

# **SCHEME OF EXAMINATION**

**&**

**SYLLABI**

**for**

**B. TECH. BIOCHEMICAL ENGINEERING**  
**FIRST YEAR - FINAL YEAR**  
**(Effective from the session: 2010-2011)**



**Uttarakhand Technical University, Dehradun**  
*www.uktech.in*

## APPENDIX- II

## Proposed Course Structure for Biochemical Engg. (II<sup>nd</sup> Semester Onwards)

### B.TECH. 2<sup>nd</sup> Year (Biochemical Engineering Branch)

#### 3<sup>rd</sup> Semester

Sl. No.	Course Code	Subject	Credits	Teaching Load (Hrs.)			Evaluation Scheme					
							Sessional			End Sem.	Total	
				Lect.	Tut.	Prac.	CT	TA	Total			
<b>Theory Courses</b>												
1	THU301	Engineering Economics & Costing	2	2	0	0	15	10	25	50	75	
2	TBE301	Principles of Modern Biology	4	3	1	0	30	20	50	100	150	
3	TBE302	Microbiology	4	3	1	0	30	20	50	100	150	
4	TCH303	Fluid Flow & Solid Handling	4	3	1	0	30	20	50	100	150	
5	TCS302	CBNST	2	2	0	0	15	10	25	50	75	
6	TME 303	Solid Mechanics	4	3	1	0	30	20	50	100	150	
<b>Practical Courses</b>												
7	PBE301	Microbiology Lab	3	0	0	3	15	10	25	50	75	
8	PCH303	Fluid Mechanics Lab	3	0	0	3	15	10	25	50	75	
9	PCS302	CBNST Lab	2	0	0	2	15	10	25	25	50	
10	PD301	Personality Development Lab									50	
			<b>28</b>						<b>Total</b>			<b>1000</b>

### B.TECH. 2<sup>nd</sup> Year (Biochemical Engineering Branch)

#### 4<sup>th</sup> Semester

Sl. No.	Course Code	Subject	Credits	Teaching Load (Hrs.)			Evaluation Scheme					
							Sessional			End Sem.	Total	
				Lect.	Tut.	Prac.	CT	TA	Total			
<b>Theory Courses</b>												
1	TCS401	Database Management Systems	4	3	1	0	30	20	50	100	150	
2	TBE401	Instrumental Methods of Analysis	2	2	0	0	15	10	25	50	75	
3	TBE402	Biochemistry	4	3	1	0	30	20	50	100	150	
4	TBE403	Fermentation Biotechnology - I	2	2	0	0	15	10	25	50	75	
5	TCH406	Industrial Fuels & Process Calculations	4	3	1	0	30	20	50	100	150	
6	TCH407	Chemical Engineering Thermodynamics	4	3	1	0	30	20	50	100	150	
<b>Practical Courses</b>												
7	PBE401	Instrumental Methods of Analysis Lab	3	0	0	3	15	10	25	50	75	
8	PBE402	Biochemistry Lab	3	0	0	3	15	10	25	50	75	
9	PCS401	Database Management Systems Lab	2	0	0	2	15	10	25	25	50	
10	PD401	Personality Development Lab									50	
			<b>28</b>						<b>Total</b>			<b>1000</b>

**B.TECH. 3<sup>rd</sup> Year (Biochemical Engineering Branch)****5<sup>th</sup> Semester**

Sl. No.	Course Code	Subject	Credits	Teaching Load (Hrs.)			Evaluation Scheme				
							Sessional			End Sem.	Total
				Lect.	Tut.	Prac.	CT	TA	Total		
<b>Theory Courses</b>											
1	TCH506	Heat Transfer Operations	4	3	1	0	30	20	50	100	150
2	TCH507	Mass Transfer Operations - I	4	3	1	0	30	20	50	100	150
3	TBE501	Bioprocess Engineering - I	4	3	1	0	30	20	50	100	150
4	TBE502	Bioseparation Processes	4	3	1	0	30	20	50	100	150
5	TBE503	Bioprocess Principles	2	2	0	0	15	10	25	50	75
6	TBE504	Fermentation Biotechnology - II	2	2	0	0	15	10	25	50	75
<b>Practical Courses</b>											
7	PCH508	Chemical Engineering Operations Lab	2	0	0	2	10	15	25	25	50
8	PBE504	Fermentation Lab	3	0	0	3	30	20	50	50	100
9	PBE502	Bioseparation Processes Lab	3	0	0	3	30	20	50	50	100
<b>Total</b>			<b>28</b>							<b>1000</b>	

**B.TECH. 3<sup>rd</sup> Year (Biochemical Engineering Branch)****6<sup>th</sup> Semester**

Sl. No.	Course Code	Subject	Credits	Teaching Load (Hrs.)			Evaluation Scheme				
							Sessional			End Sem.	Total
				Lect.	Tut.	Prac.	CT	TA	Total		
<b>Theory Courses</b>											
1	THU601	Principles of Management	2	2	0	0	15	10	25	50	75
2	TBE601	Bioprocess Engineering - II	4	3	1	0	30	20	50	100	150
3	TBE602	Waste Water Treatment	4	3	1	0	30	20	50	100	150
4	TCH607	Chemical Reaction Engineering	4	3	1	0	30	20	50	100	150
5	TCH608	Mass Transfer Operations - II	2	2	0	0	15	10	25	50	75
6	TBE603	Genetic Engineering	4	3	1	0	30	20	50	100	150
<b>Practical Courses</b>											
7	PBE602	Waste Water Analysis Lab	3	0	0	3	30	20	50	50	100
8	PBE652	Bioprocess Engineering Lab	2	0	0	2	10	15	25	25	50
9	PBE603	Genetic Engineering Lab	3	0	0	3	30	20	50	50	100
<b>Total</b>			<b>28</b>							<b>1000</b>	

**B.TECH. 4<sup>th</sup> Year (Biochemical Engineering Branch)****7<sup>th</sup> Semester**

Sl. No.	Course Code	Subject	Credits	Teaching Load (Hrs.)			Evaluation Scheme				
							Sessional			End Sem.	Total
				Lect.	Tut.	Prac.	CT	TA	Total		
<b>Theory Courses</b>											
1	TCH702	Instrumentation & Process Control	4	3	1	0	30	20	50	100	150
2	TPE71	Professional Elective - I*	4	3	1	0	30	20	50	100	150
3	TPE72	Professional Elective - II*	4	3	1	0	30	20	50	100	150
4	TPE73	Professional Elective - III*	4	3	1	0	30	20	50	100	150
5	TOE01	Open Elective**	4	3	1	0	30	20	50	100	150
<b>Practical Courses</b>											
6	PBE701	Minor Project	6	0	0	6	--	100	100	100	200
7	PBE702	Summer Training & Colloquium	2	0	2	0	--	50	50	0	50
			<b>28</b>							<b>Total</b>	<b>1000</b>

<b>Professional Electives</b>	
<b>TPE71: Professional Elective – I*</b>	
TPE711 : Bioinformatics	TPE712: Creativity, Innovation and Product Development
TPE713: Biopharmaceutical Technology	
<b>TPE72: Professional Elective – II*</b>	
TPE721: Bioethics, Biosafety & IPR	TPE722: Biomaterial Science and Technology
TPE723: Advanced Separation Processes	
<b>TPE73: Professional Elective – III*</b>	
TPE731: Environmental Biotechnology	TPE732: Immunology
TPE733: Preservation of Biomaterials	
<b>**Open Elective</b>	
TOE011: Nanobiotechnology	TOE012: Biosensors
TOE013: Environmental Biotechnology	TOE014: Bioinformatics

**B.TECH. 4<sup>th</sup> Year (Biochemical Engineering Branch)****8<sup>th</sup> Semester**

Sl. No.	Course Code	Subject	Credits	Teaching Load (Hrs.)			Evaluation Scheme				
							Sessional			End Sem.	Total
				Lect.	Tut.	Prac.	CT	TA	Total		
<b>Theory Courses</b>											
1	TBE801	Bioprocess Plant Design and Economics	4	3	1	0	30	20	50	100	150
2	TPE81	Professional Elective - IV*	4	3	1	0	30	20	50	100	150
3	TPE82	Professional Elective - V*	4	3	1	0	30	20	50	100	150
4	TPE83	Professional Elective - VI*	4	3	1	0	30	20	50	100	150
<b>Practical Courses</b>											
5	BE802	Major Project	10	0	0	10	--	100	100	250	350
6	BE801	Bioprocess Plant Design Lab	2	0	0	2	15	10	25	25	50
			<b>28</b>							<b>Total</b>	<b>1000</b>

<b>Professional Electives</b>	
<b><i>TPE81: Professional Elective – IV*</i></b>	
• TPE811: Nanobiotechnology	• TPE812: Food Technology
• TPE813: Industrial Safety & Hazard Management	
<b><i>TPE82: Professional Elective – V*</i></b>	
• TPE821: Animal Biotechnology	• TPE822: Genomics & Proteomics
• TPE823: Plant Cell Biotechnology	
<b><i>TPE83: Professional Elective – VI*</i></b>	
• TPE831: Molecular Modeling and Drug Design	• TPE832: Modelling and Simulation of Bioprocesses
• TPE833: Non Conventional Energy Resources	

\*\* **Open Elective course:** Offered for other departments.

**Total credits for all semester: 238**

**THU-301: ENGINEERING ECONOMICS AND COSTING**

**L T P 2 0 0**

**Unit I**

Time value of money : Simple and compound interest, Time value equivalence, Compound interest factors, Cash flow diagrams, Calculation, Calculation of time -value equivalences. Present worth comparisons, Comparisons of assets with equal, unequal and infinite lives, comparison of deferred investments, Future worth comparison, payback period comparison.

**Unit II**

Use and situations for equivalent annual worth comparison, Comparison of assets of equal and unequal life. Rate of return, Internal rate of return, comparison of IRR with other methods, IRR misconceptions.

**Unit III**

Analysis of public Projects: Benefit/ Cost analysis, quantification of project, cost and benefits, benefit/cost applications, Cost -effectiveness analysis.

**Unit IV**

Depreciation, computing depreciation charges, after tax economic comparison, Break-even analysis; linear and non-linear models.

Product and Process Costing, Standard Costing, cost estimation, Relevant Cost for decision making, Cost control and Cost reduction techniques.

**Reference Book :**

1. Horn green, C.T., Cost Accounting, Prentice Hall of India
2. Riggs, J.L., Dedworth, Bedworth, D.B, Randhawa, S.U. Engineering Economics, McGraw Hill International Edition, 1996

**TBE301: PRINCIPLES OF MODERN BIOLOGY**

**L T P 3 1 0**

**UNIT -I**

Characteristics of living systems; Classification of the living organisms (five kingdom classification, major groups and principles of classification within each kingdom). Systematic and binomial system of nomenclature. Prokaryotic and eukaryotic cell; Plant and animal cell.

