

# ANNA UNIVERSITY TIRUCHIRAPPALLI

Tiruchirappalli – 620 024

Regulations 2007

Curriculum

**B.TECH. BIOTECHNOLOGY**

## SEMESTER III

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	MA1201	Mathematics III	3	1	0	100
2	CH1205	Principles of Chemical Engineering	4	0	0	100
3	BT1201	Bioorganic Chemistry	4	0	0	100
4	BT1202	Biochemistry	4	0	0	100
5	BT1203	Cell Biology	4	0	0	100
6	BT1204	Microbiology	4	0	0	100
<b>Practical</b>						
7	BT1205	Bioorganic Chemistry Laboratory	0	0	3	100
8	BT1206	Biochemistry Laboratory	0	0	3	100
9	BT1207	Cell Biology Laboratory	0	0	3	100

## SEMESTER IV

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	MA1251	Numerical Methods	3	1	0	100
2	HS1201	Environmental Science and Engineering	4	0	0	100
3	BT1251	Unit Operations	4	0	0	100
4	CS1262	Unix Operating System and Programming Language C++	3	1	0	100
5	BT1252	Molecular Biology	4	0	0	100
6	BT1253	Biothermodynamics	3	1	0	100
<b>Practical</b>						
7	BT1254	Unit Operations Laboratory	0	0	3	100
8	BT1255	Microbiology Laboratory	0	0	3	100
9	BT1256	Molecular Biology Laboratory	0	0	3	100

## SEMESTER V

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	<b>BT1301</b>	Mass Transfer Operations for Bioprocesses	4	0	0	100
2	<b>BT1302</b>	Bioprocess Principles	4	0	0	100
3	<b>BT1303</b>	Basic Industrial Biotechnology	4	0	0	100
4	<b>BT1304</b>	Food Technology	4	0	0	100
5	<b>BT1305</b>	Enzyme Engineering and Technology	4	0	0	100
6	<b>BT1306</b>	Instrumental methods of analysis	4	0	0	100
<b>Practical</b>						
7	<b>BT1307</b>	Mass Transfer Operations Laboratory	0	0	3	100
8	<b>BT1308</b>	Bioprocess Laboratory I	0	0	3	100
9	<b>BT1309</b>	Instrumental Methods of Analysis Laboratory	0	0	3	100

## SEMESTER VI

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	<b>BT1351</b>	Process Economics and Industrial Management	4	0	0	100
2	<b>BT1352</b>	Genetic Engineering	4	0	0	100
3	<b>BT1353</b>	Bioprocess and Bioreactor Engineering	4	0	0	100
4	<b>BT1354</b>	Protein Structure, Function and Engineering	4	0	0	100
5	<b>E1****</b>	Elective I	3	0	0	100
6	<b>E2****</b>	Elective II	3	0	0	100
<b>Practical</b>						
7	<b>BT1355</b>	Genetic Engineering Laboratory	0	0	3	100
8	<b>BT1356</b>	Bioprocess Laboratory II	0	0	3	100
9	<b>HS1301</b>	Communication and Soft Skills Laboratory	0	0	3	100

## ELECTIVE I

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	<b>BT1001</b>	Nanobiotechnology	3	0	0	100
2	<b>BT1002</b>	Bioconjugate Technology	3	0	0	100
3	<b>BT1003</b>	Process Equipments and Plant Design	3	0	0	100
4	<b>BT1004</b>	Spectroscopy for Biotechnology	3	0	0	100

## ELECTIVE II

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	<b>BT1005</b>	Biopharmaceuticals	3	0	0	100
2	<b>BT1006</b>	Developmental Biology	3	0	0	100
3	<b>BT1007</b>	Metabolic Engineering	3	0	0	100
4	<b>BT1008</b>	Molecular Pathogenesis	3	0	0	100

