Savitribai Phule Pune University, Pune

T.E. (Biotechnology) Syllabus Structure for 2012 Course

(W.e.f. Academic Year 2015-16)

T.E. (Biotechnology) Syllabus and Structure for 2012 Course Sem-I
(W.e.f. Academic Year 2015-16)

Subject Code	Subject	Teaching Scheme Hrs/Week			Examination Scheme (Marks)					
		Lect	Tut	Pr	Theory		TW	Pr	Or	Total
					In Sem.	End Sem				
315461	Biochemistry-II	4	-	-	30	70	--	-	-	100
315462	Mass Transfer	4	-	-	30	70	-	-	-	100
315463	Reaction Engineering	4	-	-	30	70	-	-	-	100
315464	Genetic Engineering	4	-	-	30	70	-	-	--	100
315465	Fermentation Technology	4	-	-	30	70	--	-	-	100
315466	Biochemistry-II and Fermentation Technology Lab	-	-	4	---	--	50	50	-	100
315467	Mass Transfer and Reaction Engineering	-	-	4	-	-	50	-	50	100
315468	Employability Skill in Genetic Engineering	-	-	2	-	-	-	-	50	50
Total →		20	00	10	150	350	100	50	100	750

T.E. (Biotechnology) Sem-II

Subject Code Subject Code	Subject Subject	Teaching Scheme Hrs/Week			Examination Scheme (Marks)					
		Lect	Tut	Pr	Theory		TW	Pr	Or	Total
					In Sem.	End Sem				
315469	Computational Techniques and Biostatistics	3	2	-	30	70	-	-	-	100
315470	Immunology and Diagnostics	3	-	-	30	70	-	-	-	100
315471	Bioseparation-I	4	-	-	30	70	-	-	-	100
315472	Instrumentation and process Control	4	-	-	30	70	-	-	--	100
315473	Bioinformatics and Management	4	-	-	30	70	-	--	-	100
315474	Bioseparation-I	-	-	2	-	-	50	50	-	100
315475	Bioinformatics & Management and Instrumentation & Process Control	-	-	4	-	-	50	-	50	100
315476	Seminar and Demonstration of Diagnostics methods	-	-	4	-	-	50	-	-	50
Total →		18	02	10	150	350	150	50	50	750

T. E. Biotechnology Sem I

Biochemistry II (315461)

Teaching Scheme:
Theory: 4 hr/week

Exam Scheme:
In Semester Exam:
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT 1 **[8 Hrs]**

Protein and structure- Primary structure, secondary structure (alpha helix, beta sheets, turns and loops), tertiary structure (myoglobin), quaternary structure (hemoglobin), determination of three dimensional structure of protein from its amino acid sequence, Ramchandran plot, correlation between protein misfolding and certain neurological diseases

UNIT 2 **[8 Hrs]**

Enzymes – naming and classification of enzymes, enzyme cofactors, kinetics of enzyme catalyzed reactions,MichaelisMenten equation, effect of pH, temperature on enzyme activity, purification of enzyme, substrate specificity of enzyme, Factors leading to rate enhancement of enzyme catalyzed reactions: Acid-base catalysis, proximity and orientation effects, covalent catalysis, strain or distortion and change in environment, regulatory enzyme, isozymes, multi-enzymes

UNIT 3 **[7 Hrs]**

Coenzyme I -Coenzyme A, Thiamine diphosphate, pyridine nucleotides, flavins and lipoic acid Coenzyme II Biotin and pyridoxal phosphate. Enzyme inhibition: feedback inhibition, irreversible and reversible inhibition (competitive, non-competitive, uncompetitive), allostericinhibition

UNIT 4 **[8 Hrs]**

Basic physiology, hormone cascade, hormones (insulin, glucagons, epinephrine, growth hormone, thyroid, parathyroid), glucose homeostasis, signal transduction , role of heterotrimeric G protein, 7TM receptors, and signaling pathways, insulin signaling, EGF signaling, defects in signal transduction pathways

UNIT 5 **[7 Hrs]**

Biochemical response to environmental changes: Detection of various organic compounds by olfaction, biochemistry of vision, taste, hearing and touch, ATP dependent pumping of ions and molecules across membrane, (Na/k pumps), Muscle contraction: motor proteins, myosin and actin, kinesin and dynein

UNIT 6 **[8 Hrs]**

Clinical Biochemistry, hyper glycaemia, hypoglycemia, LDL, HDL, VLDL, cholesterol, application of biochemistry in monitoring systemic diseases. Cerebrospinal fluid, composition in health and disease, Blood coagulation, clotting factors, mechanism of coagulation, fibrinolysis, fibronectins, water and electrolyte balance

Text Books:

1. D J Voet, J G Voet, C W Pratt, "Principles of Biochemistry", 3rd ed., John Wiley & Sons, Inc. 2008
2. D L Nelson, MM Cox "Principles of Biochemistry", 4th ed., W.H. Freeman and company, New York, 2007
3. DT. Plummer, "An Introduction to practical biochemistry", Tata McGraw Publishing Company Ltd, 1988
4. T Devlin, "Textbook of Biochemistry with clinical correlations", 7thed, John Wileyand sons, 2010

Reference Books:

1. J.J .H Weil, "General Biochemistry", New Ages International (P) Ltd. 1997.
2. J M Berg, J L Tymoczko, L Stryer ,"Biochemistry", 6th ed., Freeman WH & Company, New York, 2007
3. C R Ireland, S P Lang, "Microcomputers in Biology- A practical approach" IRLPress Ltd., 1985
4. A. Fielding, "Computing for Biologists", Addison Wesley Pub., UK 1985

T. E. Biotechnology Sem I

Mass Transfer (315462)

Teaching Scheme:
Theory: 4 hr/week

Exam Scheme:
In Semester Exam:
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT 1 **[8Hrs]**