**UNIT -II**

Cell organelles and their function; respiration and photosynthesis, Concept of genes, Organisation of DNA into chromosomes.

**UNIT -III**

Cell cycle, mitotic and meiotic cell division; Brief idea of transcription, translation and DNA replication.

**UNIT - IV**

Tissues in animals and plants; Morphology, anatomy and functions of different parts of flowering plants: Root, stem, leaf, inflorescence, flower, fruit and seed.

**UNIT - V**

Mendelian inheritance, linkage, crossing over, Sex determination, genetic code, mutations.

**Reference Book :**

1. Gardener, Simmons & Snustad. "*Principles Of Genetics, 8th Ed*" Wiley India
2. Ajay Poul. "*Text Book of Cell and Molecular Biology*" Books and Allied(P) (2007).
3. Ganguly, Das and Datta. "*College Botany*" New Central Book Agency(2007).

### TBE-302 : MICROBIOLOGY

L T P 3 1 0

#### Unit-I

Introduction; aim and scope; Historical background, Morphology, Physiology, Nutrition, Growth and reproduction in bacteria, Methods of genetic recombination in bacteria

#### Unit-II

Ultrastructure, nutrition, reproduction and other characteristics of fungi, Distinguishing features of actinomycetes, cyanobacteria and yeasts, Morphology, ultrastructure, nature and multiplication of viruses (plant, animal and bacteriophages)

#### Unit-III

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

#### Unit-IV

Physical and chemical methods of control of microorganisms; Microbial ecology, Bioremediation, incidences of microorganisms in soil, water, air, food and sewage, food spoilage organisms, Brief idea of food borne infections and poisoning organisms.

#### Unit-V

An introduction to Immunology; innate and acquired immunity, Various cells and organs involved in immune response, Nature of antigens, epitopes and haptens, Structure and classes of antibody

#### Reference Book :

1. Microbiology by M.J. Pelczar, Jr. E.C.S. Chan and N.R. Krieg, 5<sup>th</sup> Ed. , TMH Book Company.

1. Roitt's Essential Immunology , Delves, Wiley India
2. "Foundation in Microbiology", Kathleen Talaro & Arthur Talaro, W.C.B. Wm. C. Brown Publishers (1994).
3. Immunology 6<sup>th</sup> edition by Kindt, goldsby, Osborne, W.H.freeman and Company, New York

### TCH-303: FLUID FLOW AND SOLID HANDLING

L T P 3 1 0

#### Unit-I

Solids and Their Handling: Properties of solids, Screening, industrial screening equipments. Determination of particle size, Screen analysis, size reduction of solids, stages of reduction , operating variables, intermediate and fine size reduction, power requirement and mechanism. Power driven machines: Crushers, grinders, and conveyors.

#### Unit –II

Filtration: Theory, continuous and batch equipments. Flow of solids through fluids, classification and sedimentation.

#### Unit –III

Fluid flow: Properties of fluids

Fluid statics: Hydrostatic Law and Pressure Measurement, Transport of fluids, energy relationships, pipe fittings, minor losses in pipe flow.

#### Unit IV

Flow Measurements: Orifice meter, Nozzle and Venturimeter, Rotameter and Pitot tube.

#### Unit V

Pumping and Compressing: Reciprocating pumps, rotary pumps, centrifugal pumps and blowers. Introduction to fluidization.

#### Reference Book :

- 1.Foust A. S. et.al., "*Principles of Unit Operations*" 2<sup>nd</sup> ed Wiley India
2. McCabe Smith; "*Unit Operations in Chemical Engineering*", McGraw Hill

1. Fox, R.A. & McDonald, "Introduction to Fluid Mechanics", 7<sup>th</sup> ed Wiley India
2. Fundamentals Of Fluid Mechanics, 6th Ed, Si Version , Munson Wiley India
3. Kumar D.S. "Fluid Mechanics", S.K. Katria and Sons, Delhi (1998.)

## **TCS-302: COMPUTER BASED NUMERICAL AND STATISTICAL TECHNIQUES**

**L T P 2 0 0**

### **Unit-I**

Introduction: Numbers and their accuracy, Computer Arithmetic, Mathematical preliminaries, Errors and their Computation, General error formula, Error in a series approximation.

Solution of Algebraic and Transcendental Equation:

Bisection Method, Iteration method, Method of false position, Newton-Raphson method, Methods of finding complex roots, Muller"s method, Rate of convergence of Iterative methods, Polynomial Equations.

### **Unit-II**

Interpolation: Finite Differences, Difference tables Polynomial Interpolation: Newton"s forward and backward formula Central Difference Formulae: Gauss forward and backward formula, Stirling"s, Bessel"s, Everett"s formula.

Interpolation with unequal intervals: Langrange"s Interpolation, Newton Divided difference formula,

Hermite"s Interpolation

### **Unit-III**

Numerical Integration and Differentiation: Introduction, Numerical differentiation Numerical Integration: Trapezoidal rule, Simpson"s 1/3 and 3/8 rule, Boole"s rule, Waddle"s rule.

Solution of differential Equations: Picard"s Method, Euler"s Method, Taylor"s Method, Runge-Kutta Methods, Predictor Corrector Methods, Automatic Error Monitoring and Stability of solution.

### **Unit-IV**

Statistical Computation: Frequency chart, Curve fitting by method of least squares, fitting of straight lines, polynomials, exponential curves etc, Data fitting with Cubic splines, Regression Analysis, Linear and Non linear Regression, Multiple regression, Statistical Quality Control methods.

Reference Book :

1. Rajaraman V, "Computer Oriented Numerical Methods", Pearson Education
2. An Introduction To Numerical Analysis, 2nd Ed, Atkinson, Wiley India
2. Pradip Niyogi, "Numerical Analysis and Algorithms", TMH

1. Gerald & Whealey, "Applied Numerical Analyses", AW
2. Elementary Numerical Analysis (3rd Ed.) Atkinson, Wiley India
3. Grewal B S, "Numerical methods in Engineering and Science", Khanna Publishers, Delhi.
4. Numerical Method Principles, analysis and algorithms ,Srimamta Pal (Oxford Higher ed)
5. Francis Scheld, " Numerical Analysis", TMH
6. Sastry S. S, "Introductory Methods of Numerical Analysis", Pearson Education.





**TME- 303: Solid Mechanics****L T P 3 1 0****Unit-I**

Introduction. Stress and strain: stress at point, Cauchy stress tensor, equilibrium equations, analysis of deformation and definition of strain components, compatibility relations, 8  
principal stresses and strains, stress and strain invariants, Mohr's circle representation. 3

**Unit-II**

Constitutive relations: true and engineering stress-strain curves, Material properties for isotropic materials and their relations. Theories of failures for isotropic materials. 7

**Unit-III**

Shear Force and Bending Moment diagrams. Axially loaded members. Torsion of circular shafts  
Stresses due to bending: pure bending theory, combined stresses. 7

**Unit-IV**

Deflections due to bending: moment-curvature relation, load-deflection differential equation, area moment method, and superposition theorem. Stresses and deflections due to transverse shears. 8

**Unit-V**

Torsion of circular shaft. Energy methods: Strain energy due to axial, torsion, bending and transverse shear. Castigliano's theorem, reciprocity theorem etc. 7

## Reference Book :

1. S. C. Crandall, N. C. Dahl, and T. J. Lardner, *An Introduction to the Mechanics of Solids*, 2e, McGraw Hill, 1978.
2. Nag, *Fundamentals Of Strength Of Materials*, Wiley India
1. Riley, *Mechanics of Materials*, 5ed, Wiley India
2. E. P. Popov, *Engineering Mechanics of Solids*, Prentice Hall, 1990
3. I. H. Shames, *Introduction to Solid Mechanics*, 2e, Prentice Hall, 1989
4. S. P. Timoshenko, *Strength of Materials*, vols. 1 & 2, CBS publ., 1986
5. *Mechanics of Materials* by Bear Jhonson

**PBE452: MICROBIOLOGY LAB****L T P 0 0 3**

- 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.

**PCH-303: FLUID MECHANICS LAB**

**L T P 0 0 3**

1. Characteristic curves of a centrifugal pumps.
2. Verification of Bernoulli"s equation for flow process.
3. Measurement of flow by venturimeter, Orifice meter etc.
4. Measurement of flow by rotometer, V-notch.
5. Measurement of losses in various fitting and valves.
6. Measurement of losses due to contraction and expansion.
7. Verification of laminar/ turbulent flow regime in a flow process

**PCS- 302 : Computer Based Numerical Techniques Lab**

**L T P 0 0 2**

**Write Programs in 'C' Language:**

1. To deduce error involved in polynomial equation.
2. To Find out the root of the Algebraic and Transcendental equations using
3. To implement Newton"s Forward and Backward Interpolation formula.
4. To implement Gauss Forward and Backward, Bessel"s, Sterling"s and Evertt"s Interpolation formula.
5. To implement Newton"s Divided Difference and Langranges Interpolation formula.
6. To implement Numerical Differentiations.
7. To implement Numerical Integration using Trapezoidal, Simpson 1/3 and Simpson 3/8 rule.
8. To implement Least Square Method for curve fitting.
9. To draw frequency chart like histogram, frequency curve and pie-chart etc.
10. To estimate regression equation from sampled data and evaluate values of standard deviation, t-statistics, regression coefficient, value of R<sup>2</sup> for atleast two independent variables.

## TBE401 INSTRUMENTAL METHODS OF ANALYSIS

L T P 2 1 0

### Unit -1 Spectroscopy

Interaction of EM radiation with matter : Overview of Electromagnetic spectrum; physical phenomenon : Absorption, Resonance fluorescence, Emission, Refraction, Diffraction, Scattering, Raman Scattering, Resonance Raman Scattering, Beer-Lambert's Laws. UV-Vis spectrophotometer: Principle, Instrumentation, working and Application

Atomic spectroscopy: Principles and application of Atomic Absorption / Emission Spectrometer

Mass Spectroscopy, MALDI

Basics of IR and NMR and their application in biotechnology and Basics of X-Ray diffraction analysis and their application in biotechnology

### Unit -2 Advance Microscopy methods and Centrifugation.

Differential interference contrast microscopy. Electron microscopy: TEM and SEM, Atomic force microscopy and confocal scanning laser microscopy

Centrifugation: Theory of centrifugation and sedimentation, use and design of different types of rotors  
Types of centrifuges, Preparative and analytical centrifugation

### Unit -3 Chromatography

Chromatography :Basic Theory of Chromatography, Plate and Rate Theory and HETP, Partition theory and solvent extraction theory Introduction to key terms: retention time, retardation factor(Rf), elution, Capacity factor, peak shapes, band broadenings, column Efficiency and resolution, selectivity, normal and reverse phase chromatography, countercurrent chromatography.