## SEMESTER VII

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	<b>BT1401</b>	Bioethics and Biosafety	4	0	0	100
2	<b>BT1402</b>	Downstream Processing	4	0	0	100
3	<b>BT1403</b>	Computational Biology	4	0	0	100
4	<b>BT1404</b>	Immunology	4	0	0	100
5	<b>E3****</b>	Elective III	4	0	0	100
6	<b>E4****</b>	Elective IV	4	0	0	100
<b>Practical</b>						
7	<b>BT1405</b>	Downstream Processing Laboratory	0	0	3	100
8	<b>BT1406</b>	Computational Biology Laboratory	0	0	3	100
9	<b>BT1407</b>	Immunology Laboratory	0	0	3	100

### SEMESTER VIII

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	<b>MG1352</b>	Total Quality Management	4	0	0	100
<b>Practical</b>						
2	<b>BT1455</b>	Project Work	0	0	12	100

### ELECTIVE III

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	<b>BT1009</b>	Environmental Biotechnology	3	0	0	100
2	<b>BT1010</b>	Plant and Animal Biotechnology	3	0	0	100
3	<b>BT1011</b>	Genomics and Proteomics	3	0	0	100
4	<b>BT1012</b>	Molecular Modeling and Drug Design	3	0	0	100

### ELECTIVE IV

S.No.	Subject Code	Subject	L	T	P	Max. Marks
<b>Theory</b>						
1	<b>BT1013</b>	Cancer Biology	3	0	0	100
2	<b>BT1014</b>	Biosensors and Transducers	3	0	0	100
3	<b>BT1015</b>	Cryopreservation in Biotechnology	3	0	0	100
4	<b>BT1016</b>	Technology Management	3	0	0	100

# ANNA UNIVERSITY TIRUCHIRAPPALLI

Tiruchirappalli – 620 024

Regulations 2007

Syllabus

**B.TECH. BIOTECHNOLOGY**

**SEMESTER III**

**MA1201 – MATHEMATICS III**

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

**UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients.

**UNIT II FOURIER SERIES 9**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis.

**UNIT III BOUNDARY VALUE PROBLEMS 9**

Classification of second order Quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two – Dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

**UNIT IV FOURIER TRANSFORM 9**

Fourier integral theorem (without proof) – Fourier transform pair – Sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

**UNIT V Z-TRANSFORM AND DIFFERENCE EQUATIONS 9**

Z-Transform – Elementary properties – Inverse Z-Transform – Convolution theorem – Formation of difference equations – Solution of difference equations using Z-Transform.

**L: 45 T: 15 Total: 60**

**TEXT BOOK**

1. Grewal, B.S., "Higher Engineering Mathematics", 40th Edition, Khanna Publishers, 2007.

**REFERENCES**

1. Veerarajan T., "Engineering Mathematics III", 3rd Edition, Tata McGraw-Hill Education, 2007.
2. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics", Vol-III, S. Chand and Company Ltd., 2007.
3. Churchill R.V. and Brown J.W., "Fourier Series and Boundary Value Problems", 4th Edition, McGraw-Hill, 1987.

## CH1205 – PRINCIPLES OF CHEMICAL ENGINEERING

**L T P**  
**4 0 0**

### **UNIT I STOICHIOMETRY 12**

Introduction – Units and dimensions – Stoichiometric principles – Composition relations – Density and specific gravity.

### **UNIT II MATERIAL BALANCE 12**

Material balance without chemical reaction – Processes involving with chemical reaction – Combustion of coal, fuel gases and sulphur – Recycling operations.

### **UNIT III ENERGY BALANCE 12**

Thermo chemistry – Calculation of heat of reaction at other temperatures – Hess's law of summation – Heat of formation, reaction, mixing, adiabatic reaction, combustion – Mean specific heat.

### **UNIT IV PROPERTIES OF FLUIDS AND CONCEPTS OF PRESSURE 12**

Nature of fluids – Rheological properties of fluids – Types of fluids – Momentum balances – Mechanical energy balances – Bernoulli's equation – Motion of particles through fluids – Motion under gravitational and centrifugal fields – Terminal settling velocity.

