic Gene Expression, control circuit of operon. Tryoptophan operon. Repressor blockage.

r-DNA Technology : Principles, construction and properties of vectors and restriction enzyme properties and uses.

Gene cloning and expression of genes. Restriction mapping and -DNA sequencing.

References:

1. "Molecular Biology of the Gene", J.D. Watson, Melnopark, California.
2. "Genes", 8th Ed., Benjamin Lewis (2000) John Wiley & Sons, New York.
3. "Biochemistry", A.L. Lehninger, Worth Publication, New York.
4. " Recombinant DNA Technology", Dhillon J.R., John Wiley & Sons, New York.
1. "Genetics", P.K. Gupta, Rastogi Publication, Meerut.

HBE-551 BIOCHEMICAL ENGINEERING LAB

L : T : P
0 : 0 : 3

1. Effect of physical and chemical environment on growth; selected biochemical tests.
2. Study the growth curve of bacterial and yeast strains.
3. Growth kinetic studies of yeast in a bench top lab fermentor under controlled conditions.
4. Studies on settling characteristics of various microbial cultures.
5. Study the solid state fermentation with suitable example.

References:

1. "Biochemical Engineering Fundamentals" by J.E. Bailey and D.F. Ollis, McGraw-Hill Book Co., New York.
2. "Principle of Fermentation Technology", P.F. Stanbury and A. Whitaker; Pergamon Press.
3. "Immobilized Cells and Organelles" Vol. I; B. Mattiason, CRC Press, Florida.
4. "Methods in Enzymology", S.P. Colwick and N.O. Kaplan, Academic Press.

HBE - 552: MOLECULAR BIOLOGY LAB

L : T: P

0 0 6

1. Screening and selection of mutants by exposure of microbial cells to physical agents.

2, Mutation using chemical agents.

3. Estimation of DNA and RNA in microbial cells.

4. Induction and repression of β-galactosidase in yeast.

5. Development of recombinant strains.

References:

1. "An Introduction to Practical Biochemistry", david T. Plummer, Tata McGraw-Hill Pubblishing Co. Ltd., New Delhi.

2. "Methods in Microbiology", Ed. J.R. Norris and D.W. Ribbons, Vol. 3 A, Academic Press, London & New York.

3. "Methods in Yeast Genetics", A Laboratory Mannul of Cold Spring Harbour Laboratory, (1974 F. Sherman, G.R. Fink & C.W. Lawrence, Cold Spring Harbour, New York.

HBE-601 - FERMENTATION TECHNOLOGY

L : T: P
3 : 1: 0

Alcoholic fermentation and related products. Glycerol fermentation.

Malting and brewing: beer production, wine manufacturing and other distilled liquors.

Microbial production of organic acids and fermentation processes.

Biomass as a fermentation product: Baker's yeast, Bioinsecticides, Biofertilizers.

Amino acids: Lysine and glutamic acid. Commercial enzymes: Solid and submerged fermentation, recovery etc.

Secondary metabolites such as antibiotics and vitamins.

Microbial transformations, vaccines, recombinant therapeutic proteins.

References:

1. "Industrial Microbiology", S.C. Prescott and C.G. Dunn, McGraw-Hill Book Company, Inc. New York.
2. "Industrial Microbiology", L.E. Casida Jr. Wiley Eastern Ltd.
3. "Microbial Technology", Vol.II, H.J. Peppler and D. Perlman, Academic Press, New York.

HBE – 602 WASTE TREATMENT

L :	T:	P
3 :	1:	0

Source and characteristics of waste, physical and chemical methods of waste treatment.

Bioprocess kinetics applied to waste treatment. Operation and design features of trickling filters and rotating biological contractor (RBC).

Theory of activated sludge process, design, operation and control, BOD reduction and biomass relationship, modifications, stabilization ponds, operational and design aspects.

Anaerobic treatment systems. Sludge digestion theory, digestor design, high rate digestion, heat transfer in digestor.

New developments, fixed film reactors, UASB. Nitrification - denitrification, Phosphorous removal.

Treatment and disposal of waste of the industries e.g. distilling and brewing, antibiotics and sugar etc.

References:

1. "Waste Water Engineering: Treatment, Disposal and Reuse", Metcalf & Eddy, Inc.; Tata McGraw-Hill Publishing Company Ltd., New Delhi.

2. "Water supply and Pollution control", Warren Viessman Jr. and Mark J. Hammer; Harper & Row Publishers; New York.