Introduction, General principles of Mass Transfer, Classification of Mass Transfer Operations, Choice of separation method, Methods of conducting mass transfer operations, Design principles Diffusion and Mass transfer, Types of diffusion - Molecular diffusion, Turbulent diffusion, Diffusion in Solids, Fick's and Maxwell law of diffusion, Molecular Diffusion in gases and liquids, Diffusivities of gases and liquids, types of solid diffusion, Numerical relating various types of diffusion, Theories of Mass transfer, Mass, Heat and Momentum transfer analogies, Introduction to Inter phase mass transfer, Equilibrium, Two resistance theory, Local and overall mass transfer coefficients, Use of local overall, coefficients, Stages, Cascades

UNIT 2 **[8 Hrs]**

Distillation: Definition, Vapor-liquid equilibria for Ideal and Non-ideal systems, Relative volatility, Ideal solutions-Raoult's law, Azeotropes, Positive and negative deviations from Ideality, Multi component system, Methods of distillation-Continuous rectification, Differential, Flash, Azeotropic, Extractive, Low pressure, Steam distillation, Batch rectification, Molecular distillation

UNIT 3 **[8Hrs]**

Tray tower calculations

Continuous rectification for binary system, Multistage tray towers-McCabe Thiele method, Tray efficiencies, Reflux ratio-Total reflux, Minimum reflux ratio, Optimum reflux ratio, Fenske's equation, Types of reboilers, Types of condensers-Total condensers, partial. Condensers, NTU, HTU, HETP concept and calculations

UNIT 4 **[8Hrs]**

Gas Absorption: Mechanism of gas absorption, Equilibrium in gas absorption, Ideal liquid solutions, Non ideal liquid solutions, Choice of solvent for absorption, L/G ratios for absorbers, Absorption factor, Real trays and Tray efficiency, Use of Reflux, absorption with chemical reaction, Material balances – one component transferred in counter current flow, Numerical relating counter current operations

UNIT 5 **[8Hrs]**

Drying: Definition, Principles, Equilibrium in drying, Drying hysterisis, Types of moisture binding, Drying operations, Batch drying, Rate of batch drying, Rate of drying curve, Mechanism of batch drying, Mechanism of moisture movement in solid continuous drying, Time required for drying, Classification of drying equipments, Numerical relating drying operations

UNIT 6 **[6Hrs]**

Crystallization: Principle rate of crystal growth, Population balance and size distribution, Calculations of yield, Enthalpy balances, Equipment

Text Books:

1. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill International Editions, 1980
2. Warren McCabe, Julian Smith, Peter Harriott, "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill Chemical Engineering Series, 0ctober 27, 2004

Reference Books:

1. Coulson J.M. and |Richardson J.F., "Chemical Engineering", Vol I & II –McGraw Hill International
2. Alan Shivers Foust, Leonard A. Wenzel, L. Bryce Andersen, Louis Maus, Curtis W. Clump, "Principles of Unit Operations in Chemical Engineering", John Wiley & Sons, January 1st 1980
3. Buford D. Smith, "Design of Equilibrium Stage Processes", McGraw-Hill, New York, 17 June 2004

T. E. Biotechnology Sem I

Reaction Engineering (315463)

Teaching Scheme:
Theory: 4 hr/week

Exam Scheme:
In Semester Exam:
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT 1 **[8 Hrs]**

Defining a rate equation and it's representation, Classification of reactions – single and multiple reactions, elementary and non-elementary reactions, Definition and significance of rate of reaction,molecularity and order of reactions, factors affecting rate of reaction, Temperature dependency, rate equation, activation energy, searching for a reaction mechanism, rate controlling step

UNIT 2 **[8 Hrs]**

Introduction to Reactor design: Conversion of mass in reactors, Different types of reactors: Batch (Constant and variable volume), Mixed flow reactor, plug flow reactor, performance equation for ideal stirred tank reactor, tubular flow reactor, batch reactor– concept of space time and space velocity, Integral analysis of variable volume batch reactor, problems on performance and conversion, fixed bed and fluidized bed reactor

UNIT 3 **[8 Hrs]**

Non-ideal Reactor Systems: Definition of non-ideality, age distribution, RTD studies, Residence time distribution curves – F , C and E curves, their significance and the relation between them, Models for non-ideal reactions, dispersion model, tanks in series model segregated flow model, Temperature dependency from Arrhenius law,Collision theory, transition state theory

UNIT 4 **[8 Hrs]**

Heterogeneous Reactions: Introduction – examples of heterogeneous systems: solid liquid systems, catalysis, surface kinetics rate of reaction for shrinking spherical particles, the concept of rate controlling step, fluid particle reactions – progressive conversion model, shrinking core model, determining controlling resistance and rate equation

UNIT 5 **[8 Hrs]**

Heterogeneous systems, mixed flow reactors, packed bed catalytic reactor, fluidized bed reactors, slurry and trickle bed reactors, performance equation for porous catalysts, diffusion in liquids in porous catalyst, surface diffusion, Mass transfer with reaction, effectiveness factor, selectivity for porous catalyst.