### **UNIT V TRANSPORTATION AND METERING 12**

Pumps – Suction lift and cavitation – Positive displacement pumps – Centrifugal pumps – Performance and characteristics – Air lift pumps – Measurement of fluid flow – Orifice meter, venturimeter, pitot tube, rotameter, weirs and notches – Hot wire anemometer.

**Total: 60**

### **TEXT BOOKS**

1. Bhatt B.I. and Vora S.M., "Stoichiometry", 4th Edition, Tata McGraw Hill Publishers Ltd., 2005.
2. McCabe W.L., Smith J.C. and Harriott P., "Unit Operations in Chemical Engineering", 7th Edition, Tata McGraw-Hill, 2004.

### **REFERENCES**

1. Geankoplis C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall, 2007.
2. Coulson J.M. and Richardson J. F., "Coulson and Richardson's Chemical Engineering", Vol-I, 3rd Edition, Butterworth – Heinemann Publishers, 2004.
3. Venkataramani V. and Anantharaman N., "Process Calculations", Prentice Hall, 2004.

## BT1201 – BIOORGANIC CHEMISTRY

L T P  
4 0 0

### UNIT I CONCEPTS IN ORGANIC CHEMISTRY 12

Atomic structure – Bonding – Hybridization – Isomerism – Stereochemistry – R and S notation – E and Z symbol – Conformers – Ethane, cyclohexane – Markovnikov's rule – Nucleophilic and electrophilic substitution reaction – Elimination reaction.

### UNIT II CARBOHYDRATES 12

Classification of carbohydrates – Monosaccharide – Reactions of glucose and fructose – Open chain and cyclic structures of glucose and fructose – Mutarotation – Epimerization – Killiani-Fischer synthesis – Conversion of aldoses to ketoses and ketoses to aldoses – Disaccharides – Properties and structure of sucrose – Polysaccharides – Properties and structure of starch and cellulose.

### UNIT III AMINO ACIDS AND PROTEIN 12

Amino acids – Synthesis, zwitterions and iso-electric point, polarity, stereochemistry – Synthesis, reactions, structure level in proteins – Amide bond, hydrogen bond, disulfide bond, hydrophobic interactions, denaturation – Enzyme-substrate interaction - Enzyme kinetics.

### UNIT IV NUCLEOSIDES, NUCLEOTIDES AND NUCLEIC ACIDS 12

Structure and properties of nucleosides, nucleotides and nucleic acids – Nucleoside and oligonucleotide synthesis – Solid-phase oligonucleotide synthesis.

### UNIT V REDOX CHEMISTRY IN BIOLOGICAL SYSTEMS 12

Cytochromes – Complexation with tetrapyrrole ring – Influence on redox potential oxygen transport – Coenzyme Q/QH<sub>2</sub>, FAD/FADH<sub>2</sub> – Vitamin B<sub>2</sub>, B<sub>3</sub>, B<sub>12</sub>, C and K – Redox characteristics.

**Total: 60**

### TEXT BOOKS

1. Finar I.L., "Organic Chemistry", Vol-II, Fifth Edition, Pearson Education, 2000.
2. Bahl A. and Bahl B.S., "Advanced Organic Chemistry", S.Chand and Company Ltd., 2004.

### REFERENCES

1. Dugas H., "Bioorganic Chemistry – A chemical approach to enzyme action", Third Edition, Springer India Pvt. Ltd., 2004.
2. Morrison R.T. and Boyd R.N., "Organic Chemistry", Sixth Edition, Prentice Hall, 2003.
3. McMurry J., "Organic Chemistry", Fifth Edition, Brooks/Cole, 2000.

## BT1202 – BIOCHEMISTRY

L T P  
4 0 0

### UNIT I BIOMOLECULES 12

Overview of biomolecules – Structure and properties of monosaccharides, disaccharides, polysaccharides and glycoconjugate – Nomenclature and classification of enzymes – Structure and properties of amino acids – Primary, secondary and tertiary structure of proteins – Structure and properties of fatty acids, triglycerols, glycerophospholipids, sphingolipids, steroids – Structure and properties of nucleic acids – Biochemical role of vitamins.