Partition and adsorption chromatography

Different techniques of chromatography: Principle, stationary and Mobile phase, operation, Detection/elution of solute, Application –Planner Chromatography, (Paper Chromatography, TLC), GC, Ion exchange chromatography,

Gel exclusion chromatography, Affinity, chromatography, HPLC and FPLC .Adsorption chromatography- dioxylapatite chromatography and hydrophobic chromatography.

### Unit-4 Electrophoresis:

Electrophoresis : Theory of electrophoresis, electrophoresis of protein-PAGE,SDS PAGE, Agarose electrophoresis of nucleic acid, Isoelectric focusing of protein pulse gel electrophoresis and western blotting.

**Unit-5 Immunological Techniques:** Immunodiffusion, Immunoelectrophoresis Techniques, ELISA, RIA, Fluorescence Activated Cell Sorter.

Reference Book :

1. Wilson, K, Walker, J.: Principles and Techniques of Practical Biochemistry. 5th Ed. - Cambridge University Press,. Cambridge 1999.

1.Analytical Chemistry, 6th Ed by Christian , Wiley India

2. Handbook of Analytical Techniques Published Online: 2008. Helmut Günzler, Alex Williams. John Wiley & Sons

2. Fundamentals of Analytical Chemistry (with CD-ROM and InfoTrac) by Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Hardcover: 992 pages, Publisher: Brooks Cole.

**L T P 3 1 0**

**Unit I**

Structure and function of biomolecules; carbohydrates, proteins, lipids and nucleic acids. Biochemical separation methods. Vitamins, enzymes and coenzymes.

**Unit-II**

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, glyoxilate cycle, phosphoketolate pathway.

**Unit-III**

Lipid metabolism; transport and oxidation of fatty acids in animal tissues, glycerol metabolism, biosynthesis of fatty acids and triacylglycerol.

Protein metabolism; out lines of amino acid metabolism and their significance.

**Unit-IV**

Nuclic acid metabolism; mechanism and biosynthesis of DNA and RNA, reverse transcription. Protein biosynthesis, inhibitors of protein synthesis, transport of proteins and signal peptides.

**Text Books:**

1. Outlines Of Biochemistry, 5th Ed ,Conn, Wiley India
2. "Biochemistry", Lubert Stryer, W.H. Freeman & Co. , New York.

**References:**

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

**TBE-403 : FERMENTATION BIOTECHNOLOGY-I**

**L T P 2 0 0**

**Unit-I**

Fundamentals of microbial fermentation processes. Alcoholic fermentation and developments, Beer production : Malting and brewing; Wine manufacturing and other distilled liquors.

**Unit-II**

Glycerol fermentation. Microbial production of citric acid, lactic acid, gluconic acid and vinegar.

**Unit-III**

Biomass as a fermentation product: Baker"s yeast, single cell protein, Biofertilizers.

**Unit-IV**

Amino acids: Lysine and glutamic acid. Vitamin production through fermentation: vitamin B12, Riboflavin.

**Unit-V**

Commercial enzymes production: Amylase, Protease, Amyloglucosidase and Lipase.

**Reference Book :**

1. "Industrial Microbiology", S.C. Prescott and C.G. Dunn, McGraw-Hill Book Company, Inc. New York.

1. "Industrial Microbiology", L.E. Casida Jr. Wiley Eastern Ltd.
2. "Microbial Technology", Vol.II, H.J. Peppler and D. Perlman, Academic Press, New York.
3. Hugo And Russell's Pharmaceutical Microbiology, 7th Ed by Denyer, Wiley India

**TCH407: INDUSTRIAL FUELS & PROCESS CALCULATIONS**

**L T P 3 1 0**

### **Unit –I**

**Fuels:** Origin, chemical composition, classification, storage, and general uses of industrial fuels. Types of solid fuels, Introduction to biofuels.

### **Unit II**

Proximate and ultimate analysis of coal, calorific values of fuels, specification of fuel oil. Types of gaseous fuels, control of combustion. Types of liquid fuels, petroleum and its distillation products, coal tar and its distillation products, modified and synthetic fuels, fuels for cryogenic engines.

### **Unit - III**

Process calculations: Systems of units. Stoichiometry and composition relations. Material balances, the use of ideal gas laws and vapour pressures, solubility and heat capacity data.

### **Unit-IV**

Humidity and solvent recovery. Material balance for various unit operations like absorption, distillation, crystallization etc.

### **Unit-V**

Thermochemistry and energy balances. Material and energy balances for typical processes.

### **Reference Book :**

1. Elementary Principles Of Chemical Processes, 3rd Ed by Felder, Wiley India
2. Chemical Process: Design And Integration by Smith, Wiley India
3. Hougan D. A., Watson K.M. and Ragatz R. A. "Chemical Process principles", Asia Publishing House.
1. Himmelblau, D.M. "Basic Principles and Calculations in Chemical Engineering", 6th ed. Prentice Hall (1996).
2. Felder, R.M. & Rousseau, R.W. "Elementary Principles of Chemical Processes ", 3rd edition. John Wiley
3. Bhatt., B.I. and Vora S.M. "Stoichiometry" IIInd edition, Tata McGraw Hill (1984)

## **TCH-408 : CHEMICAL ENGINEERING THERMODYNAMICS**

**L T P 3 1 0**

### **Unit-I**

Basic Concepts and Definitions

System, Surroundings, Property, Energy, Macroscopic, Microscopic Viewpoint, Thermodynamic Equilibrium, Work, pdV-work, work interaction between a system and surroundings.

### **Unit-II**

First Law of Thermodynamics

Conservation of energy, Perpetual Motion Machine of the First Kind, First Law analysis of Elementary Processes(Constant Volume Process, Constant Pressure Process, Isothermal Process, Adiabatic Process, Polytropic Process), Applications to steady , unsteady flow and other engineering problems.

### **Unit-III**

Second Law of Thermodynamics

Limitations of First Law of Thermodynamics, Energy Reservoirs, Heat Engine, Heat Pump, Refrigerator, Statements of Second Law of Thermodynamics, Perpetual Motion Machine of the Second Kind, Reversible Process, Irreversible Process, Carnot Cycle, Carnot Theorems, Types of Irreversibility, Entropy Principle of Entropy increase, Available Energy, dead State and Availability, Applications to engineering problems.

### **Unit-IV**

Properties of Pure Substances

Pure Substance, Concept of Phase, P-V and P-T Diagrams of a pure substance, Changes in thermodynamic properties and their inter-relationships, Maxwell's Relations, Specific Heat Relations, Dryness Fraction, Steam Tables, Measurement of steam quality, Liquid-Vapour mixtures, Gibbs Phase Rule, Ideal Gas, Equations of State, Applications to systems of engineering interest.

## Unit-V

### Reactive Systems

Stoichiometric coefficients, Reactants, Products, degree of Reaction, Law of mass action, Heat of Reaction, Temperature Dependence of the Heat of Reaction, Absolute Entropy and the third law of thermodynamics, Chemical Exergy, Second law efficiency of a reactive system..

### Reference Book :

1. Engineering And Chemical Thermodynamics by Koretsky Wiley India
2. "Introduction to Chemical Engineering Thermodynamics"; J. M. Smith and H.C. Van Ness; McGraw-Hill Book Company, New York.
1. A Textbook Of Chemical Engineering Thermodynamics" Narayanan K. V.; Prentice-hall Of India Pvt Ltd.
2. Thermodynamics"; J. P. Holman McGraw-Hill Book Company, New York.
3. Chemical, Biochemical And Engineering Thermodynamics, 4th Ed Sandler Wiley India

## PBE- 301: BIOCHEMISTRY LAB

### L T P 0 0 3

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.

## PBE451: INSTRUMENTAL METHODS OF ANALYSIS LAB

### L T P 0 0 3

- 1 Introduction to quality control. Use concepts of accuracy and precision.
- 2 Compute component of given percentage solution, molarity solution, PRN, PPS solution and stock solution.
- 3 pH meter :
  - List uses of pH meter, measurement, detailed diagram of pH electrode and reference electrode (combined electrode also), find pH of a solution giving detailed account of pH meter operation, troubleshooting.
  - Preparation of solution using pH meter.
  - Demonstration of the effect of the solution
- 4 Spectroscopy :
  - To determine maximum absorption spectra of mixtures (potassium dichromate and potassium permanganate) solution.
- 5 Centrifugation :
  - Measure components and working of centrifuges, solving g and RPM of centrifuge with respect to various heads. rotors
  - Isolation of cellular organelles by differential centrifugation
- 6 Chromatography :
  - Solvent-solvent extraction of plant pigments,
  - Use of paper chromatography for separation of plant pigments

- Use of thin-layer chromatography for amino acid (TLC)
- Demonstration of Ion-exchange chromatography
- Demonstration of Gel-exclusion chromatography

7 Electrophoresis: Electrophoresis of protein by SDS-PAGE

8 Demonstration of Sterilization of solution by filtration

9 PCR

10 Demonstration of Dialysis

### TCH-507: HEAT TRANSFER OPERATIONS

L T P 3 1 0

#### Unit-I

Introduction to heat transfer and general concepts of heat transfer by conduction, convection and radiation. Conduction: Basic concepts of conduction in solids, liquids and gases, steady state temperature fields and one dimensional conduction without heat generation e.g. through plane walls, cylindrical and spherical surfaces, composite layers etc. Insulation materials, critical and optimum insulation thickness. Extended surfaces, fins and their practical applications.

#### Unit-II

Convection: Fundamentals of convection, basic concept of convection and definitions. Natural and forced convection, laminar and turbulent heat transfer inside and outside tubes. Dimensional analysis, determination of individual and overall heat transfer coefficients and their temperature dependence.

#### Unit-III

Radiation: Basic laws of heat transfer by radiation, black body and gray body concepts, view factors, Kirchhoff's law, solar radiations, combined heat transfer coefficients by convection and radiation.

#### Unit-IV

Heat transfer with phase change: Condensation of pure vapors, film wise and drop wise condensation, loading in condensers and basic calculation on condensers, heat transfer in boiling liquids, boiling heat transfer coefficients.