UNIT 6 **[8 Hrs]**

Enzyme catalyzed reactions: Introduction to MichaelisMenten kinetics, enzyme inhibition kinetics, application of reaction engineering to biochemical reactions;

Microbial growth kinetics: Product distribution, fractional yields, substrate and product limiting microbial fermentation, Monod growth kinetics, kinetic implications of endogenous and Maintenance metabolism, environmental effects on growth kinetics, enzyme deactivation kinetics

Text Books:

1. O.Levenspiel, "Chemical Reaction Engineering", John Wiley Publishers
2. H. Scott, Fogler, "Elements of Chemical Reaction Engineering", Academic Press
3. C.G. Hill, "An Introduction to Chemical Reaction Kinetics& Reactor Design"
4. Carberry&Verma, "Chemical and Catalytic reaction Engineering"

Reference Books:

1. J. Smith, "Chemical Engineering Kinetics", McGraw Hill Publication
2. Bishoffand Fromment, "Reactor design and analysis", Oxford University Press

T. E. Biotechnology Sem I

Genetic Engineering (315464)

Teaching Scheme:
Theory: 4 hr/week

Exam Scheme:
In Semester Exam:
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT I **[8 Hrs]**

Techniques and tools in genetic engineering: Blotting techniques, PCR-design and optimization, PCR types – RTPCR, colony PCR, real time PCR

DNA sequencing methods: sequencing strategies, Sangers Sequencing, pyrosequencing, automation, basecalling, applications and impact of sequencing, Human genome project, micro arrays, flow cytometry

UNIT 2 **[8 Hrs]**

Enzymes used in GE: Restriction enzymes, DNA ligase: adapters, linkers, homopolymer tailing,

Cloning vectors: Plasmids, basics of plasmids, lambda phage, insertional, replacement lambda vectors, in-vitro packaging, M13 vectors, phagemids, cosmids, Multiple cloning sites, selection markers, Expression Vectors, artificial chromosomes (BACs, YACs)

UNIT 3 **[8Hrs]**

Gene Cloning strategies: genomic libraries, PCR in cloning, cDNA libraries, amplification of gene libraries,strategies for screening of libraries: hybridization, colony PCR, immunological screening, blue white selection, selection based on nutrient deficiency

UNIT 4 **[6 Hrs]**

Cloning in bacteria, competency, broad host range plasmids, copy number significance, cloning in gram positive bacteria, Cloning in yeast and fungi: Cloning in *S. cerevisae*, problems in cloning, vectors for yeast, promoters, significance of *Pichiapastoris*, YAC's classical and circular

UNIT 5 **[8 Hrs]**

Gene transfer technologies: Transformation,, Transfection, Electroporation, Gene transfer to animal cells: bacterial vectors, Viral vectors – Adenovirus, Baculovirus, retro virus, strategies for transformation of animal cells: Pronuclear microinjection, Recombinant retroviruses, transfection of ES cells to get chimeras, Gene transfer to plants: Callus culture, protoplast transformation, strategies Agrobacterium mediated, Particle bombardment, *In planta* transformation, plant viruses

UNIT 6 **[8 Hrs]**

Modification of bacteria and viruses: live vaccines, Animal transgenesis - Applications, Transgenic plants – Applications, Applications of rDNA technology in health and agriculture: Humulin, Hep B, factorVIII, DNA diagnostics, *Bt* cotton, Golden rice. DNA markers for improvement of quality and yield of crops, Gene therapy

Text Books:

1. Principles of Gene manipulation and Genomics by Primrose and Twyanman (Blackwell Publishers)
2. From Genes to Genomes: Concepts and applications of DNA technology by J. W. Dale and M.V.Schantz (Wiely Publishers)

Reference Books:

1. Molecular biotechnology by Pasternack and Glick
2. From Genes to clones by Winnacker. PANIMA
3. Gene cloning and DNA Analysis: An introduction (4th edition) by T. A. Brown
4. Molecular cloning by Sambrook, *et al*

T. E. Biotechnology Sem I

Fermentation Technology (315465)

Teaching Scheme:
Theory: 4 hr/week

Exam Scheme:
In Semester Exam:
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT 1 **[8 Hrs]**

Introduction to Microbial Fermentation, microbial / Industrial fermentation: Applications for production of industrially important products, Examples of classical fermentation systems, Concept of upstream processing - Screening and isolation of microbes, Preserving industrially important microbes, Inoculum preparation, Monod growth kinetics

UNIT 2 **[8 Hrs]**

Media Preparation and optimization, Different types of media, nutrient supply, sources ofnutrients i.e. carbon, nitrogen etc., effect of media components on fermentation, media preparation, optimization for maximum yield, Sterilization: Need for sterilization, different types of sterilization techniques – their mechanism of destruction, *in situ* sterilization, HTST

UNIT 3 **[8 Hrs]**

Microbial production of industrially important products: Alcohols and acids, Microbialfermentation of organic acids viz. Citric, gluconic, fumeric, itaconic, gibberellic and kojicacids, Activities of lactic acid bacteria and industrial production of lactic acid, Activitiesof acetic acid bacteria and production of vinegar, Alcohol Production: wine and other alcoholic beverages, glycerol, beer

UNIT 4 **[8 Hrs]**

Production of Antibiotics and Microbial enzymes, Antibacterial antibiotics: penicillin, streptomycin, chloromycetin, tetracyclines, semisynthetic penicillins; Antifungal antibiotics, Microbial production of vitamins B2 and B12

UNIT 5 **[8 Hrs]**

Isolation, Production and use of microbial enzymes, Methods of Immobilization, immobilized enzymes and their applications, Case studies of Fructose, Glucose production using enzymes. Single Cell protein Production, Fungal, algal Protein Production, Microbial Transformations.