### UNIT II METABOLISM 12

Glycolysis and regulation – Gluconeogenesis – Pentose phosphate pathway – Metabolism and regulation of glycogen – Citric acid cycle – Electron transport chain – Fatty acid oxidation and biosynthesis of triglycerols, glycerophospholipids, sphingolipids – Transport shuttle system – Biosynthesis of cholesterol – Biosynthesis of purine and pyrimidine nucleotides – Catabolism of nucleotides.

### UNIT III MINERALS AND NUTRITION 12

Micro and macro elements – Properties, functions and metabolism of trace elements – Principles of micro and macro nutrients – Digestion and absorption of nutritional constituents – Basal metabolic rate – Specific dynamic action.

### UNIT IV PHYSIOLOGICAL PROCESS 12

Body fluids and electrolyte balance – Endocrine system and neuroendocrine system in regulatory process (Hypothalamus, pituitary and adrenal medulla) – Biochemistry of hormones (polypeptide, steroids) – Iron and heme metabolism – Extracellular matrix – Active and passive transport – Ionic channels and mediators, G-proteins and secondary messengers.

### UNIT V CLINICAL BIOCHEMISTRY 12

Metabolic disorders – Glycogen storage diseases – Lipid storage diseases – Inborn errors of metabolism – Biochemical and genetic based diseases – Organ function tests – Sickle cell anemia – Protein-energy malnutrition.

**Total: 60**

### TEXT BOOK

1. Robert K.M., Daryl K.G. and Victor W.R., “Harper’s Illustrated Biochemistry”, Twenty Seventh Edition, McGraw-Hill Companies, Inc., 2006.

### REFERENCES

1. Horton R., Moran L.A., Serimgeour G., Perry M. and Rawn J.D., “Principles of Biochemistry”, Fourth Edition, Prentice Hall, 2005.
2. Voet. D. and Voet G., “Biochemistry”, Third Edition, John Wiley & Sons, 2004.
3. Devlin T.M., “Text Book of Biochemistry”, Fifth Edition, John Wiley & Sons, 2003.

## BT1203 – CELL BIOLOGY

**L T P**  
**4 0 0**

### **UNIT I CELL STRUCTURE 12**

Types of eukaryotic and prokaryotic cells – Plasma membrane, Chromosome organization – Intracellular organelles and their function – Cell division – Mitosis and Meiosis – Cell cycle and cell cycle genes.

### **UNIT II CELL MEMBRANE AND TRANSPORT 12**

Molecular organization of cell – Endocytosis and exocytosis – Passive and active transport – Sodium and potassium pumps – Ca<sup>2+</sup>ATPase pumps – ATP dependent proton pumps – Co-transport – Symport and antiport.

### **UNIT III RECEPTORS AND EXTRACELLULAR SIGNALING 12**

Cytosolic, nuclear and membrane bound receptors – Autocrine, endocrine and paracrine models of action – Cytoskeletal structures and their role in cell organization, division and motility.

### **UNIT IV SIGNAL TRANSDUCTION 12**

Ligands and receptors – Signal amplification – Cyclic AMP, biosynthesis and role of inositol tri phosphates as messengers – Cyclic GMP and G proteins and their role in signal transduction - Calcium ion flux – Cell signaling.

### **UNIT V CELL CULTURE 12**

Cell fractionation techniques – Cytochemical staining methods – Techniques in cell culture – Primary cultures – Explant cultures – Three dimensional organ cultures and role of matrix in cell growth – Generation and maintenance of cell lines.

**Total: 60**

### **TEXT BOOKS**

1. Lodish H., Berk A., Matsudaira P., Kaiser C A., Krieger M., Scott M P., Zipursky S L. and Darnell J., “Molecular Cell Biology”, Fifth Edition, W.H. Freeman, 2004.
2. Karp G., “Cell and Molecular Biology – Concepts and Experiments”, Third Edition, John Wiley & Son’s Inc., 2003.