3. "Environmental Engineering", Howard & Peavy, Donald R. Rawe and George Tehobanoglousd, Mcgraw- Hill International Editions.

4. "Waste Water Treatment", Rao & Dutta.

HBE - 603 BIOPROCESS ENGINEERING

L : T: P
3 : 1: 0

Kinetics of microbial growth, substrate utilization and product formation in batch reactors. Mixed culture systems.

Sterilization of media: Principles, design of batch and continuous sterilization processes.

Sterilization of air: Principles, methods of air sterilization, design of air filters.

Aeration and agitation: Oxygen transfer in microbial systems, oxygen demands, mass transfer theories, measurements of volumetric oxygen transfer coefficient, power requirements in gassed and ungassed bioreactors, rheology of fermentation fluids.

Scale-up: criteria, basic concepts and related problems.

References:

1. "Biochemical Engineering", Shuichi Aiba, Arthur E. Humphrey, Nancy F. Millis; University of Tokyo Press.
2. "Biochemical Engineering Fundamentals" by J.E. Bailey and D.F. Ollis, McGraw-Hill Book Co.
3. "Basic Biotechnology", J. Bu'lock, B. Kristiansen, Academic Press.
4. "Principle of Fermentation Technology", P.F. Stanbury and A. Whitaker; Pergamon Press.

HBE-651 FERMENTATION LAB

L :	T:	P
0	0	6

1. Analysis of molasses.
2. Preparation of malt and determination of diastatic power.
3. Determination of fermentation efficiency of yeast for batch production of ethanol.
4. Effect of substrate concentration on biomass yield for baker's yeast production and its characterization.
5. Fermentation efficiency for vinegar production.
6. Citric acid production by (a) solid state and (b) submerged fermentation.
7. Microbial production of enzymes by (a) solid state and (b) submerged fermentation.
8. Analysis of' finished products (rectified sprit, beer etc.).

References:

1. "Industrial Microbiology", S.C. Prescott and C.G. Dunn, McGraw-Hill Book Company, Inc. New York.
2. Official methods of analysis of AOAC.
3. BIS booklets for various products.
4. "An Introduction to Practical Biochemistry", david T. Plummer, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

HBE-652 WASTE TREATMENT LAB

L : T: P
0 : 0 : 3

1. Estimation of dissolved oxygen in water sample.
2. Determination of Biochemical Oxygen Demand (BOD) in wastewater sample.
3. Determination of Chemical Oxygen Demand (COD) in wastewater sample.
4. Determination of Solids: Volatile, fixed and total.
5. Evaluation of the effect of process, variables on the performance of activated sludge process.
6. Evaluation of performance of anaerobic digestor.
7. Estimation of inorganic ions in water.

HBE-653 SEMINAR

L : T: P
0 : 0 : 3

The student(s) will be required to prepare and deliver a seminar as well as submit a written report on the topic assigned to him/her

HBE-701 ENZYME ENGINEERING AND TECHNOLOGY

L : T: P
3 : 1: 0

Introduction - and scope, mechanism of enzymatic catalysis, characterization of active sites and ligand binding sites.

Enzyme kinetics of single and multiple substrates. Kinetics of inhibition and activation, King and Altman method, allosteric enzymes.

Immobilization of enzymes and cells. Methods of immobilization.

Effect of micro and macro environmental parameters on the kinetics of immobilized enzymes: External f i l m and internal pore diffusion, partitioning and electrostatic interactions.

P erformance of soluble and immobilized enzyme reactors, operational strategies, carrier life and cycle time.

Production and applications of selected industrial enzymes.

References:

1. "Biochemical Engineering Fundamentals" by J.E. Bailey and D.F. Ollis, McGraw-Hill Book Co., New York.
2. "Immobilized Enzymes" by Trevan.
3. Enzyme kinetics by Roberts.
4. Enzyme Engineering by Laidler

HBE-702 BIOREACTOR DESIGN AND ANALYSIS

L : T: P
3 : 1: 0

Design equations for batch, continuous and fed batch reactors. Non- ideal flow behaviour of continuous flow reactors.

Novel bioreactor configuration such as fluidized bed reactor, air-lift reactor, bubble column, membrane bioreactor etc.

Bioreactor operation measurement and control: Aseptic operations, measurement and control of process variables (pH, dissolved oxygen, viscosity, temperature, NADH), agitative power and foam control. On-line analysis and computer control of fermentation process.