UNIT 6 **[8 Hrs]**

Submerged and solid state fermentation, advantages and disadvantages, applications of SLF and SSF, Scale-up: Principles, theoretical considerations &techniques used, Sterilization, inoculum development, operation parameters Conceptof downstream processing, Fermentation and product recovery costs, yields, productrecovery, product purity, fermentation efficiency, case example such as ethanoleconomics; Introduction to GMPs

Text Books:

1. Casida, “Industrial microbiology”, Newage Publication, 2001
2. Stanbury, Whitaker, S.Hall. “Principles of Fermentation Technology”, Second Edition, Elsevier publication
3. Bailey and Ollis, “Biochemical Engineering Fundamentals”, McGraw Hill, NewYork

Reference Books:

1. Trevor Horwood, “Enzymes”, 2001
2. Prescott and Dunn, “Industrial microbiology”, CBS publications 4thEdition, 1999
3. M.Y. Young, “Comprehensive Biotechnology Vol. 1- 4:, Pergamon Press
4. T.D. Brock, “Biotechnology: A Text Book of Industrial Microbiology”, Smaeur Associates, 1990
5. Paulin M. Doran, “Bioprocess Engineering Principles”, Academic Press, London
6. S. Aiba, A. E. Humphrey, N. F. Milli, “Biochemical Engineering”

T. E. Biotechnology Sem I

Biochemistry-II and Fermentation Technology Lab (315466)

Teaching Scheme:
Practical: 4 hr/week

Exam Scheme:
Term Work: 50marks
Practical: 50 Marks
Total: 100 Marks

Biochemistry II (Any 8)

1. Isolation of enzyme
2. Quantitative assay for enzyme using enzyme substrate reaction
3. To check effect of varying substrate on enzyme activity and to calculate Km and Vmax
4. Effect of inhibitor on enzyme activity
5. To study the effect of pH on enzyme activity
6. To assess optimum temperature of enzyme
7. To study specific activity of enzyme
8. Thermo stability of enzyme
9. Determination of blood cholesterol
10. Estimation of alkaline phosphatase from serum
11. Blood sugar determination by Folin-Wu method

Computer Programming based on BASIC/Fortran/C for following experiments

12. Linear regression
13. Quadratic equation
14. MichaelisMenten enzyme kinetics

Text Books:

1. D J Voet, J G Voet, C W Pratt, "Principles of Biochemistry", 3rd ed., John Wiley & Sons, Inc. 2008

2. D L Nelson, MM Cox "Principles of Biochemistry", 4th ed., W.H. Freeman and company, New York, 2007

3. DT. Plummer, "An Introduction to practical biochemistry", Tata McGraw Publishing Company Ltd, 1988

4. T Devlin, "Textbook of Biochemistry with clinical correlations", 7thed, John Wileyand sons, 2010

Reference Books:

1. J. J .H. Weil, "General Biochemistry", New Ages International (P) Ltd. 1997.

2. J M Berg, J L Tymoczko, L Stryer ,"Biochemistry", 6th ed., Freeman WH & Company, New York, 2007

3. C. R. Ireland, S P Lang, "Microcomputers in Biology- A practical approach" IRLPress Ltd., 1985
15. A. Fielding, "Computing for Biologists", Addison Wesley Pub., UK 1985

Fermentation Technology (Any 8)

1. Study of fermenter design
2. Estimation of Carbohydrates from Fermentation Broth
3. Estimation of Proteins from Fermentation Broth
4. Fermentation of any two microbial products
5. Use of alginate for cell immobilization
6. Production of Single cell Proteins (SCP) of yeast cells

7. Effect of aeration in fermentation
8. Solid state Fermentation
9. Effect of different media components (Carbon, Nitrogen etc.) on fermentation

Text Books:

1. Casida, “Industrial microbiology”, Newage Publication, 2001

2. Stanbury, Whitaker, S.Hall. “Principles of Fermentation Technology”, Second Edition, Elsevier publication

3. Bailey and Ollis, “Biochemical Engineering Fundamentals”, McGraw Hill, NewYork

Reference Books:

1. Trevor Horwood, “Enzymes”, 2001

2. Prescott and Dunn, “Industrial microbiology”, CBS publications 4thEdition, 1999

3. M.Y. Young, “Comprehensive Biotechnology Vol. 1- 4:, Pergamon Press

4.T.D. Brock, “Biotechnology: A Text Book of Industrial Microbiology”, SmaeurAssociates, 1990

5. Paulin M. Doran, “Bioprocess Engineering Principles”, Academic Press, London

6. S. Aiba, A. E. Humphrey, N. F. Milli, “Biochemical Engineering”

T. E. Biotechnology Sem I

Mass Transfer and Reaction Engineering (315467)

Teaching Scheme:
Practical: 4 hr/week

Exam Scheme:
Term Work: 50marks
Oral: 50 Marks
Total: 100 Marks

Mass Transfer: (Any 8)

1. Liquid liquid Diffusion – To calculate the Diffusion Coefficient for a liquid – liquid system
2. Solid liquid diffusion – To calculate the Diffusion Coefficient for a solid –liquid system
3. Process of Crystallization and its Characteristics
4. Simple Distillation
5. Steam Distillation
6. Multistage crosscurrent liquid - liquid extraction
7. Batch/continuous leaching
8. Tray Dryer – To study the characteristics of Tray Dryer
9. Interphase Mass Transfer Coefficient – To calculate the individual and overall Mass Transfer Coefficient
10. Fluidized Bed Dryer – To study the characteristics of Fluidized bed Dryer
11. Wetted Wall Column – To find the mass transfer coefficient in a wetted wall Column

Text Books:

1. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill International Editions, 1980

2. Warren McCabe, Julian Smith, Peter Harriott, "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill Chemical Engineering Series, 0ctober 27, 200

Reference Books:

1. Coulson J.M. and |Richardson J.F., "Chemical Engineering", Vol I & II –McGraw Hill International
2. Alan Shivers Foust, Leonard A. Wenzel, L. Bryce Andersen, Louis Maus, Curtis W. Clump, "Principles of Unit Operations in Chemical Engineering", John Wiley & Sons, January 1st 1980
3. Buford D. Smith, "Design of Equilibrium Stage Processes", McGraw-Hill, New York, 17 June 2004

Reaction Engineering: (Any 8)