### **REFERENCES**

1. Robertis De E.D.P. and Robertis De E.M.F., “Cell and Molecular Biology”, Eighth Edition, B.I. Publications Pvt. Ltd, 2005.
2. Bruce A., Dennis B., Karen H., Alexander J., Julian L., Martin R., Keith R. and Peter W., “Essential Cell Biology”, Second Edition, Garland Science, 2004.
3. David E.S., “Cell Biology Organelle Structure and Function”, Panima Publishing Corporation, 2004.



**BT1205 – BIOORGANIC CHEMISTRY LABORATORY**

**L T P**  
**0 0 3**

**LIST OF EXPERIMENTS**

1. Synthesis of aspirin.
2. Hydrolysis of sucrose.
3. Preparation of pyruvic acid from tartaric acid.
4. Preparation of oleic acid from tartaric acid.
5. Preparation of  $\alpha$ -d-glucopyranose pentaacetate.
6. Preparation of 1,2,5,6 dicyclohexylnoine  $\alpha$ -d-glucofuranose.
7. Isolation of Lycopene from tomato paste.
8. Preparation of L-proline.
9. Preparation of L-cysteine from hair.
10. Preparation of S-ethyl hydroxybutonate from ethyl acetoacetate using yeast.
11. Resolution of S-ethyl hydroxybutonate using 3,5-dinitrobenzoate.
12. Preparation of 5,10,15,20-tetrakisphenyl porphyrin.

**Total: 45**

## BT1206 – BIOCHEMISTRY LABORATORY

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

### LIST OF EXPERIMENTS

1. Qualitative test for carbohydrates by Benedict's method, Molisch test, Iodine test and Seliwanoff's test.
2. Estimation of total sugars by Anthrone method.
3. Estimation of total sugars by Phenol method.
4. Estimation of amino acids by Ninhydrin method.
5. Protein estimation by Lowry's method.
6. Protein estimation by Bradford method.
7. Enzymatic measurements – Phosphatase and amylase from potato.
8. Enzymatic measurements – Catalase and peroxidase.
9. Enzyme assays – Proteases and lactate dehydrogenase (LDH).
10. Estimation of calcium.
11. Estimation of cholesterol and phospholipid.
12. Estimation of serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT).
13. Estimation of bilirubin.
14. Estimation of creatine and urea.

**Total: 45**

## BT1207 – CELL BIOLOGY LABORATORY

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

### LIST OF EXPERIMENTS

1. Micrometry.
2. Observation of prokaryotic and eukaryotic cells.
3. Blood smear and WBC differential staining.
4. Temporary preparation of cells and tissues.
5. Permanent preparation of cells and tissues.
6. Study of cell organelles adopting preparations/models.
7. Squash preparation of onion root tip for mitosis.
8. Squash preparation of grass hopper testis for meiosis.
9. Antherlobes for meiosis.
10. Preparation of buccal smear for epithelial cells.
11. Subcellular fractionation.
12. Metaphase chromosome preparation and preliminary banding techniques.
13. Cytotoxicity / Cell viability – Typhan blue exclusion assay.
14. Giant chromosome preparation from the salivary glands of Chironomous larvae / Drosophila larvae.

**Total: 45**

## SEMESTER IV

L T P  
3 1 0

### MA1251 – NUMERICAL METHODS

#### UNIT I SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 9

Linear interpolation methods (method of false position) – Newton’s method –Solution of linear system by Gaussian elimination and Gauss – Jordon methods – Iterative methods: Gauss Jacobi and Gauss-Seidel methods – Inverse of a matrix by Gauss–Jordan method – Eigen value of a matrix by power method.

#### UNIT II INTERPOLATION AND APPROXIMATION 9

Lagrangian polynomials – Divided differences – Interpolating with a cubic spline – Newton's forward and backward difference formulae.

#### UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9

Derivatives from difference tables – Divided differences and finite differences – Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Double integrals using trapezoidal and Simpson's rules.

#### UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9

Single step methods: Taylor series method – Euler’s method – Modified and improved Euler’s method – Fourth order Runge-Kutta method for solving first and second order equations – Multi-step methods: Milne’s and Adam’s predictor and corrector methods.

#### UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9

Finite difference solution of second order ordinary differential equation – Finite difference solution of one dimensional heat equation by implicit and explicit methods – one dimensional wave equation and two dimensional Laplace and Poisson equations.

**L: 45 T: 15 Total: 60**

#### TEXT BOOK

1. Gerald C.F. and Wheatley P.O., “Applied Numerical Analysis”, Sixth Edition, Pearson Education, 2005.

#### REFERENCES

1. Jain M.K., Iyengar S.R.K. and Jain R.K., “Numerical Methods for Scientific and Engineering Computation” Fourth Edition, New Age International Publishers, 2003.
2. Venkataraman M.K., “Numerical Methods”, National Publication Company, 1991.
3. Kandasamy P., Thilakavthy K. and Gunavathy K., “Numerical Methods”, Second Edition, S.Chand & Company Ltd., 2003.

## HS1201 – ENVIRONMENTAL SCIENCE AND ENGINEERING

L T P  
4 0 0

### UNIT I IMPORTANCE OF ENVIRONMENTAL STUDIES 12

Scope and importance – Need for public awareness – Forest resources – Water resources – Mineral resources – Land resources – Energy resources – Food resources – Equitable use of resources for sustainable lifestyles.

### UNIT II ECOSYSTEMS AND BIODIVERSITY 12

Concept of ecosystem – Structure and function of an ecosystem – Energy flow in the ecosystem – Food chains – Food webs – Ecological pyramids – Definition of biodiversity – Biogeographical classification in India – Value of biodiversity – Biodiversity at global – National and local levels – India as a mega diversity nation – Hot spots of biodiversity – Threats to biodiversity – Conservation of biodiversity

### UNIT III ENVIRONMENTAL POLLUTION 12

Causes and effects of environmental pollution – Air pollution – Water pollution – Soil pollution – Marine pollution – Noise pollution – Thermal pollution – Nuclear hazards – Solid waste management – Societal role in pollution prevention – Environmental disasters and management.

### UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 12

Unsustainable to sustainable development – Concept of conservation – Water and energy conservation – Rain water harvesting – Climate change – Global warming – Acid rain – Ozone layer depletion – Nuclear accidents and holocaust – Environmental Protection Act – Issues involved in enforcement of environmental legislation – Public awareness.

### UNIT V HUMAN POPULATION AND THE ENVIRONMENT 12

Population growth – Population explosion – Family welfare programme – Environment and human health – Human rights – Value education – HIV/AIDS – Women and child welfare – Role of IT in environment and human health.

**Total: 60**

### TEXT BOOKS

1. Gilbert M.M., “Introduction to Environmental Engineering and Science”, Third Edition, Prentice Hall, 2007.
2. Venugopala Rao P., “Principles of Environmental Science and Engineering”, Prentice Hall, 2006.

### REFERENCES

1. Davis M.L. and Masten S.J., “Principles of Environmental Engineering and Science”, McGraw-Hill, 2004.
2. Bharucha E., “Text book of Environmental Studies”, University Press, 2005.
3. Trivedi R.K., “Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards”, Vol-I & II, Enviro Media, 1996.

## BT1251 – UNIT OPERATIONS

**L T P**  
**4 0 0**

**UNIT I CONDUCTION 12**

Modes of heat transfer – Steady and unsteady state heat transfer – Concept of heat conduction – Fourier’s law of heat conduction – One dimensional steady state heat conduction equation for flat plate and hollow cylinder – Effect of temperature on thermal conductivity.