Bioprocess economics

HBE-703 DOWN STREAM PROCESSING

L :	T:	P
3 :	1:	0

Characteristics of bio products: Flocculation and conditioning of broth.

Mechanical separation: Filtration, centrifugation.

Cell disruption. Membrane based separation.

Protein precipitation and its separation; Aqueous two phase extraction, Adsorption.

Chromatographic separation based on size, charge, hydrophobic interaction, metal ion affinity.

Electrophoresis, crystallization and drying.

References:

1. "Biochemical Engineering Fundamentals" by J.E. Bailey and D.F. Ollis, McGraw-Hill Book Co., New York.
2. "Basic Biotechnology", J. Bu'lock, B. Kristiansen, Academic Press.
3. "Comprehensive Biotechnology"; Vol. 2, Murray-Moo-Young, Pergamon Press, New York.

HOE-41 : PRINCIPLES OF BIOCHEMICAL ENGINEERING AND BIOTECHNOLOGY *

L : T: P
3 : 1: 0

1. Introduction: Development and prospects of biotechnology. Characteristics of living organisms, classification, morphology and physiology of microorganisms.

2. Growth, reproduction and nutritional aspects of micro-organisms. Culture isolation, maintenance. Physical and chemical control of micro-organisms.

3. General requirements of the microbial processes. Batch fermentation, growth and product formation kinetics. Sterilization of media and air. Aeration and agitation. Down stream processing.

4. Production of alcohol, glycerol, organic acids, baker'ss yeast, enzymes.

5. Antibiotics, biofertilizers, biopesticides. Concepts of biological waste treatments. New developments in biotechnology.

* For the students of branches other than Biochemical Engineering.

References:

1. "Principle of Fermentation Technology", P.F. Stanbury and A. Whitaker; Pergamon Press.

2. "Basic Biotechnology", J. Bu'lock, B. Kristiansen, Academic Press.

3. "Biochemical Engineering Fundamentals" by J.E. Bailey and D.F. Ollis, McGraw-Hill Book Co., New York.

HBE-751 ENZYME ENGINEERIGN LAB

L : T: P
0 : 0: 6

1. Assay of enzyme activity and specific activity.
2. Kinetic analysis of an enzyme catalyzed reaction.
3. Immobilization of enzymes by adsorption and covalent binding.
4. Salt precipitation of an enzyme.
5. Immobilization of microbial cells by entrapment.
6. Effect of water activity and solvent on the lipase catalyzed esterification reaction.
7. Comparative study of performance of soluble and immobilized enzyme reactors.

HBE- 752: INDUSTRIAL TRAININGREPORT PRESENTATION

L : T: P
0 : 0 : 3

The student(s) will be required to undertake training in the Biochemical industry after III B. Tech./ VI semester for a specified period and submit its report after completion for evaluation and oral examination in the VII semester of his studies in Final B. Tech.

HBE-753: PROJECT (DISSERTATION)

L : T: P
0 : 0 : 3

The student (s) will be required to search literature pertaining to design of an equipment / processing of a biochemical product / production of biochemical product, comprehend it and prepare a report for assessment.

HBE – 801 BIOINFORMATICS

L : T: P
3 : 1: 0

Definitions of informatics, chronological history Molecular Biology's Central dogma; Gene structure and Information content, protein structure and function, Molecular Biology tools.

Database concept, Biological Databases; (Different types of data books spl. Biochemical pathway databases). Sequence Analysis, Pairwise Alignmant and Database Searching.Multiple sequence Alignments, Trees and Profiles.

Genomies and Gene Recognition; From Sequencing Genes to Genomes Sequence Assembly,
Annotation and Analyzing whole Genome sequences, Functional Genomics.

Predicting protein structure and function from sequences, Determine the structures of Proteins, Predicting the structures of proteins, from 3D to 1D. Feature Detection, in protein sequences, Secondary structure prediction, predicting 3D structures.

Applications and software Tools for Bioinformatics, Challenges for Bioinformatics, Industry Drug Design & DNA chip.

HBE-802 FOOD BIOTECHNOLOGY

Microbes in food process operations and production, new protein foods, SCP, mushroom, algal protein etc. Alcoholic beverages and other products.

Preparation and preservation of food by fermentation. Microbial food additives, colouring, flavours and vitamins.