#### Unit-V

Heat transfer equipment: Classification, principles and design criteria, Types of Exchangers, viz. double pipe, Shell and Tube heat exchangers, LMTD, Correction factors, heat exchanger effectiveness, Fouling factors, Prevention of fouling, Common failures in heat exchangers.

Reference Book:

1. Holman, J. P., "Heat Transfer", 9th ed. McGraw Hill (1989).
2. Fundamentals Of Heat And Mass Transfer, 6th Ed, Incropera, Wiley India
1. McAdams, W. H., "Heat Transmission", 3rd ed., McGraw-Hill (1954).
2. Convection Heat Transfer, 3rd Ed, Bejan, Wiley India
3. Kern, D. Q., "Process Heat Transfer", McGraw Hill Book (1950).
4. Badger, W. L. & Bancharo, J. T., "Introduction to Chemical Engineering", Tata McGraw Hill.

### TCH-508 : MASS TRANSFER OPERATIONS – I

L T P 2 1 0

#### Unit-I

**Basic Principles of mass transfer:** Molecular diffusion in fluids, mass transfer coefficients, Interphase mass transfer.



**Humidification Operations:** Vapour pressure, enthalpy, absolute humidity, dew point, etc., Unsaturated vapour gas mixtures. Adiabatic operation.

**Unit-II**

Absorption and Stripping: Equipments, gas-liquid equilibria, Henry's law, selection of solvent, absorption

in tray column, graphical and analytical methods. Absorption in packed columns. HTU, NTU & HETP concepts, design equations for packed column.

Wef 2010 - 2011

### Unit-III

**Distillation :** Entrainment, pressure drops , flooding , transfer coefficients and relative volatility. McCabe Thiele and Ponchon method for binary component distillation of azeotropes. Flash vaporization and Steam distillation. Extractive distillation.

### Unit-IV

**Liquid extraction:** Cocurrent and countercurrent operations in single and multistage solvent extraction, triangular diagrams.

### Unit-V

**Drying:** Batch and freeze drying, rotary driers. Surface vs diffusion controlled operations.

**Leaching:** Co current and countercurrent operations in single and multistage leaching operation.

Reference Book :

1. Treybal, R “*Mass Transfer Operations*”, 3rd ed. New York: McGraw-Hill, (1980).
2. Fundamentals Of Momentum, Heat, And Mass Transfer, 5th Ed by Welty, Wiley India

1. Foust A. S. et.al., “*Principles of Unit Operations*” 2<sup>nd</sup> ed Wiley India (2008)

2. Sherwood T. K., Pigford R. L.. “*Mass Transfer*” McGraw Hill (1975).
3. McCabe Smith; “*Unit Operations in Chemical Engineering*”, McGraw Hill.

## TBE501 : BIOPROCESS ENGINEERING - I

L T P 3 1 0

### Unit-I

Definition and scope of Biochemical Engineering. Different biochemical unit operations and processes. Production of industrial enzymes.

### Unit-II

Immobilization of enzymes and cells. Methods of immobilization.

### Unit-III

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

### Unit-IV

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

### Unit-V

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

Reference Book :

1. “ Principle of Fermentation Technology”, P.F. Stanbury and A. Whitaker; Pergamon Press.
2. Bioprocess Engineering: Systems, Equipment And Facilities by Lydersen, Wiley
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. Biochemical Calculations, 2nd Ed , Segel, Wiley India
5. Textbook Of Biotechnology, 4th Ed Das Wiley India

## TBE502 : GENTIC ENGINEERING

L T P 3 1 0

### UNIT I

Introduction and historical background;

Cloning vectors:

- Plasmids: structural and functional organization, construction of pBR322
- Phages: Biology of bacteriophages, construction of vectors
- Cosmids, phagemids, BAC, YAC

Wef 2010 - 2011

## UNIT II

Enzymes used in molecular cloning: restriction enzymes, ligases, and other enzymes  
Gene cloning, construction of genomic library

## UNIT III

cDNA synthesis, construction of cDNA library, expression of genes, chromosome walking,  
Human genome project

## UNIT IV

Identification of rDNA clones, gene sequencing (Maxam and Gilbert, Sangers, pyrosequencing), gene transfer methods in plants (Direct delivery and *Agrobacterium* mediated )

## UNIT V

DNA fingerprinting, antisense RNA technology, RNAi, Gene therapy

### Reference Book :

1. Principles Of Genetics, 8th Ed, Gardner, Wiley India
2. "Principles of Gene Manipulation" Bob Old, SB Primrose, John Wiley & Sons
1. "Molecular Biology of the Gene", J.D. Watson, Melnopark, California.
2. "Genes", 8<sup>th</sup> Ed., Benjamin Lewis (2000) John Wiley & Sons,
3. "Recombinant DNA Technology", Dhillon J.R., John Wiley & Sons
4. "Genetics", P.K. Gupta, Rastogi Publication, Meerut.

## TBE503 : BIOPROCESS PRINCIPLES

L T P 2 0 0

### UNIT I

Coordination of microbial metabolism with reference to carbohydrates, lipids, proteins, etc. Metabolic pathway synthesis of small molecules, key crossroads and branch points in metabolism.

### UNIT II

Regulation of the synthesis of enzymes, control of metabolic pathway by regulatory enzymes. Control of protein synthesis by induction and repression. Regulation of a few major metabolic pathways.

### UNIT III

Basic enzyme kinetics and inhibition kinetics. Allosteric enzymes.

### UNIT IV

End-products of metabolism: Primary and secondary metabolites, such as enzymes, amino acids, organic acids, solvents, nucleotides and antibiotics. Anaerobic metabolic end products.

### UNIT V

Stoichiometry of cell growth and product formation. Overall growth stoichiometry, elemental material balance for growth, heat generation, yield concepts, etc.

### Reference Book :

1. Bioprocess Engineering: Systems, Equipment And Facilities , Lydersen, Wiley India
2. Outlines Of Biochemistry, 5th Ed By Conn, Wiley India
3. "Biochemistry", Lubert Stryer, W.H. Freeman & Co. , New York.
1. Principles of Biotechnology by A. L. Lehninger, CBS Publishers and Distributors.
2. „Biochemical Engineering Fundamentals" by J.E. Bailey and D.F. Ollis, McGraw-Hill Book Co.
3. Textbook Of Biotechnology, 4th Ed Das Wiley India

## TBE - 504: FERMENTATION BIOTECHNOLOGY-II

L T P 2 0 0

### Unit-I

Antibiotics: Penicillin, streptomycin, tetracycline, new antibiotics.



Biotransformations, Vaccines: types, mechanism and production strategies.

### Unit-III

Biopolymers, Biosurfactants.

### Unit-IV

Recombinant derived products and applications: proteins, hormones and interferons.

### Unit-V

Introduction to drug discovery process, Biotechnology based drugs.

Reference Book :

1. "Microbial Technology", Vol.II, H.J. Peppler and D. Perlman, Academic Press, New York.
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.

## **PCH-559 : CHEMICAL ENGINEERING OPERATIONS LAB**

**L T P 0 0 2**

1. Studies on Jaw Crushers, Hammer mill, Ball Mill, Crushing Rolls
2. Screen Analysis
3. Pressure Drop studies in pipe fittings
4. Studies on Rotameter, Orifice meter, Venturi meter and V – Notch.
5. Studies on sedimentation and filtration.
6. Studies on Heat Exchangers viz. Concentric pipe heat exchanger, Shell and tube heat exchanger.
7. Studies on Single effect/ Multiple effect evaporators.
8. Studies on Bubble cap/ tray/ fractional column.
9. Studies on Absorption/ Humidification/ Dehumidification columns.
10. Studies on extraction column.

## **PBE551: FERMENTATION LAB**

**L T P 0 0 4**

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 spirit, beer etc.).

## **PBE 552 : GENETIC ENGINEERING LAB**

**L T P 0 0 4**

1.  $\lambda$ -max of nucleic acid
2. Isolation of the DNA, by dinitrophenylamine methods.
3. Isolation of RNA by Orcinol method.
4. Isolation of the plasmid from the bacterial sample.
5. Transformation of the bacterial cell.
6. Estimation of  $T_m$  in given sample of DNA.
7. PAGE electrophoresis of the given sample of DNA

8. Induction and repression of  $\beta$ -galactosidase in yeast

**TBE-601 : BIOPROCESS ENGINEERING-II**

**L T P 0 0 3**

1. Scale-up: Basic concepts and related problems. Fed batch fermentation: Principle and applications.
2. Continuous fermentation: Kinetic analysis, comparison with batch fermentations, applications and its limitations.
3. Bioreactor operation measurement and control: Aseptic operations, measurement and control of process variables (pH, dissolved oxygen, viscosity, temperature, NADH), agitative power, foam control, On-line analysis and computer control of fermentation process.
4. Packed and fluidized bed reactors: Analysis and application.
5. Non-mechanically agitated bioreactors such as airlift and bubble column.

Reference Book :

1. "Bioprocess Engineering-Basic Concepts" Shuler, M.L., Fikret Kargi, , Prentice Hall Pvt. Ltd., New Delhi, 2nd Edition, 2004
2. Bioprocess Engineering: Systems, Equipment And Facilities, Lydersen, Wiley India
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. "Comprehensive Biotechnology"; Vol. 2, Murray-Moo-Young, Pergamon Press, New York.

**TBE – 603 WASTE WATER TREATMENT**

**L T P 3 1 0**

**UNIT-I**

Introduction, Definition and types of wastes, sources of pollution, Physical, chemical and biological properties

**UNIT-II**

Physical treatment: Screening, grit chambers, Operation and design features of sedimentation tanks, clarifiers, Septic and Inhofe tanks.

**UNIT-III**

Chemical treatment: pH adjustment, Coagulation, Oxidation and reduction, Absorption and ion exchange.

**UNIT-IV**

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.

**UNIT-V**

Anaerobic treatment systems. Sludge digestion theory, digester design, high rate digestion, heat transfer in digester. New developments, fixed film reactors, UASB. Nitrification - denitrification, Phosphorous removal. Treatment and disposal regulations, standards & norms of waste of the industries e.g. distilling and brewing, antibiotics and sugar etc.

**Reference Book :**

1. Theory And Practice Of Water And Wastewater Treatment, Droste, Wiley India
2. "Waste Water Engineering: Treatment, Disposal and Reuse", Metcalf & Eddy, Inc.; Tata McGraw-Hill Publishing Company Ltd., New Delhi.
1. "Environmental Engineering", Howard & Peavy, Donald R. Rawe and George Tehobanoglousd, McGraw-Hill International Editions.
2. "Waste Water Treatment", Rao & Dutta.