**UNIT II CONVECTION 12**

Concept of heat transfer by convection – Natural and forced convection – Concept of LMTD – Local and overall heat transfer coefficient – Application of dimensional analysis for convection.

**UNIT III HEAT EXCHANGERS AND EVAPORATORS 12**

Heat exchanger types – Parallel and counter flow heat exchangers – Overall heat transfer coefficient – Log mean temperature difference – Evaporation – Single effect and multiple effect evaporators – Boiling point elevation – Capacity and economy of multiple effect evaporators – Types of evaporation equipments.

**UNIT IV CHARACTERISTICS OF PARTICULATE SOLIDS 12**

Properties and characterization of particulate solids – Analysis and technical methods for size and surface area distribution of powder – Mechanical classifiers – Screening equipments – Capacity and effectiveness – Principles of magnetic separation.

**UNIT V AGITATION AND MIXING 12**

Introduction to agitation and mixing of liquids – Agitation equipment – Axial and radial flow impellers and flow patterns in agitated vessels – Prevention of swirling – Power consumption in agitated vessels – Mixing of solids.

**Total: 60**

### TEXT BOOK

1. McCabe W.L., Smith J.C. and Harriott P., “Unit Operations in Chemical Engineering”, Seventh Edition, Tata McGraw-Hill, 2004.

### REFERENCES

1. Geankoplis C.J., “Transport Processes and Unit Operations”, Fourth Edition, Prentice Hall, 2007.
2. Coulson M. and Richardson J.F., “Coulson and Richardson’s Chemical Engineering”, Vol-II, Fourth Edition, Butterworth – Heineman, 2004.
3. Kern D.Q., “Process Heat Transfer” Tata McGraw-Hill, 2005.

## CS1262 – UNIX OPERATING SYSTEM AND PROGRAMMING LANGUAGE C++

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

### **UNIT I UNIX OPERATING SYSTEM 9**

Introduction to Operating Systems – Basic commands in UNIX – vi editor – Filters – Input/output redirection – Piping – Transfer of data between devices – Shell scripts.

#### **Programming Language C++**

### **UNIT II INTRODUCTION TO C ++ 9**

Programming methodologies – Introduction to Object Oriented Programming – Comparison of procedural and object oriented languages – Basics of C++ environment – Data types – Control flow constructs – Library functions – Arrays.

### **UNIT III CLASSES 9**

Definition – Data members – Function members – Access specifiers – Constructors – Default constructors – Copy constructors – Destructors – Static members – This pointer - Constant members – Free store operators – Control statements.

### **UNIT IV INHERITANCE AND POLYMORPHISM 9**

Overloading operators – Functions – Friends – Class derivation – Virtual functions – Abstract base classes – Multiple inheritances.

### **UNIT V TEMPLATES AND FILE HANDLING 9**

Class templates – Function templates – Exception handling – File handling

**L: 45 T: 15 Total: 60**

#### **TEXT BOOKS**

1. Ira Pohl., “Object-oriented Programming using C++”, Second Edition, Pearson Education, 2003.
2. Bach M.J., “The Design of Unix Operating Systems”, Prentice Hall, 1999.

#### **REFERENCES**

1. Kochen S.J and Wood P.H., “Exploring the Unix System”, Techmedia, 1999.
2. Lippman S.B., “The C++ Primer”, Addison Wesley, 1998.
3. Deitel and Deitel, “C++ How to Program”, Prentice Hall, 1998.

## BT1252 – MOLECULAR BIOLOGY

**L T P**  
**4 0 0**

### **UNIT I MENDELIAN AND BACTERIAL GENETICS 12**

Mendelian laws of inheritance – Sex chromosomes and sex-linked inheritance – Linkage and crossing over – Genetic mapping of chromosomes – Bacterial genetics – Transposons, transformation, conjugation, and transduction.

### **UNIT II GENOME AND ITS STRUCTURE 12**

Molecular basis of life – Central dogma of life – Structure of DNA – Different forms of DNA and RNA – Genome organization in prokaryotes and in eukaryotes – Interaction of histones – Extranuclear genomes.