1. Reaction kinetics of first order reaction
2. Reaction kinetics of pseudo first order reaction-Acid catalyzed hydrolysis ofmethyl acetate
3. Reaction kinetics of a second order reaction – Saponification of ethyl acetate
4. Design of PFR
5. Design of CSTR
6. Design of CSTR combination in first order reactions
7. Non ideal reactions-F & C curves in CSTR
8. Non ideal reactions-F & C curves in PFR
9. Evaluation of PFR followed by CSTR
10. Design of two PFR in series

Text Books:

1. O.Levenspiel, "Chemical Reaction Engineering", John Wiley Publishers
2. H. Scott, Fogler, "Elements of Chemical Reaction Engineering", Academic Press

3. C.G. Hill, “An Introduction to Chemical Reaction Kinetics& Reactor Design”
4. Carberry&Verma, “Chemical and Catalytic reaction Engineering”

Reference Books:

1. J. Smith, “Chemical Engineering Kinetics”, McGraw Hill Publication
2. Bishoffand Fromment, “Reactor design and analysis”, Oxford University Press

T. E. Biotechnology Sem I

Employability Skill in Genetic Engineering (315468)

Teaching Scheme:
Practical: 2 hr/week

Exam Scheme:
Oral: 50 Marks
Total: 50 Marks

Practical: (Any 8)

1. Isolation of Plant genomicDNA
2. Isolation of Bacterial genomic DNA
3. Isolation of Plasmid DNA
4. Isolation of RNA
5. RE digestion
6. Competent Cell Preparation
7. Transformation
8. Selection of Transformants
9. PCR
10. Real time PCR (demo)
11. Restriction Fragment Length Polymorphism RFLP
12. Ligation with plasmid DNA
13. Selection of recombinants
14. Conformation of insert

Text Books:

1. Principles of Gene manipulation and Genomics by Primrose and Twyanman (Blackwell Publishers)
2. From Genes to Genomes: Concepts and applications of DNA technology by J. W. Dale and M.V.Schantz (Wiely Publishers)

Reference Books:

1. Molecular biotechnology by Pasternack and Glick
2. From Genes to clones by Winnacker. PANIMA
3. Gene cloning and DNA Analysis: An introduction (4th edition) by T. A. Brown
4. Molecular cloning by Sambrook, *et al*

Term-II

T. E. Biotechnology Sem II

Computational Techniques and Biostatistics (315469)

Teaching Scheme:
Theory: 3 hr/week
Tutorial: 2hr/week

Exam Scheme:
In Semester Exam:
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT 1 **[6Hrs]**

Biostatistics: Introduction to Biostatistics

Sampling: Introduction, theoretical basis of sampling, Sample method, Essentials of Sampling, random and systematic sampling, cluster sampling, Sample size- determination of sample size, sampling errors

Diagrammatic and graphic presentation: Introduction, Significance of graphs anddiagrams, General rules for constructing diagrams, Types of diagrams (Bar, pie chart etc),Frequency distribution graphs

UNIT 2 **[6 Hrs]**

Types of averages: Introduction, Types of averages, Calculation of Arithmetic mean,Median, Mode, Geometric mean, Harmonic mean for discrete series, continuous series, and individual observations

UNIT 3 **[5 Hrs]**

Standard deviation, and Mean deviation, Tests of Significance: Students t - distribution (parametric), Chi square test (nonparametric)

UNIT 4 **[6 Hrs]**

Solutions of Algebraic equations: Bisection method, Regular false method, Solutions of linear simultaneous equations: Newton Raphson method, deductions from NR method, Solutions of Nonlinear simultaneous equations: Newton Raphson method for nonlinear equations

UNIT 5 **[6 Hrs]**

Linear and Polynomial Regression: Method of Least Squares: Fitting of a straight lineusing linear regression, fitting of a parabola using polynomial regression, fitting of other curves

Numerical Integration: Newton Cote's quadratic formulae;Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Weddle's rule

UNIT 6 **[6 Hrs]**

Finite differences and Interpolation: Forward differences, backwarddifferences, central differences, Factorial notation, Newton's Interpolation formulae with equal intervals: Newton's forward and Newton's backward formulae, Interpolation with unequal intervals: Lagrange's formula, divided differences

Text Books:

1. M.K.Jain, R.K.Jain, S.R.K.Iyengar, "Numerical methods for scientific and engineering computation", 5th edition, New Age International Pvt. Ltd Publishers, December 1, 2005
2. Dr. B.S.Grewal, "Higher Engineering Mathematics", 40th Edition , Khanna Publishers, New Delhi, October 2007
3. S.P.Gupta, "Statistical methods", Sultan Chand and Sons Educational Publishers, New Delhi

Reference Books:

1. Steven C. Chapra, Reynolds P Canale, "Numerical methods for Engineers with software and programming applications", 6th Edition, April 20, 2009

T. E. Biotechnology Sem II
Immunology and Diagnostics (315470)

Teaching Scheme:
Theory: 3hr/week

Exam Scheme:
In Semester Exam
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT 1 [8 Hrs]

Overview of immune system: Historical Perspective, Innate immunity : Physiological barriers against infection, phagocytosis, inflammation; Adaptive Immunity, Cells and organs of immune system, Functions of T cells and B cells

UNIT 2 [8 Hrs]

Antigens: study of antigenicity; Antibody: Structure and function,Humoral immunity: Activation of B cells, B cell: maturation and activation, theories of antibody production- clonal selection theory, organization and expression of Ig genes, generation of antibody diversity, Monoclonal Antibody, Hybridoma Technology.

UNIT 3 [8 Hrs]

Antigen – antibody interactions- principles and applications, Precipitation and agglutination reactions. Immune effector mechanisms.Cytokines – properties, the complement system.

UNIT 4 [8 Hrs]

Cell mediated immunity, Major Histocompatibility Complex (MHC), Antigen processing and presentation, TCR, Transplantation immunology: Graft rejection, Graft-versus-Host, Cell mediated effector responses: cytotoxic T cells, Natural killer cells, ADCC.