**TCH-607: CHEMICAL REACTION ENGINEERING****L T P 0 0 3****Unit-I**

Chemical Reactions: Rate of chemical reactions, variable affecting the reaction rate, order of reaction, reaction rate constant, elementary and non-elementary reaction mechanism. Arrhenius equation, absolute reaction rates, predictability of reaction rate.

**Unit-II**

Kinetics of homogeneous chemical reactions, rate equations for simple and complex reactions, irreversible reaction, parallel reactions, consecutive reactions, auto catalytic reactions and homogeneous catalytic reactions. Interpretation of reactor data in constant volume and variable volume batch reactions, integral and differential method of kinetic data analysis.

**Unit-III**

Classification of chemical reactions. Reactor designs for homogeneous, batch, semi-batch, plug flow and continuous stirred tank. Isothermal as well as non-isothermal operation, space velocity and residence time in flow reactors. Size comparison of single reactors like batch, plug flow and CSIR for first and second order single reactions. Multiple reactor systems, Plug flow reactions in series and for parallel equal sized CSTR"s in series.

**Unit-IV**

Catalysts: Preparation, activity and the factors which influence it. The effect of physical properties on catalyst activity, methods of determination of their physical properties, catalyst poisoning, Heterogeneous catalytic reactions, principles, absorption isotherms, kinetics of solid catalysed fluid reactions, rate-controlling steps.

**Unit-V**

Biocatalysis: Kinetics of the immobilized enzymes. External and internal diffusional characteristics of immobilized systems. Enzymes reactor performance, operational strategies, carrier life and cycle time.

Reference Book :

1. Levenspiel. O. "*Chemical Reaction Engineering*", 3rd ed. Wiley India (2006)
1. Fogler, H.S. "*Elements of Chemical Reaction Engineering*", 4th ed. Prentice Hall
2. Smith, J. "*Chemical Engineering Kinetics*", 3rd edition. McGraw-Hill,(1990).

**TCH-608: MASS TRANSFER OPERATIONS –II****L T P 3 1 0****Unit –I**

Diffusion: Molecular and turbulent diffusion , diffusion coefficient. Fick"s law of diffusion, measurement

and estimation of diffusivity. Diffusion in multicomponent gas mixtures. Diffusion in solids: Molecular, Knud sen and surface diffusion. Mass transfer theories. Mass transfer in fluidized beds.

**Unit –II**

**Gas adsorption:** Counter-current, co-current, multistage continuous contact operations.

**Unit –III**

Humidification and Dehumidification: Vapour liquid equilibrium and enthalpy for a pure substance, vapour pressure – temperature curve, vapour gas mixtures, definition and derivations of relationships related with humidity, fundamental concept of humidification. Dehumidification and water cooling, wet bulb temperature, adiabatic and non-adiabatic operation, evaporative cooling, classification and design of cooling towers.

**Unit –IV**

Drying: Solid-gas equilibria, definitions of moisture contents, types of batch and continuous dryers, rate of batch drying, time of drying, mechanism of batch drying, continuous drying.

#### **Unit –V**

Crystallization; Equilibrium yield of crystallization, heat and mass transfer rates in crystallization, theories of crystallization. Classification and design of crystallizers.

Reference Book :

1. Treybal, R. “*Mass Transfer Operations*”, 3rd ed. New York: McGraw-Hill, (1980).
2. Fundamentals Of Heat And Mass Transfer, 6th Ed, Incropera, Wiley India

1. Foust A. S. et.al., “*Principles of Unit Operations*” 2<sup>nd</sup> ed Wiley India (2008)
2. Sherwood T. K., Pigford R. L.. “*Mass Transfer*” McGraw Hill (1975).
3. McCabe Smith; “*Unit Operations in Chemical Engineering*”, McGraw Hill.

### **\*\*TBE-602 Enzyme Engineering**

**L T P 3 1 0**

#### **Unit –I**

Introduction - scope, mechanism, Nomenclature, classification of enzyme, Industrial & analytical application of enzyme.

#### **Unit –II**

Enzyme kinetics. Single substrate steady state kinetics; Michaelis Menten equation, Inhibitors and activators; Multisubstrate systems. Types of Inhibition- kinetic models; Substrate and Product Inhibition; Allosteric enzyme.

#### **Unit –III**

Immobilization of enzymes and cells. Methods of immobilization. Kinetics of the immobilized enzymes. External and internal diffusional characteristics of immobilized systems.

#### **Unit –IV**

Production of industrial enzymes, Design of enzymes reactor, performance, operational strategies, carrier life and cycle time.

#### **Unit –V**

Extraction and Purification of Crude Enzyme extracts from plant, animal and microbial sources-some case studies; methods of characterization of enzymes; development of enzymatic assays.

**Reference Book :**

1. Enzymes: A Practical Introduction To Structure, Mechanism And Data Analysis, 2nd Ed, Copeland, Wiley India
2. “*Biochemical Engineering Fundamentals*” by J.E. Bailey and D.F. Ollis, McGraw-Hill Book Co., New York.
1. “*Immobilized Enzymes*” by Trevan Palmer.
2. *Industrial Enzymes & their applications*, H. Uhlig, John Wiley and Sons.
3. “*Principles of Biochemistry*”, A.L. Lehninger, D.L. Neston, N.M. Cox, CBS Publishers & Distributors.

### **PBE-651 : WASTE WATER ANALYSIS 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 digester.
7. Estimation of inorganic ions in water.



**PBE – 652: BIOPROCESS ENGINEERING LAB**

**L T P 0 0 4**

1. Determination of kinetic parameters for batch cultivation of yeast under stationary and shake flask conditions.
2. Growth kinetic studies of yeast in a bench top lab fermentor under controlled conditions.
3. Determination of volumetric oxygen transfer coefficient ( $K_L a$ ), effect of aeration and agitation speed etc.
4. Comparison of filtration efficiency of fibrous and PVA air filter.
5. Determination of specific thermal death rate constant ( $K_d$ ) and activation energy for microbial strains.
6. Studies on settling characteristics of various microbial cultures.
7. Preparation of immobilized enzymes & cells and evaluation of kinetic parameters.
8. Enzyme concentration by ultrafiltration.

**\*\*PBE-653 : ENZYME ENGINEERING LAB**

**L T P 0 0 3**

1. Isolation of enzymes from plant and microbial sources.
2. Enzyme assay; activity and specific activity – determination of amylase, nitrate reductase, cellulase, protease.
3. Purification of Enzyme by ammonium sulphate fractionation.
4. Enzyme Kinetics: Effect of varying substrate concentration on enzyme activity, determination of Michaelis-Menten constant ( $K_m$ ) and Maximum Velocity ( $V_{max}$ ) using Lineweaver-Burk plot.
5. Effect of Temperature and pH on enzyme activity.
6. Enzyme immobilization

**TBE-701 : BIOINFORMATICS**

**L T P 3 1 0**

**UNIT-I**

Primary and secondary databases. Specialized sequence databases of EST, TFB Sites, SNPs, gene expression. Pfam, PROSITE, BLOCK( Secondary databases). Data retrieval with ENTREZ, SRS, DBGET

**UNIT-II**

Sequence alignment (pairwise and multiple, global and local). Sequence alignment algorithm (FASTA, BLAST, Needleman and Wunsch, Smith Waterman). Database similarity searches (BLAST, FASTA and PSI BLAST). Amino acid substitution matrices (PAM, BLOSUM)

**UNIT-III**

Phylogentic Analysis, Hidden Markov Model (HMM) and its Application, Genomics and Gene Recognition; From Sequencing Genes to Genomes Sequence Assembly, Annotation and Analyzing whole Genome sequences, Functional Genomics.

**UNIT-IV**

Protein structure prediction (Chou Fasman method): Secondary and tertiary structures, Homology Modelling, ORF prediction, Gene prediction, Microarray data analysis, Profiles and motifs.

**UNIT-V**

Structure visualization methods (RASMOL, CHIME etc.), Protein Structure alignment and analysis, Application of Bioinformatics in drug discovery and drug designing.

Reference Book :

1. Bioinformatics : Principles and applications by Ghosh and Mallick (oxford) university press)
2. Bioinformatics by Andreas D Boxevanis 3<sup>rd</sup> ed Wiley India
3. Bioinformatics A Beginner's Guide, Claverie, Wiley India
4. Fundamental concept of bioinformatics by Dan e. krane

**Reference books:**

1. Introduction to bioinformatics by Attwood and Parry Smith (Pierson education Publication)
2. instant notes in Bioinformatics by Westhead, parish and Tweman ( Bios scientific publishers)

**TBE-702: BIOSEPARATION AND DOWNSTREAM PROCESSES**

**L T P 3 1 0**

**Unit I**

An overview of Bioseparation, Role of Downstream Processing in Biotechnology, Problems and requirement of bioproduct purification, Cost cutting strategies.

**Unit II**

Primary separation and Recovery Process: Cell, Disruption methods (Physical, chemical and Enzymatic) for intracellular products. Conditioning of broth, Removal of insoluble, biomass. Separation techniques – Flocculation, Sedimentation, Centrifugation and Filtration.

**Unit III**

Product Isolation - Extraction and Adsorption methods, Solid- Liquid , Liquid -liquid Separation, Aqueous two phase extraction, Membrane based Separation -micro and ultrafiltration (Theory, Design and Configuration of the Equipment), Precipitation methods- Ammonium, Sulphate, organic solvents, High molecular weight polymers.

**Unit IV**

Product Purification: Case studies for using Electrophoresis and Chromatography process for product purification, Different Electrophoresis technique -Isoelectric, focussing , chromatographic technique with special reference to ion-exchange ,affinity, GLC, HPLC

**Unit V**

Product Polishing: Crystallization, Drying. A Few case studies: Citric acid, Glutamic acid, Penicillin G, Extracellular Enzymes, Intracellular enzymes, Antibodies

Reference Book :

1. Product Recovery in Bioprocess Technology, Heinemann, Butterworth Publication.
1. Comprehensive biotechnology- Murray Moo-Young, Vol. II-latest ed., Pergan Publishers.
2. Electrophoresis, Velson Wiley India
3. H. J. Rehm and G. Reed, Biotechnology- Vol. 3, 4, 5, Verlag Publishers
4. A Biologist's Guide to Principles & Techniques of Practical Biochemistry- Wilson and Golding, Cambridge University Press
5. Electrophoresis in Practice, Westermeier- John Wiley & Sons.
6. Handbook of Analytical techniques-H. Gunzler, John Wiley & Sons.
7. International Methods of Analysis- Willard et al., CBS Publication.
8. Bioseparation Techniques, Sivasankar, Prentice-Hall of India, 2004.
9. Bioseparations (Principles & techniques), B. Sivasankar, Prentice-Hall of India, 2005.