Mechanisms of enzyme functions and reactions in process techniques, baking by amylases, deoxygenation and desugaring by glucose-oxidase.

Cheese making by protease and various other enzyme reactions in food processing, lipase and their application in oil quality improvement.

Bioconversion of process waste like whey, molasses, starch substrates to useful products. Genetically Modified Food.

References:

1. "Industrial Microbiology", S.C. Prescott and C.G. Dunn, McGraw-Hill Book Company, Inc. NewYork.
2. "Microbial Technology", Vol.II, H.J. Peppler and D. Perlman, Academic Press, New York.

HBE-011 IPR, BIOSAFETY AND REGULATORY ISSUES

L : T: P
3 : 1: 0

Jurisprudential definition and concept of property, right, duties and their correlation. History and evolution of IPR- like patent, design and copy right Indian patent act, international convention in IPR. TRIPS agreement; IPR issues in relation to biotech products/ processes; architecture of patent application.

Detailed information on patenting biological products, biodiversity, Budapest treaty, appropriate case studies.

Biosafety Principles - environment and health risk assessment; biosafety regulatory guidelines and controlling agencies, Environmental law for hazardous microorganisms and GMOs; Biotechnology Related Issues of Public Concern - Bioethics.

Regulatory issues concerning the global biotechnology & pharmaceutical industries, including Good Laboratory & Clinical Practice (GLP & GCP).

HBE-012 NOVEL BIOPRODUCTS

L : T: P
3 : 1: 0

Microbioreactors in biochemical engineering, biosensors and biomarkers.

Natural Biopreservatives (Bacteriocin/Nisin), and Biopolymers (Pullulan/Xanthan Gum and PHB) production and applications.

Biopharmaceuticals and nutraceuticals, bioinsecticides and biopesticides production by microorganisms.

Lignocellulosic bioconversion to bioproducts, novel bioproducts from renewable resources.

Biofuels from renewable raw materials: liquid biofuels and gaseous biofuels. Biofuel cells and applications.

Steroid bioconversions; bioconversion of vegetable oils, bioleaching, MEOR etc.

HBE-013 PLANT CELL BIOTECHNOLOGY

L : T: P
3 : 1: 0

1. Special features and organization of plant cells; totiopotency and regeneration of plants, examples of regeneration from leaves, roots, stem etc.

2. Plant product of industrial importance, biochemistry of major metabolic pathways and products, cells suspension culture development.

1. Large scale production of secondary metabolites from suspension cultures. Characterization, kinetics of growth and the product formation, examples.

2. Nutrient optimization, cells growth regulators, biological and technological barriers, mutation, somaclonal variation.

3. Genetic engineering of plant cell, plant cells reactors and their performance. Immobilized plant cell reactor and novel design concepts.

References:

1. "Plant Tissue Culture and its Biotechnological Application", W. Barz, E. Reinhard and M.H. Zenk (Eds.); Springer-Verlag, Berlin.

2. "Plant Cell Biotechnology", H. Smith and Mantell (Eds); Cambridge University Press, Cambridge.

HBE-014: BIOSENSORS

L : T: P
3 : 1: 0

Introduction about Biosensors, advantages and limitations, various components of biosensors.
Types of biosensors: biocatalysis based biosensors, bioaffinity based biosensors & microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions.

Transducers in biosensors: various types of transducers; principles and applications - calorimetric, optical, potentiometric / amperometric conductrometric/resistormetric,
piezoelectric, semiconductor, mechanical and molecular electronics based transducers etc.
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.

References:
1. Pearson, J.E. Gill, A., and Vadgama, P. (2000) Analytical aspects of biosensors Ann Clin Biochem 37, 119-145.
2. Roger, K.R. and Gerlach, C.L. 1~99. Update on environmental for biosensors. Env. Sci. Techno! 33 500A - 506A.
3. Bilitewski, U. Turner, A.P.F. 2000 Biosensors for environmental monitoring Harwood, Amsterdam.
4. Moses, V and Cape, R.E. 1991, Biotechnology the science and business, Harwood, Academic Publisher London
5. Rogers, K.R. and Mascini, M. 2001. Biosensors for analytical monitoring EPA biosensors group.

HBE-851 : DESIGN PROJECT

L : T: P
0 : 0: 1 2

The student(s) will be required to prepare a Detailed Project Report on fabrication of an equipment / establishment of a plant for producing biochemical product with complete layout in continuation of Dissertation work of BE-753 with a Techno-economic Feasibility Report of suitable size.