UNIT 5 [8 Hrs]

Vaccines: Active and Passive Immunization, role of adjuvants, Designing Vaccines for Active Immunization, Whole-Organism Vaccines, Purified Macromolecules as Vaccines, Recombinant-Vector vaccine, DNA Vaccines, Multivalent Subunit Vaccines

UNIT 6 [8 Hrs]

The hypersensitive reactions Immune system in diseases: Cancer, Tuberculosis and AIDS, Autoimmunity : Organ-Specific and Systemic Autoimmune Diseases, treatment

Text Books ;

R. A. Goldsby, T.J. Kindt, B.A. Osborne, “Kuby- Immunology”, 4th Edition
Essentials of Immunology(6th Edition): Ivan Roit- BlakswellScientificPublications,Oxford, 1988

Reference Books :

Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York, 1988
Antibodies A laboratory Manual: Harlow and David Lane (1988), Cold springharbor laboratory

T. E. Biotechnology Sem II

Bioseparation- I (315471)

Teaching Scheme:
Theory: 4 hr/week

Exam Scheme:
In Semester Exam:
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT 1 **[9Hrs]**

An overview of Bioseparations, Salient features, Advantages, Disadvantages, Need of Bioseparations, Range of Bio products, Mechanical and enzymatic methods of cell disruption, importance of cell disruption in product release

UNIT 2 **[9 Hrs]**

Basic separation techniques: Centrifugation - Ultracentrifugation, Gradient centrifugation, Filtration – Constant pressure and volume filtration, Rate of filtration, Filter medium and filter cake resistance, specific cake resistance, Types of Filters, Washing and dewatering of filter cakes

UNIT 3 **[9 Hrs]**

Extraction Operations: SLE (Leaching): Definition, Preparation of the solid, Factorseffecting leaching operations, Methods of operation, Single stage leaching, Continuouscounter current leaching, Leaching equipment

LLE(Solvent extraction) : Definition, Fields of usefulness, Ternaryliquid equilibria, Equilateral triangular coordinates, Mixture rule, Choice of solvent,Material balances - Single stage extraction, Multistage crosscurrent, countercurrent andco current extraction, Types of extractors – stage type and differential type

UNIT 4 **[6 Hrs]**

Membrane Separation Techniques: Classification of separation techniques, Definition ofa membrane, Criteria of membrane separation processes, Types of membranes,Advantages of membrane separation processes over conventional separation techniques,Industrial Applications, Membrane separations - Micro filtration, Ultra filtration,Reverse Osmosis, Piezodialysis, Electro dialysis, Membrane electrolysis, Pervaporation,Carrier mediated transport- liquid membranes, Membrane contactors, PolarizationPhenomenon, Membrane fouling, Membrane modules and Industrial applications of allProcesses

UNIT 5 **[6 Hrs]**

Adsorption and Ion Exchange

Definition, Types of Adsorption - Physical and Chemical, Nature of adsorbents,Adsorption Isotherms - Langmuir, Freundlich, BET, Heat of adsorption, Introduction toPressure Swing Adsorption (PSA), and Temperature Swing Adsorption (TSA),Equipments for adsorption

UNIT 6 **[6 Hrs]**

Chromatography –Separation Technique, Classification of chromatographic techniques, General description of column chromatography, chromatography column dynamics, Chromatographic terms and parameters, HPLC; scale up of chromatography, planar chromatographic techniques, process consideration in preparative chromatography, Types of chromatography

Text Books:

1. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill International Editions, 1980
2. Coulson J.M. and |Richardson J.F., "Chemical Engineering", Vol I & II –McGraw Hill International Editions, 1980
3. Stanbury, S. Hall, A. Whitaker, "Principles of Fermentation Technology", Second Edition , Elseveir Publications, New Delhi, 2009
4. Pauline Doran, " Bioprocess Engineering Principles", Elseveir Publications, New Delhi,2010
5. Michael R. Ladisch, " Biosepration Engineering, Principles, practice and economics", Wiley-Blackwell Publishers ,9 April 2001
6. B.Shivshankar, " Bioseparations: Priniples and Techniques", Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012

Reference Books:

1. Alan Shivers Foust, Leonard A. Wenzel, L. Bryce Andersen, Louis Maus, Curtis W. Clump, "Principles of Unit Operations in Chemical Engineering", John Wiley & Sons, January 1st 1980
2. Warren McCabe, Julian Smith, Peter Harriott, "Unit Operations of Chemical Engineering", McCabe W.L. and Smith J.C. , 7th Edition, McGraw Hill Chemical Engineering Series, 0ctober 27, 2004
3. Buford D. Smith, "Design of Equilibrium Stage Processes", McGraw-Hill, New York,17 June 2004
4. P. A. Belter, E.L. Cussler and W.S. Hu , "A review of Bioseparations (Downstream Processing for Biotechnology)", Wiley Interscience Publishers, New York, 1988

T. E. Biotechnology Sem II

Instrumentation and Process Control (315472)

Teaching Scheme:
Theory: 4 hr/week

Exam Scheme:
In Semester Exam:
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT 1 **[5Hrs]**

Instrumentation in Process Industries

Need for measurement of different process parameters, Instruments used for measurement : Pressure – Mechanical and electric transducers, Low pressure - McLeod Gauge and Pirani Gauge, Temperature - bi-metal thermometers, resistance thermometer, thermistors, thermocouples, Radiation and optical pyrometers, Flow – Hot Wire anemometer and magnetic flow meters, Flow measurement by Visualization by shadow-graph and interferometer, Liquid level measurement in open vessels and in pressure vessels, Thermal conductivity measurement of solids, liquids and gases, Measurement of diffusivity in gases.