**TCH 707 : INDUSTRIAL SAFETY & HAZARD MANAGEMENT**

**L T P 3 1 0**

**Unit I**

Industrial safety, Industrial hygiene and safety aspects related to toxicity, noise, pressure, temperature, vibrations, radiation etc. Explosions including dust, vapor, cloud and mist explosion. Regulation and legislation, government role.

**Unit II**

Elements of safety, safety aspects related to site, plant layout, process development and design stages, identification of hazards and its estimation, risk, risk analysis and assessment methods; fault free method, event free method, scope of risk assessment, controlling toxic chemicals and flammable materials.

### **Unit III**

Toxic substances and degree of toxicity, its estimation, their entry routes into human system, their doses and responses, control techniques for toxic substances exposure, use of respirators, ventilation systems.

### **Unit IV**

Prevention of losses, fire and its prevention, release of hazardous materials; relief systems: their types and location. Handling, transportation and storage of flammable and toxic materials, disaster planning and management.

### **Unit V**

Biohazards, classification of microbes with respect to pathogenicity, methods of containment, disposal rules, hazard reduction in biochemical industries.

Reference Book :

1. Sanjoy Banerjee, "*Industrial Hazards & Plant Safety*", Taylor & Francis Group

#### **Reference Books:**

1. D. A. Crowl and J.F. Louvar. "*Chemical Process Safety (Fundamentals with Applications)*", Prentice Hall (1990)

2. H. H. Fawcett and W.S. Wood. "*Safety and Accident prevention in Chemical Operations, 2<sup>nd</sup> Edition*", John Wiley & Sons, New York, 1982.

## **TCH-702: INSTRUMENTATION & PROCESS CONTROL**

**L T P 3 1 0**

### **Unit-I**

Elements of measurement , functions and general classifications of measuring instruments. Indicating and recording type of instruments. Elements of measuring instruments, static and dynamic characteristics of measuring instruments.

### **Unit-II**

Principle of operation, construction and application of important industrial instruments for the measurement of temperature, flow, liquid level, DO, pH and composition.

### **Unit III**

Introduction to Process control systems, Regulator & Servo control, Feed Forward & Feed backward control, Negative & Positive Feedback Control, variables & Physical Elements of a Control system, Physical, Block & Signal Flow Diagram. Use of Laplace & Inverse Laplace Transformation is study of Process Dynamics.

### **Unit IV**

Dynamic Modeling of a Process, Dynamic behavior of First order systems and First order systems in series. Dynamic behavior of second & higher order system for various kind of inputs, Linearization of nonlinear system, Transportation & Transfer Lag.

### **Unit V**

Modes of control action, Controllers & Final control Elements, Reduction of Block & Signal Flow Diagrams, Closed loop transfer function and response of closed loop control system for various type of control actions.

Reference Book :

1. Process Dynamics & Control, 2nd Ed , Seborg, Wiley India

1. Process system Analysis & Control, D.R. Coughanoowr, McGraw Hill Publication.

1. Process Control. Peter Harriot, Tata McGraw Hill.

2. Process control, Staphno polies, Prentic Hall India Ltd.

3. Automatic Process Control , Eckman,Wiley India

## **PBE751 : BIOSEPARATION PROCESSES LAB**

**L T P 3 1 0**

1. Cell disruption techniques.

2. Solid separation methods-filtration, sedimentation techniques.
3. Centrifugation techniques
4. Product enrichment operations (precipitation, ultra filtration, two-phase aqueous extraction)
5. High-resolution purification
6. Preparative liquid chromatographic techniques
7. Product crystallization and drying

### **PBE752: BIOINFORMATICS LAB**

1. Construction of database for specific class of proteins/enzymes, genes/ ORF/ EST/Promoter sequences/ DNA motifs or protein motifs using oracle.
2. Access and use of different online protein and gene alignment softwares
3. Gene finding related search for a given nucleotide sequence in order to predict the gene
4. ORF prediction for different proteins out of some given nucleotide sequences.
5. Exon identification using available softwares for a given nucleotide sequences
6. Secondary structure prediction for amino acid sequences of a given protein.

### **PBE752: MINOR PROJECT**

**L T P 0 0 4**

The student would be allotted a project in the beginning of the VII semester itself. The project may or may not be based on the industry where he/she has undergone in plant training in industry during summer vacations. He/She would be expected to submit a detailed plant design report later in the (VIII) semester. In this semester he/she will be assessed (out of 50 marks) for the work that he/she does during the seventh semester under the supervision of a faculty of the department.

### **PBE753: COLLOQUIUM**

**L T P 0 0 2**

Each student is required to deliver a seminar on pre-assigned topic. Group discussion will be organized to develop skill of presentation, organization and impromptu discussion.

### **TBE802: BIOPROCESS PLANT DESIGN AND ECONOMICS**

**L T P 3 1 0**

#### **Unit I**

**Process Development:** Process selection, study of alternative processes, pilot plant, Scale up methods, Flow sheet preparation, sketching techniques, Equipment numbering, Stream designation, Material and energy balances.

**Plant Design:** Design basis, Process selection- Selection of equipment, specification and design of equipment's, material of construction, Plant location, Plant layout and installation, Safety, Start up, Shutdown and Operating guidelines.

#### **Unit II**

**Cost Engineering:** Time value of money and equivalence, Interest, cost comparisons by present worth, Annual equivalent cost and capitalized cost methods, Uniform gradient and series. Depreciation, Taxes and Insurances, Nature of depreciation, Methods of determining depreciation, depreciation rates in current Indian situation, Types of taxes and insurance's, Procedure for cost comparison after taxes.

#### **Unit III**

**Cost Estimation:** Types of cost estimation, capital investment cost, fixed capital cost, working capital cost, start-up costs, process equipment cost estimation, cost index, Equipment costs due to inflation,

Battery limit investments, estimation of plant cost, Estimation of total product cost, Manufacturing cost, General expenses.

**Profitability:** Criteria of profitability, Payout period, Return on investment, Present value, Cash flow analysis, Alternative investment analysis, Sensitive analysis in project profitability.

#### Unit IV

**Economic Optimization and Optimum Design:** Nature of optimization, Uni-variable and multivariable systems, Analytical, graphical and incremental methods of solution, LaGrange multiplier method, Linear programming and dynamic programming establishing optimum conditions, Break even chart for production schedule, Optimum production rates in plant operation, Optimum conditions in batch, cyclic and semicyclic operation, Sensitivity and response analysis.

#### Unit V

**Optimisation of Different Process Equipment:** Viz., transportation systems, heat exchangers, evaporators, mass transfer equipments and reactors. Determination of height and diameter of different process equipments at conditions of optimum cost .Pinch Technology analysis. Preparation of techno-economic feasibility report.

Reference Book :

- 1.Peters M., Timmerhaus K. & Ronald W., Plant Design & Economics for Chemical Engineers, McGraw Hill
2. Bioprocess Engineering: Systems, Equipment And Facilities, Ydersen,Wiley India

1. James R Couper, Process Engg. Economics (Chemical Industries) CRC Press
2. Aries & Newton, Chemical Engg. Cost Estimation, McGraw Hill

### PBE851: MAJOR PROJECT

L T P 3 1 0

This project course is in continuation of Minor project course (PBE752) allotted in the beginning of the VII the semester .Here the students are supposed to do the detail work as scheduled in the last semester. Finally he/she will be required to submit a detailed project report on which viva-voce examination will be conducted by a committee having one External Examiner.

### PBE852 : BIOPROCESS PLANT DESIGN LAB

L T P 3 1 0

#### Recommended to be done using a commercial simulator

1. Design of a Flow network containing Pumps, fittings and Piping (horizontal, vertical, inclined)
2. Process design of simple reactors (CSTR, Tubular) with or without heat transfer.
3. Process design & Rating of stand alone Multi-component Distillation columns.
4. Process design & Rating of TEMA Type Shell &Tube Heat exchangers.
5. Steady state flow sheeting of acyclic processes.
6. Steady state flow sheeting of Processes with recycles /Purge/Bypass etc.

#### Recommended to be done using a Simulation Language/Programming Environment

1. Study of dynamic behavior of simple systems such as tank in series, double effect evaporators,etc.
2. Study of coupling of manipulated and controlled variables using relative gain analysis (RTA).

#### Recommended to be done using a commercial simulator

1. Dynamic simulation of Simple process systems with controllers
2. Dynamic simulation & controllability analysis of Binary distillation column.

#### Recommended Software

1. Steady state/Dynamic simulator (such as Hysys. Plant or Aspen Plus/Aspen Dynamic)
2. Simulation Language /Programming Environment (MATLAB).



## **Syllabus for Open/ Professional Elective Courses**

### **NANOBIOTECHNOLOGY**

**L T P 3 1 0**

#### **Unit I**

Basic biology principles and practice of micro fabrication techniques, Atomic force microscopy, biological production of metal nano-particles, macro molecular assemblies.

#### **Unit II**

Application in Biomedical and biological research, nano-particles, viruses as nano-particles, nano chemicals and application, tumor targeting and other diagnostic applications.

#### **Unit III**

Developing drug delivery tools through nanobiotechnology, nano-particle based immobilization assays, quantum dots technology and its application.

#### **Unit IV**

Synthesis and characterization of different classes of biomedical polymers- their uses in pharmaceutical, cardiovascular ophthalmologic orthopedic areas.

#### **Unit V**

Biosensors and nanobiotechnology principles used in construction of micro electronic devices sensors and macro mechanical structures and their functioning, immuno-nanotechnology

Reference Book :

1. Nanobiotechnology- concepts, applications and perspectives, niemeyer, Christ of m. Mirkin, chad a., John Wiley & Sons

1. Nanobiotechnology of biomimetic membranes, martin, donald (edt), springer verlag publishers.

### **BIOINFORMATICS**

**L T P 3 1 0**

#### **UNIT-I**

Definitions of informatics, chronological history Molecular Biology's Central dogma; Gene structure and

Information content, protein structure and function, Molecular Biology tools.

#### **UNIT-II**

Primary and secondary databases. Specialized sequence databases of EST, TFB Sites, SNPs, gene expression. Pfam, PROSITE, BLOCK( Secondary databases). Data retrieval with ENTREZ, SRS, DBGET

#### **UNIT-III**

Sequence alignment (pairwise and multiple, global and local). Sequence alignment algorithm (FASTA, BLAST, Needleman and Wunsch, Smith Waterman). Database similarity searches (BLAST, FASTA and PSI BLAST). Amino acid substitution matrices (PAM, BLOSUM)

#### **UNIT-IV**

Protein structure prediction (Chou Fasman method): Secondary and tertiary structures, Homology Modelling, ORF prediction, Gene prediction, Microarray data analysis, Profiles and motifs.