HBE-852 : EDUCATIONAL TOUR

The student(s) will be required to visit Biochemical industries after VII semester for a specific period and submit its report after completion for evaluation an oral examination in the VIII semester of his/her studies in Final B. Tech.

H.B.Technological Institute, Kanpur-02 (U.P.)
M.Tech Chemical Technology (Biochemical Engineering)
Detailed Syllabus (w.e.f. 2010-11)
Recommended by BOS

Semester-I

PCH-103 ADVANCE MATHEMATICS AND STATISTICAL DESIGN OF EXPERIMENTS

PBE-101 BIOREACTOR DESIGN AND ANALYSIS

Bioreactors for microbial, animal and plant cell culture. Stirred tank reactor for bio-processing. Design principles, mixing & mass transfer behavior and characterization of plug flow reactor, Air-lift reactor, tubular reactor etc. Bioreactors used for immobilized cells and enzymes. Design and applications of non-conventional bioreactors such as spiral reactor, membrane reactor, photo-bioreactor, tower reactors. Monitoring, on-line measurements & computer control of bioreactors.

PBE-102 STRUCTURAL AND MOLECULAR BIOLOGY

Characteristics of living systems, Structure and functions of biomolecules and cell organelles. Non covalent interactions in living cells. Taxonomy, Morphology and Physiology of microorganisms. Transport across biological membranes. Bioenergetics: energy producing and consuming metabolic processes.

Genetic information and its perpetuation. Transcription and translation: mechanism and control. Gene exchange and gene regulation in microbes. The Operon models.

ELECTIVE -I

PBE-103: BIOINFORMATICS

Introduction and overview: The NCBI, sequence databases, sequence retrieval, sequence file formats, submitting DNA and protein sequences, sequence assembly.

Exact string matching -classical comparison based methods, semi numerical string matching, suffix trees -construction and application, Databases and rapid sequence analysis –Blast and Fasta , sequence comparison by statistical content; Dynamic programming alignment -The number of alignments, shortest and longest paths in a network, global distance and similarity alignments, Fitting one sequence onto the other, trace backs, parametric sequence comparison.

Global and local alignments, scoring matrices-pam and blosum and gap penalties, filtering, position specific scoring matrices, internet resources , uses of multiple sequence alignment programs and methods pattern searching programs, family and superfamily representation, profit analysis.

Trees-representation of sequences, tree interpretation, Distance – additive, ultrameric and nonadditive distances, tree building methods, phylogenetic analysis, parsimony, Bootstrap, maximum likelihood trees , estimating the rate of change, likelihood and trees; analysis software.

Annotation, ESTs – databases, comparative genome analysis clustering, gene discovery, protein identification, physical properties, motifs and patterns, structure, folding classes, structure classification; Structure databases– PDB and MMDB, visualizing structural information, Docking of Molecules, structure prediction in proteins, prediction of buried residues in proteins, RNA secondary structure –minimum free-energy structures, Genome analysis, genome rearrangements with inversions, gene identification, gene expression, expression analysis,

gene identification and functional classification.

PBE-104 ANALYTICAL METHODS IN BIOPROCESSES

Nature & properties of biochemical metabolites. Principle and application of Chromatography, Hydrodynamic methods, Sedimentation, Ultracentrifugation. Spectrophotometry, Mass spectrometery and HPLC. Analysis of raw materials, Quality control of bioproducts, Assay of vitamins, Antibiotics, Steroids, Vaccines, Amino acids, Nucleic acids.

PBE-105 BIOCHEMICAL ENGINEERING

Biochemical Engineering and its role in the development of bioprocesses. Kinetics of microbial growth and product formation, kinetics of enzyme reactions. Chemically and genetically structured models. Batch, continuous and fed-batch processes. Media and air sterilization. Aseptic operation. Aeration and agitation. Scale-up criteria. Immobilization of enzymes and cells. Operation, measurement of parameters and control of bioreactors.

PMA-101 ENGINEERING MATHEMATICS

Matrix and vector algebra with applications, numerical solution of algebraic and transcendental equations, interpolation, differentiation and numerical differentiation, integration and numerical integeration, curve fitting, regression and correlation analysis, statistical quality control, design of experiments, flow charts, algorithms and C/C++ programs of the above numerical/statistical methods.