UNIT 2 **[8Hrs]**

Dynamics of First Order Systems

Introduction

Need for studying process dynamics and control, Laplace transforms and its application to process dynamics, characteristics of ideal forcing functions (step, ramp, pulse, impulse, and frequency)

Linear open loop Systems – First Order Systems

Definition, characteristics and physical examples of first order systems such as thermometer, liquid tank, CSTR etc., model transfer function and significance of time constant, Dynamic behavior/ Response of first order systems to different forcing functions, linearization of non-linear systems (for single variable systems only)

UNIT 3 **[6Hrs]**

Dynamics of Second Order Systems

Definition, characteristics and physical examples of second order systems such as manometer, interacting and non-interacting tank systems, model transfer function, Dynamic behavior of second order systems to different forcing functions, Response of Second order system – underdamped, critically damped and overdamped, Transportation lag, Processes with complex dynamics

UNIT 4 **[6Hrs]**

Linear Closed Loop Systems

Control systems, components of a control system, Concept of feedback control, Controller and final controlling element, pneumatic control valve, control system hardware

Different types of control actions – P, PI, PD, PID; transfer functions, open and closed loop response, advantages and limitations of each controller,

Block diagram of a control system, servo and regulatory operations, open and closed loop transfer function, overall transfer function, transfer function for change in load and set point, multi-loop control system transfer function

UNIT 5 **[8Hrs]**

Stability Analysis and Frequency Response Analysis

Concept of stability in control systems, stability criterion, Routh's test for stability, root locus analysis, root locus design and plots, frequency response analysis and stability criterion (Bode plots), controller tuning - Ziegler Nichols and Cohen-Coon methods

UNIT 6 **[5Hrs]**

Advanced Control Systems and Industrial Applications

Introduction to advanced control systems: Cascade, feed forward, selective, ratio, over ride and slit range control strategies; fuzzy logic and neural networks

Application to fermentation industries:Speed control, Temperature control, Control of gas supply, Control of pH, Control of dissolved oxygen, Antifoam control;

Text Books:

1. Donald Coughnowr, "Process System analysis and control" Mc-Graw Hill
2. Principles of Fermentation Technology – Stanbury P.F. and Whitaker A

Reference books:

1. Nise, "Control System Engineering"
2. **Marlin, T,** 1995. Process control : Designing processes and control systems for dynamic performance, McGraw-Hill
3. P. Harriot, "Process Control"
4. Fermentation Microbiology and Biotechnology – El-Mansi E.M.T. and Bryce C.F.A.

T. E. Biotechnology Sem II

Bioinformatics and Management (315473)

Teaching Scheme:
Theory: 4 hr/week

Exam Scheme:
In Semester Exam:
Paper – 30 Marks
End Semester Exam:
Paper: 70 Marks
Total: 100 Marks

UNIT 1 **[8 Hrs]**

Introduction to Bioinformatics, Terminologies used in Bioinformatics, Scope and Goal of Bioinformatics, Overview of applications of Bioinformatics, Databases, Database Management system, Data structure, Database query language, Relational Model, Object Model, Object oriented and Relational databases, Network of databases for Entrez and SRS. Overview of Biological Databases

UNIT 2 **[8 Hrs]**

DNA sequencing, Nucleotide databases as Genbank, DNA Data Bank of Japan (DDBJ), European Molecular Biology Laboratory (EMBL), NCBI's Data model, Specialized genomic recourses as SGD, UniGene, TDB. Sequence retrieval systems such as Entrez and SRS

UNIT 3 **[8 Hrs]**

Protein structures, Levels of Protein sequence and Structural organization, Protein databases, Primary protein sequence Databases as PIR, SWISS-PROT, TrEMBL. Secondary databases as PROSITE, PRINTS, Blocks. Structure Classification databases as SCOP, CATH, PDB. Various analytical tools for protein Structure Visualization

UNIT 4 **[8 Hrs]**

Introduction to sequence alignment, Pairwise and Multiple Sequence Alignment, Dot Plot, Needleman Wunsch Algorithm, Smith Waterman Algorithm, Local and Global Sequnce Alignment, Substitution Matrices such as PAM And BLOSUM, Calculation of alignment's statistical significance, Importance of Identity matrixes, gaps and penalties, Heuristic methods such as FASTA, BLAST, Working of BLAST and different variants of BLAST

UNIT 5 **[8 Hrs]**

Introduction to Phylogeny, Homologs, orthologs and paralogs, Construction of a phylogenetic tree, Different types of trees as rooted and un-rooted trees. Phylogenetic analysis, Methods of Phylogenetic analysis as Distance method, Application of bioinformatics in vaccine designs

UNIT 6 **[8 Hrs]**

Introduction to biotechnology Management, General introduction to management studies, Correlation of the management and biotechnology industry, Organizational management in biotechnology companies, various disciplines in management. Technology transfer management in Biotechnology

Text Books:

1. Introduction to Bioinformatics, by Arthur M. Lesk Oxford University Press, Oxford University Press.

2. Bioinformatics- Methods & Applications by S.C.Rastogi, N. Mandiratta, P. Rastogi
3. Principles of management- Knoots and O.Donnell

Reference books:

1. Bioinformatics Sequence and Genome Analysis by David W. Mount, 2nd edition, Cold Spring Harbor Laboratory Press
2. Bioinformatics: A practical guide to the analysis of genes and proteins A.D.Baxevanis and B.F.F. Ouellette (Eds). 2002 John Wiley and Sons
3. Bryan Bergeron, "Bioinformatics computing", Pearson Education [BB].