#### **UNIT-V**

Structure visualization methods (RASMOL, CHIME etc.), Protein Structure alignment and analysis, Application of Bioinformatics in drug discovery and drug designing.

Reference Book :

1. Bioinformatics : Principles and applications by Ghosh and Mallick (oxford) university press)
2. Bioinformatics by Andreas D Boxevanis Wiley India
3. Bioinformatics A Beginner's Guide , Claverie, Wiley India
4. Fundamental concept of bioinformatics by Dan e. krane

1. Introduction to bioinformatics by Attwood and Parry Smith (Pierson education Publication)
2. instant notes in Bioinformatics by Westhead, parish and Tweman ( Bios scientific publishers)

## PLANT CELL BIOTECHNOLOGY

L T P 3 1 0

### Unit I

Historical background; Laboratory organization; Nutritional requirement of plant cells; Media composition –solid and liquid; concept of totipotency; Tissue and organ culture; Establishment and maintenance of callus and suspension cultures; Cellular differentiation and regulation of morphogenesis; Somatic embryogenesis

### Unit II

Haploid production -Androgenesis; Anther and microspore culture; Gynogenesis; Embryo culture and rescue in agricultural and horticultural corps; Protoplast isolation and culture; Somatic hybrid-cybrids; Plant micropropagation; *in vitro* clonal multiplication – Meristem culture and virus elimination

### Unit III

Arabidopsis as a model plant for genetic engineering; Biological nitrogen fixation; nif genes; Terminator seed technology; Edible vaccines; Brief idea about molecular farming

### Unit IV

Introduction to Plant Genetic Engineering; Physical methods of transferring genes to plants - Microprojectile bombardment, Electroporation, microinjection; Plant transformation with Ti plasmid of *Agrobacterium tumefaciens*; Ti plasmid derived vector systems; Chloroplast Engineering

### Unit V

Developing insect-resistance, disease-resistance , herbicide resistance in plants and stress tolerance in plants; yield increase in plants: case study of golden rice, modification of colour, fruit softening; Public concerns about transgenic crops

Reference Book :

1. Plant Biotechnology. Mantell and Smith, 1984.

1. Principles and Practices in Plant Science. Walton, P.D. Prentice Hall 1988.
2. Plant Tissue Culture: Application and Limitations. Bhowjwani, S.S. 1990.
3. Plant Cell Culture: A practical approach. Dixon. 1994.
4. Plant Biotechnology and Development, SRC Series of Current Topics in Plant molecular Biology. Gresshoff, P.M.
5. Plant Cell Culture, Advances in Biochemical Engineering and Biotechnology. Anderson, L.A.,
6. Handbook Of Plant Biotechnology, Vol 1-2 Christou Wiley India

## ENVIRONMENTAL BIOTECHNOLOGY

L T P 3 1 0

### Unit I

Environmental pollution: Land, water, air, and noise (introduction, sources, effects and measurements). Biosensors to detect environmental pollution: BOD, Aluminium, Nitrate and sulfite biosensors

### Unit II

Biological waste treatments, Methanogenesis: methanogenic, acetogenic, and fermentative bacteria – anaerobic and aerobic digestion processes and conditions, Minimal national standards for waste disposal, Principles and design aspects of various waste treatments methods, Economical and social aspects of waste treatment.

### Unit III

Bioreactor configuration: activated sludge process, trickling filter, fluidized bed reactor, upflow anaerobic sludge blanket reactor, contact process, fixed / packed bed reactor, hybrid reactor, sequential batch reactor.

#### Unit IV

Conservation of biodiversity, Germplasm conservation, Biofertilizers, Biopesticides, Biodegradable plastics

#### Unit V

Bioremediation: land, water, industries, organic contaminants, heavy metals and nitrogenous wastes, Bioenergy, biofuels, biomass production, biogas, H<sub>2</sub>, cellulases and food and feed stocks,

Reference Book :

1. Ecology & Environment- P. D. Sharma, 8th ed.
  1. Waste Water Engineering- Metcalf & Fuddy, 3rd ed.
  2. Theory And Practice Of Water And Wastewater Treatment , Droste , Wiley India
  3. Environmental Processes I-III, J. Winter, 2nd ed., John Wiley & Sons
  4. Introduction to Waste Water Treatment- R. S. Ramalho, Academic Press.
  5. Environmental Studies- Dwivedi & Mishra, Ed. 2007.
  6. Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press, 2007.
  7. Essentials of Ecology & Environmental Science, S.V.S. Rana, Prentic-Hall India, 2006.
  8. Perspectives in Environmental Studies, Anubha Kaushik & C P Kaushik, New Age International Publishers, 2004.
  9. Environmental Biotech., Pradipta Krimar, I.K. International Pvt. Ltd., 2006.
  10. Environmental Microbiology & Biotechnology, D.P. Singh, S.K. Dwivedi, New Age International Publishers, 2004.
  11. Global Environmental Biotechnology, Wise, Elsevier Ex. Pubishers

## BIOSENSORS

### L T P 3 1 0

1. **General principles:** A historical perspective; Signal transduction; Physico-chemical and biological transducers; Sensor types and technologies.
2. **Definitions and Concepts:** Terminology and working vocabulary; Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time; Problems and trade-offs.
3. **Physico-chemical transducers:** Electrochemical transducers (amperometric, potentiometric, conductimetric); Semiconductor transducers (ISFET, ENFET); Optical transducers (absorption, fluorescence, bio/chemiluminescence, SPR); Thermal transducers; Piezoelectric and acoustic-wave transducers; Limitations & problems to be addressed; An Overview of Performance and Applications.
4. **Biorecognition systems:** Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Microbial metabolism; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors; Limitations & problems.
5. **Immobilization:** Enzyme immobilization; Peptide immobilization; Antibody immobilization; Oligonucleotides and Nucleic Acid immobilization; Cell immobilization.
6. **Biosensors:** Catalytic biosensors: mono-enzyme electrodes; bi-enzyme electrodes: enzyme sequence electrodes and enzyme competition electrodes; Affinity-based biosensors; Inhibition- based biosensors; Cell-based biosensors; Biochips and biosensor arrays; Problems and limitations.
7. **Biosensor Engineering:** Methods for biosensors fabrication: self-assembled monolayers, screen printing, photolithography, microcontact printing, MEMS, Engineering concepts for mass production.
8. **Application:** Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable sensors for long-term monitoring; Drug development and detection; Environmental monitoring; Technological process control; Food quality control; Forensic science benefits; Problems & limitations.

Reference Book :

1. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley & Sons, 1998.
2. Chemical Sensors & Biosensors, Eggins, Wiley India
1. Jiri Janata, Principles of Chemical Sensors, Plenum Press, 1989.
2. Frontiers in Biosensors, Edited by: F. Scheller, F. Schubert, J. Fedrowitz, Birkhauser Verlag, 1995.
3. Optical Biosensors. Present & Future. Editors: F. Ligler, C. Rowe Taitt, Elsevier, 2002.
4. Brian Eggins, Chemical Sensors and Biosensors, John Willey & Sons, 2002.
5. Commercial Biosensors, Graham Ramsay Editor, John Wiley & Sons, 1998.
6. Ursula Spichiger-Keller, Chemical Sensors and Biosensors for Medical and Biological Applications, John Wiley & Sons

## ANIMAL BIOTECHNOLOGY

L T P 3 1 0

### Unit I

Basic cell culture techniques, Types of cell culture media; Ingredients of media; Physiochemical properties; CO<sub>2</sub> and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics growth supplements; Foetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.

### Unit II

Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants.

### Unit III

Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

### Unit IV

Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fiber perfusion; Matrix perfusion; Microencapsulation; Growth monitoring

### Unit V

Transgenic animal production; Methods of transgene delivery; Integration of foreign genes and their validation; Gene targeting; Methods and strategies; Improving transgene integration efficiency; Cell lineages and developmental control genes in drosophila and mice; Differentiation of germ layers; Cellular polarity; Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Differentiation of cancerous cells and role of protooncogenes; Stem cell markers; Methods of stem cell production in farm animals; Using stem cells for SCNT; Transgenesis and Xenotransplants.

Reference Book :

1. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, John Wiley & Sons 2000
2. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991
3. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.
4. Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5th Edition, CRC Press, 1997.

## Advanced Separation Process

- Unit I:** Principle of membrane separations process; Classification, characterization and preparation of membrane. Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators. Dialysis, Ultra Filtration and Economics of Membrane operations.
- Unit II:** Reverse osmosis, micro-filtration, nano-filtration and dialysis; Analysis and modeling of membrane separation processes; Membrane modules and application; Ion selective membranes and their application in electro-dialysis; Pervaporation and gas separation using membranes; Electrophoresis; Liquid membranes and its industrial applications.
- Unit III:** Foam and bubble separation: Principle; Classification; Separation techniques; Column operations. Zone melting, zone refining and zone leveling. Pressure and temperature swing adsorption.
- Unit IV:** Cryogenic separation; Super- critical extraction. Parametric pumping: Batch, continuous and semi-continuous pumping; Thermal, pH and heatless parametric pumping. Multicomponent separation.

Reference Book :

1. Seader, J.D, and Henley E.J., "Separation Process Principles", wiley India
2. King, C.J., "Separation Processes", McGraw-Hill, Inc.
3. H. M. Schoen, " New Chemical Engineering Separation Techniques", John Wiley & Sons, 1972.
4. C. Loeb and R. E. Lacey, "Industrial Processing with Membranes", John Wiley & Sons, 1972.

## **PRESERVATION OF BIOMATERIALS**

**L : T: P 3 : 1: 0**

### **Unit I**

Preservation and maintenance of microbial cultures.

### **Unit II**

Chemical constituents of food/Biomaterials, their properties and function. Food spoilage and poisoning. Characteristic features of natural and processed foods.

### **Unit III**

Unit operations in food processing, Principles of food preservation: High and low temperatures.

### **Unit IV**

Drying and dehydration, radiation and osmotic pressure.

### **Unit V**

Chemical preservatives, Legislation, safety and quality control.

Reference Book :

1. "Principles of Food Science", Part-II: Physical Methods of Food Preservation by M. Karel.
2. "Principles of Food Preservation" by V. Kyzlink, Elsevier Press.
3. "Modern Food Microbiology" by James M. Jay.
4. "Food Science" by N.N. Potter, VI Publications.