Semester -II

PBE-201 BIOSEPARATION AND DOWNSTREAM PROCESSING

Characteristics of fermentation broth, Pre-treatment, Solid –liquid separation methods, Cell disintegration, Protein Precipitation, Adsorption, Extraction, Chromatography techniques, Membrane based separation processes, Electrodialysis, Electrophoresis, Aqueous two-phase extraction, Crystallization & drying. Isolation & purification of recombinant therapeutic proteins.

PBE-202BIOPROCESS TECHNOLOGY

Modification of industrial cultures: Mutation, recombinant DNA technology, protoplast fusion etc. Production of biofertilizers and biopesticides. New products using bioprocess technology: hormones, vaccines, pigments, biopolymers etc. Products derived from

animal and plant cells. Biotransformation of steroids etc. Microbial leaching and extraction of metals. Microbial emulsifier and enhanced oil recovery.

Present scenario on commercial applications of enzymes, sources and general aspects of productions, extraction and purifications. Hydrolytic enzymes for polysaccharides, Proteins and lipids, other types of enzymes, production, extraction, properties. New trends in applications of enzymes: foods, pharmaceuticals, textiles and leather industries and for analytical purposes. Applications of immobilized enzymes /cells.

PBE-203 ENVIRONMENTAL BIOTECHNOLOGY

Ecology and environment, pollutants nature, sources, distribution and their effect on living bodies. Air pollution, sources and control technologies. Waste pollution: characteristics of waste water and methods for treatment. Solid waste collection and control. Environmental impact assessment, legislation for pollution control.

ELECTIVE-II

PBE-204 PLANT BIOTECHNOLOGY

Special features and organization of plant cells. Totipotency, penetration of plants. Plant products of industrial importance. Biochemistry of major metabolic pathways and products. Autotrophic and heterotrophic growth. Plant growth regulators and Elicitors: cell suspension culture development: methodology, kinetics of growth and product formation, nutrient optimization. Production of secondary metabolites by suspension cultures with a few case studies. Biological & technological barriers- hydrodynamic shear and its quantification and impeller design aspects. Plant cell reactors: Comparison of reactor performances. Immobilized plant cell and cell retention reactors. Hairy root cultures and their cultivation.

PBE-205 ANIMAL CELL CULTURE & TISSUE ENGINEERING

Characteristics of animal cell, metabolism, regulation and nutritional requirement. Effects of shear force and kinetics of cell growth and product formation. Product and substrate transportation. Hybridoma technology; genetic engineering in animal cell culture; scale-up and large scale operation; Perfusion bioreactors, hollow fiber bioreactor, operational strategies of mass cell culture.

Disaggregation (enzymatic and mechanical) of tissue and primary culture; Cultured cells and evolution of cell lines; Maintenance of cultures – cell lines; Cloning of cell lines; Large scale cell cultures in biotechnology ; Somatic cell fusion.

Tissue culture (slide, flask and test tube cultures); Organ culture; Whole embryo culture; Tissue engineering (Artificial skin and artificial cartilage).

PBE-206 BIOMEDICAL INSTRUMENTATION

Evolution of medical instrument, components of a medical instrumentation system, Problems encountered in a measuring system, Biofeedback instrumentation. Measurement system-specification of instruments, static & dynamic characteristics of medical instruments. Biosignal, characteristics, classification of errors, statistical analysis. reliability, accuracy, fidelity, speed of response, linearization of technique, data acquisition system , Detection of physiological parameters using impedance techniques: Impedance and current distribution, bipolar and tetra polar circuits, skin impedance, galvanic skin response measurement, total body impedance, cardiac output, neural activity, respiratory activity, impedance plethysmography ,Special features of bioelectric amplifiers, safety requirements, realization of bioelectric amplifiers, carrier amplifiers, chopper amplifiers, phase sensitive detector, isolation amplifiers, and instrumentation amplifiers. Recording of bioelectric events-Analog recording system, digital recording and data logging including the use of micro-processor and flash memory chips. Recording of ECG, EMG & EEG signals. Holter monitor and cardiac stress test. Components of patient monitoring system, sources of artifacts & their implication, organization and equipments used in ICCU & ITU. Computer assisted patient monitoring system. Patient safety and electromedical equipments

PBE-207 CRITICAL REVIEW OF RESEARCH PUBLICATIONS ON ONE RELEVANT TOPIC

Semester –III

PCH-301- MODELING & SIMULATION OF CHEMICAL ENGINEERING SYSTEMS

ELECTIVE-III

PBE-301- BIO-PROCESS PLANT DESIGN

Introduction, general design information, mass and energy balance, flow sheeting, piping and instrumentation. Material of construction for bioprocess plants. Mechanical design of process equipment, vessels for biotechnology applications, design of fermenters, design consideration for maintaining sterility of process streams and processing equipment. Selection and specification of equipment for handling fluids and solids. Selection specification and design of heat and mass transfer equipment used in bioprocess industries. Design of facilities for cleaning of process equipment used in biochemical industries. Utilities for biotechnology production plants. Process economics , bioprocess validation, safety consideration.