T. E. Biotechnology Sem II

Bioseparation-I (315474)

Teaching Scheme:
Practical: 2 hr/week

Exam Scheme:
Term Work: 50 Marks
Practical: 50 Marks
Total: 100 Marks

Bioseparation-I: (Any 8)

1. Adsorption on charcoal: Application in removal of unwanted dye.
2. Lab scale Homogenization of Baker's Yeast
3. Precipitation of proteins using Ammonium Sulphate
4. Use of blender for disruption of plant tissues
5. Dialysis of proteins followed by concentration of proteins with dialysis bag.
6. Chromatography for separation of biomolecules
7. Use of sonicator for cell disruption
8. To use flocculation as a unit operation
9. Study the Characteristics of a membrane
10. Aqueous two phase extraction

Text Books:

1. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill International Editions, 1980
2. Coulson J.M. and |Richardson J.F., "Chemical Engineering", Vol I & II –McGraw Hill International Editions, 1980
3. Stanbury, S. Hall, A. Whitaker, "Principles of Fermentation Technology", Second Edition , Elseveir Publications, New Delhi, 2009
4. Pauline Doran, " Bioprocess Engineering Principles", Elseveir Publications, New Delhi,2010
5. Michael R. Ladisch, " Biosepration Engineering, Principles, practice and economics", Wiley-Blackwell Publishers ,9 April 2001
6. B.Shivshankar, " Bioseparations: Priniples and Techniques", Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012

Reference Books:

1. Alan Shivers Foust, Leonard A. Wenzel, L. Bryce Andersen, Louis Maus, Curtis W. Clump, "Principles of Unit Operations in Chemical Engineering", John Wiley & Sons, January 1st 1980
2. Warren McCabe, Julian Smith, Peter Harriott, "Unit Operations of Chemical Engineering", McCabe W.L. and Smith J.C. , 7th Edition, McGraw Hill Chemical Engineering Series, 0ctober 27, 2004
3. Buford D. Smith, "Design of Equilibrium Stage Processes", McGraw-Hill, New York,17 June 2004
4. P. A. Belter, E.L. Cussler and W.S. Hu , "A review of Bioseparations (Downstream Processing for Biotechnology)", Wiley Interscience Publishers, New York, 1988

T. E. Biotechnology Sem II

Bioinformatics & Management and Instrumentation & Process Control (315475)

Teaching Scheme:
Practical: 4 hr/week

Exam Scheme:
Term Work: 50 Marks
Oral: 50 Marks
Total: 100 Marks

Bioinformatics & Management: (Any 8)

1. **Introduction to the NCBI:** Use of different features and services enlisted in NCBI
2. **Database searches:** Search and retrieval of sequence data from Nucleotide databases as Genbank, DDBJ, and EMBL
3. **Database search Engines:** Search and retrieval of sequence and structure data using query engines such as Entrez and SRS
4. **Protein databases:** SWISSPROT, PIR PSD. Search and retrieve protein sequences
5. **BLAST:** Use of BLAST program and different types of BLAST, interpretation of results to identify homologues of genes/proteins from databases
6. **Pair-wise Sequence Alignments** and their interpretation/analysis: sequence alignments using implementations of Needleman-Wunsch and Smith-Waterman algorithms
7. **Multiple Sequence Alignments** using **Clustal Omega** method with analysis of the alignments to find conserved, variable regions
8. **Structure Visualization and Analysis**: Use of different visualization software such as RasMol, Swiss PDB Viewer to visualize protein structures and understand secondary structural motifs, tertiary structures etc.
9. **Sequence and Structure Classification**: Search and retrieval of data from sequence and structure classification data bases with analysis of search results (e.g. PFAM, SCOP databases)

Text Books:

1. Introduction to Bioinformatics, by Arthur M. Lesk Oxford University Press, Oxford University Press.
2. Bioinformatics- Methods & Applications by S.C.Rastogi, N. Mandiratta, P. Rastogi
3. Principles of management- Knoots and O.Donnell

Reference books:

1. Bioinformatics Sequence and Genome Analysis by David W. Mount, 2nd edition, Cold Spring Harbor Laboratory Press
2. Bioinformatics: A practical guide to the analysis of genes and proteins A.D.Baxevanis and B.F.F. Ouellette (Eds). 2002 John Wiley and Sons
3. Bryan Bergeron, “Bioinformatics computing”, Pearson Education [BB].

Instrumentation & Process Control: (Any 8)

1. Calibration of a thermocouple
2. Calibration of pressure gauge using dead weight tester
3. Dynamic Response of I^{st} order system.
4. Dynamic Response of II^{nd} order system.
5. Characteristics of On-Off Controller.
6. Characteristics of P, PI, PD, PID Controller.
7. Root locus analysis
8. MATLAB exercise of Control System
9. Study of Computer Aided control System.
10. Cascade Control.

Text Books:

1. Donald Coughnowr, "Process System analysis and control" Mc-Graw Hill
2. Principles of Fermentation Technology – Stanbury P.F. and Whitaker A

Reference books:

1. Marlin, T, 1995. Process control: Designing processes and control systems for dynamic performance, McGraw-Hill

T. E. Biotechnology Sem II

Seminar and Demonstration of Diagnostics methods (315476)

Teaching Scheme: **Exam Scheme:**
Practical: 4 hr/week **Term Work: 50 Marks**

Seminar:

The students should deliver the seminar on a topic approved by authorities and submit the report

Demonstration of Diagnostics methods such as:

1. Differential staining of Peripheral blood smear
2. Quantitation detection of immunoglobulin using precipitation reaction
3. Haem-agglutination – blood grouping
4. Determination of antibody titer by Radial Immuno Diffusion (RID)
5. OuchterlonyImmunodiffusion (ODD)
6. Preparation of 'O' and 'H' antigens of Salmonella Vaccine preparation

Text Books:

1. R. A. Goldsby, T.J. Kindt, B.A. Osborne, "Kuby- Immunology", 4th Edition
2. Essentials of Immunology (6th Edition): Ivan Roit- Blakswell ScientificPublications, Oxford, 1988

Reference Books

1. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York, 1988
2. Antibodies A laboratory Manual: Harlow and David Lane (1988), Cold springharbor laboratory