## **GENOMICS & PROTEOMICS**

**L T P 3 1 0**

**Unit I: Introduction to Genomics**

Structure and organization of prokaryotic and eukaryotic genomes nuclear, mitochondrial and chloroplast genomes; Computational analysis of sequences- finding genes and regulatory regions; Gene annotation; Similarity searches; Pairwise and multiple alignments; Alignment statistics; Prediction of gene function using homology, context, structures, networks; Genetic variation-polymorphism, deleterious mutation; Phylogenetics; Tools for genome analysis-PCR, RFLP, DNA fingerprinting, RAPD, Automated DNA sequencing; Linkage and pedigree analysis; Construction of genetic maps; Physical maps, FISH to identify chromosome landmarks.

**Unit II: Genome sequencing**

Human genome project-landmarks on chromosomes generated by various mapping methods; BAC libraries and shotgun libraries preparation; Physical map-cytogenetic map, contig map, restriction map, DNA sequence; DNA sequencing and sequence assembly; Model organisms and other genome projects; Comparative genomics of relevant organisms such as pathogens and nonpathogens; Evolution of a pathogen e.g. Hepatitis C virus or a bacterial pathogen; Taxonomic classification of organisms using molecular markers- 16S rRNA typing/sequencing;

**Unit III: DNA Microarray technology**

Basic principles and design: cDNA and oligonucleotide arrays; Applications: Global gene expression analysis, Comparative transcriptomics, Differential gene expression; genotyping/SNP detection; Detection technology; Computational analysis of microarray data.

**Unit IV: Proteomics**

Overview of protein structure-primary, secondary, tertiary and quaternary structure; Relationship between protein structure and function; Outline of a typical proteomics experiment; Identification and analysis of proteins by 2D analysis; Spot visualization and picking; Tryptic digestion of protein and peptide fingerprinting; Mass spectrometry : ion source (MALDI, spray sources); analyzer (ToF, quadrupole, quadrupole ion trap) and detector; clinical proteomics and disease biomarkers; Prions; proteins in disease; Protein-protein interactions: Solid phase ELISA, pull-down assays (using GST-tagged protein), far western analysis, by surface plasmon resonance technique, Yeast two hybrid system, Phage display; Protein interaction maps; Protein arrays-definition, applications- diagnostics, expression profiling.

**Unit V:**

Human disease genes; DNA polymorphism including those involved in disease; Hemoglobin and the anemias; Phenylketonuria (monogenic) and diabetes (multigenic) genetic disorders; „disease" gene vs.

„susceptibility" gene; SNP detection: hybridization based assays (allele specific probes); Polymerization based assays (allele specific nucleotide incorporation, allele-specific PCR); Ligation based assays (allele specific oligonucleotide ligation); Polymorphism detection without sequence information: SSCP; Proteomics and drug discovery; High throughput screening for drug discovery; Identification of drug targets; Pharmacogenomics and pharmacogenetics and drug development; Toxicogenomics; Metagenomics.

Reference Book :

1. Introduction to Genomics . Arthur Lesk. Oxford University Press, 2008
2. Brown TA, Genomes, 3rd Edition, Garland Science, 2006.
- 4 Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

**MODELLING AND SIMULATION OF BIOPROCESSES**

**L T P 3 1 0**

Module I:

Approach to modeling, Unstructured and structured modeling, Deterministic and stochastic models, Segregated and unsegregated models, Shu"s segregated models for Lactic acid fermentation.

Module II:

Structured kinetic models: Compartmental models (two and three), Product formation, Unstructured and structured models, Genetically structured models.

Module III:

Stochastic model for thermal sterilization of the medium, Modelling for activated sludge process, Model for anaerobic digestion, Models for lactic acid fermentation and antibiotic production.

Module IV:

Process simulation techniques, Equation oriented approach, Equation oriented simulators ( SPEED UP, ASCEND, FLOWSIM, QUASILIN, DYN SIM), simulation programs based on Euler's methods,

Newton

- Raphsen methods, Runge - Kutta methods, Simulation of biochemical system models.

Reference Book :

1. Haerder and J. A. Roels " Application of simple structured I Bioengineering, and P55 in Advances In Biochemical engineering Vol21, A. Fiechts (ed) Spring -Verlag , Berlin, 1982.
2. J.E. Bailey and D.F. Ollis, Biochemical Engg Fundamentals, 1986, McGraw Hill Book Company

## FOOD BIOTECHNOLOGY

L T P 3 1 0

### Unit : 1

History of Microorganisms in food, Historical Developments. role and significance of microorganisms in foods. Intrinsic and Extrinsic .Parameters of Foods that affect microbial growth. Basic principles, unit operations, and equipment involved in the commercially important food processing methods and unit operations

### Unit : 2

**Microorganisms** in fresh meats and poultry, processed meats, seafood"s, fermented and fermented dairy

products and miscellaneous food products. **Starter cultures**, cheeses, beer, wine and distilled spirits, SCP, medical foods, probiotics and health benefits of fermented milk and foods products. **Brewing**, malting, mashing, hops, primary & secondary fermentation: Biotechnological improvements: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl. Beer, wine and distilled spirits.

### Unit : 3

**Nutritional boosts and flavor enhancers:** Emerging processing and preservation technologies for milk and dairy products. **Microbiological Examination** of surfaces, Air Sampling, Metabolically Injured Organisms. Enumeration and Detection of Food-borne Organisms, Bioassay and related Methods.

### Unit 4:

**Food Preservation**, Food Preservation Using Irradiation, Characteristics of Radiations of Interest in Food Preservation. Principles Underlying the Destruction of Microorganisms by Irradiation, Processing of Foods for Irradiation, Application of Radiation, Radappertization, Radicidation, and Radurization of Foods Legal Status of Food Irradiation, Effect of Irradiation of Food constituents.

### Unit 5:

**Storage Stability Food Preservation with Low Temperatures**, Food Preservation with High Temperatures, Preservation of Foods by Drying, Indicator and Food-borne Pathogens, Other Proven and Suspected Food-borne Pathogens. Rheology of Food Production.

Reference Book :

1. Mann & Trusswell , 2007. Essentials of human nutrition. 3rd edition .oxford university press.
2. Jay, J.M., 1987. Modern Food Microbiology, CBS Publications, New Delhi.
3. Lindsay, 1988. Applied Science Biotechnology. Challenges for the flavour and Food Industry. Willis Elsevier.
4. Roger, A., Gordon, B. and John, T., 1989. Food Biotechnology.

## BIOETHICS, BIOSAFETY & IPR

L T P 3 1 0

### Unit I

Jurisprudential definition and concept of property, rights, duties and their correlation. History and evolution of IPR- like patent, design and copy right, Indian patent act 1970 (amendment 2000), international convention in IPR, major changes in Indian patent system as post TRIPS effects

(i) obtaining patent (ii) geographical indication.

### Unit II

Distinction among various forms of IPR, Requirement of a patentable novelty, invention step and prior art and state of art, procedure

### Unit III

Rights/protection, infringement or violation, remedies against infringement – civil and criminal.

### Unit IV

Detailed information on patenting biological products, Biodiversity, Budapest treaty, Appropriate case studies.

### Unit V

Biosafety and Bioethical issues in Biotechnology

Reference Book :

1. Biotechnology & Safety Assessment, Thomas, Ane/Rout Publishers.
2. Intellectual Property Protection & Sustainable Development, Phillippe Cullet, Lexis Nexis Butterworths.

1. Patent Strategy For Researchers & Research Managers- Knight, John Wiley & Sons.
2. Agriculture & Intellectual & Property Rights, V. Santaniello & R E Evenson, University Press.
3. Biotechnology in Comparative Perspective, Fuchs, Ane/Rout Publishers

## IMMUNOLOGY

L T P 3 1 0

### UNIT--1

Introduction to immunity, Characteristics of innate and adaptive immunity, Humoral and Cell mediated immune response, Hematopoiesis, Cells and Molecules of the immune system, Primary and Secondary lymphoid organs, Inflammation, Characteristics of T&B cell epitopes, T &B cell maturation, activation and differentiation.

### UNIT-2

Characteristics and types of Antigens, Factors affecting the immunogenicity, Haptens and adjuvants, ABO blood group antigens, Epitopes, Structure, functions and characteristics of different classes of antibodies, Antigenic Determinants on Immunoglobulins.

### UNIT-3

Structure and Function of MHC molecules, Exogenous and Endogenous pathways of antigen processing and presentation, Complement system, Structure, function and application of cytokines, regulation of immune response, immune tolerance.

### UNIT-4

Antigen and antibody interactions, cross reactivity, precipitation reactions, serological techniques – ELISA, RIA and western blotting Production and application of monoclonal antibodies, dose of antigens, Vaccines.

### UNIT-5

Immunity against infectious diseases (virus, bacteria and protozoan), Hyper-sensitivity, Autoimmunity, Cancer, AIDS and Transplantation immunology.



**Reference books:**

1. Immunology by Benacera
2. Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press)
3. Immunology by C. Fatima
4. Immunology by Kuby (Free man publication)
5. Roitt's Essential Immunology, 11th Ed , Delves, Wiley India

**MOLECULAR MODELING AND DRUG DESIGN**

**L T P 3 1 0**

**UNIT I**

Introduction to Molecular Modelling. What are models used for? Areas of application – Single molecule calculation, assemblies of molecules. Reaction of the molecules. Drawbacks of mechanical models as compared to graphical models. Co-ordinate systems two – matrix, potential energy surface. Postulates of quantum mechanics, electronic structure calculations, ab initio, semi-empirical and density functional theory calculations, molecular size versus accuracy. Approximate molecular orbital theories.

**UNIT II**

Molecular Mechanisms, energy calculations, Bond stretch, angle bending, torsional term. Electrostatic interaction- Vander waals interactions. Miscellaneous interaction. Introduction, Molecular Dynamics using simple models. Dynamics with continuous potentials. Constant temperature and constant dynamics. Conformation searching, Systematic search. Applications to protein folding

**UNIT III**

Modelling by Homology-the alignment, construction of frame work ,selecting variable regions, side chain placement and refinement, validation of protein models –Ramchandran plot, threading and ab initio modeling.

**UNIT V**

Introduction to QSAR. lead module, linear and nonlinear modeled equations, biological activities, physicochemical parameter and molecular descriptors, molecular modelling in drug discovery.

**UNIT V**

3D Pharmacophores, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies. 3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching, combinatorial libraries – generation and utility,

Reference Book :

1. Principles and applications of modelling by Leach
2. Molecular Modelling by Hans Pieter, Heltje & Gerd Folkens, VCH.
3. Computational Chemistry by Guy H, Grant & W. Graham Richards, Oxford University Press