PBE-302- BIOENTERPRENEURSHIP AND REGULATORY ISSUES

Overview of biotechnology Industry management: Business of Biotechnology, Emerging Areas of Biotechnology Industry, corporate governance and bioethics and societal issues in biotechnology industry; Biotechnology Product Management: Product development, assessment of market potential, testing and lifecycle analysis, preclinical and clinical trial design and conduct, risk analysis, quality control and assurance, fundamentals of validation, good manufacturing practices.

Biotechnology Entrepreneurship: Entrepreneurial process and the practicalities of venture creation, specific features of biotechnology-based products and services, human resource management, partnerships with other businesses; negotiation techniques and motivation,

leadership skills, communication, conflict resolution, and goal integration, key tasks and challenges faced by biotech entrepreneurs, crisis management principles, strategies, tactics, and communications methods

Marketing in biotechnology industry: Marketing practices and application, marketing plan,

relationship between the marketing and sales functions, marketing a scientific product and a scientific service, pricing strategies, distribution alternatives, communications, promotion, and the importance of perception. International business and marketing trends in biotechnology; advertising approved products.

Finance management for biotechnology industry: Defining and distinguishing the biotechnology industry, competitive forces and impact on strategy, regulation of genetic products, planning under uncertainty, system thinking and system failure, the economic environment, estimating costs and benefits, strategic components, marketing and sales, modeling, costs and benefits, and ratio and break-even analysis, commercializing biotechnology and technology transfer

Biotechnology regulatory issues: Regulatory processes and agencies, Legal Aspects of Biotechnology, Intellectual Property Rights-Basis of Patentability, Patent Application Procedure, Compulsory License, Infringement of Patents, Product Registration for Regulated and Non Regulated Markets, Scientific Exchange in Biotechnology research, Treaties/Conventions and regulatory policies relevant to India, International regulatory affairs, regulatory information, drug submissions, biologics submissions, medical device submissions, GLP, GCP, GMP, inventorship and ownership issues in academia and industry.

PBE-303- BIOENERGY

Bioenergetics, Biomass Sources, Characteristics & Preparation: Biomass Sources and Classification. – Chemical composition and properties of different biomass materials and bio-fuels – Sugar cane molasses and other sources for fermentation ethanol-Sources and processing of oils and fats for liquid fuels- Energy plantations -Preparation of woody biomass: Size reduction, Briquetting of loose biomass, Drying, Storage and Handling of Biomass, hydrogen production and biological fuel cell

Biogas, Technology: Feedstock for biogas production, Aqueous wastes containing biodegradable organic matter, animal residues-. Microbial and biochemical aspects- Operating parameters for biogas production Kinetics and mechanism - Dry and wet fermentation. Digesters for rural application-High rate digesters for industrial waste water treatment.

Bio-Ethanol and Bio-Diesel Technology: Production of Fuel Ethanol By Fermentation Of Sugars. Gasohol as a Substitute for Leaded Petrol. - Trans-Esterification of Oils to Produce Bio-Diesel.

Pyrolysis and Gasification of Biomass: Thermo-chemical conversion of ligno-cellulose biomass – Biomass processing for liquid fuel production - Pyrolysis of biomass-Pyrolysis regime, effect of particle size, temperature, and products obtained. Thermo-chemical gasification principles: Effect of pressure, temperature and of introducing steam and oxygen. Design and operation of Fixed and Fluidized Bed Gasifiers.

Combustion of Biomass And Cogeneration Systems: Combustion Of Woody Biomass: Theory, Calculations And Design Of Equipments. Cogeneration In Biomass Processing Industries. Case Studies: Combustion of Rice Husk, Use of Bagasse for Cogeneration.

PBE-304- PROJECT DISSERTATION

PBE-305- SEMINAR

Semester- IV

PBE-401- RESEARCH PROJECT