### **UNIT III DNA REPLICATION AND EXPRESSION 12**

Replication, transcription and translation – Codon and anticodon concept – Codon usage – Inhibitors of transcription and translation – Exon and intron concepts – Transcription initiation factors – Characteristic motifs, promoters and enhancers, RNA splicing, RNA editing – Post translational modifications – Protein folding, glycosylation, phosphorylation.

### **UNIT IV MUTATION 12**

Biochemical basis of mutation – Gene as the unit of expression – Types of mutation – Spontaneous, induced, reverse mutation – Suppression of mutation – DNA repair mechanisms – SOS response – Photo reactivation.

### **UNIT V GENE REGULATION 12**

Operon concept – gal, lac and trp – Allosteric enzymes and feed back inhibition – Repression – DNA looping – Homeobox in gene regulation in eukaryotes.

**Total: 60**

### **TEXT BOOK**

1. Lewin B., “Genes – IX”, Ninth Edition, Jones and Bartlett Publishers, 2008.

### **REFERENCES**

1. Watson J.D., Baker T.A., Bell S.P., Gann A. and Levin M., “Molecular Biology of the Gene”, Fifth Edition, Pearson Education Pvt. Ltd., 2004.
2. Bruce A., Dennis B., Alexander J., Julian L., Martin R., Keith R. and Peter W., “Molecular Biology of the Cell”, Third Edition, Garland Science, 2002.
3. Freifelder D. and Malacinski G.M., “Essentials of Molecular Biology”, Third Edition, Jones and Barlett Publishers Inc., 1998.

## BT1253 – BIOTHERMODYNAMICS

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

### **UNIT I ENERGY TRNSFORMATIONS 9**

Distribution of energy – Systems, boundary and surroundings – Animal energy consumption – Carbon, energy and life – State and equilibrium – Heat, work and conservation of energy.

### **UNIT II FIRST LAW OF THERMODYNAMICS 9**

Internal energy, work – The first law in operation – Enthalpy – Standard state – Some examples from biochemistry – Heat capacity – Energy conservation in the living organism.

### **UNIT III SECOND LAW OF THERMODYNAMICS 9**

Entropy – Heat engines – Entropy in the universe - Isothermal systems – Protein denaturation – The third law and biology – Irreversibility and life.

### **UNIT IV GIBBS FREE ENERGY-THEORY 9**

Equilibrium – Reversible processes – Phase transitions – Chemical potential – Effects of solutes on boiling points and freezing points – Ionic solutions – Equilibrium constant – Standard state in biochemistry – Effect of temperature in  $K_{eq}$  – Acids and bases – Chemical coupling – Redox reactions.

### **UNIT V GIBBS FREE ENERGY- APPLICATIONS 9**

Photosynthesis, glycolysis and citric acid cycle – Oxidative phosphorylation and ATP hydrolysis – Donnan equilibrium – Membrane transport – Enzyme-substrate interaction - Free energy of transfer of amino acids – Protein solubility – Protein stability – Protein dynamics – Non-equilibrium thermodynamics and life.

**L: 45 T: 15 Total: 60**

### **TEXT BOOK**

1. Haynie D.T., “Biological Thermodynamics”, Second Edition, Cambridge University Press, 2008.

### **REFERENCES**

1. Sandler S.I., “Chemical, Biochemical and Engineering Thermodynamics”, Fourth Edition, John Wiley & Sons Inc., 2006.
2. Nicholls D.G. and Ferguson S.J., “Bioenergetics 3”, Second Edition, Elsevier Science Ltd., 2002.
3. Smith J.M., Van Ness H.C. and Michael A., "Introduction to Chemical Engineering Thermodynamics", Sixth Edition, Tata McGraw- Hill, 2001.

## BT1254 – UNIT OPERATIONS LABORATORY

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

### LIST OF EXPERIMENTS

1. To study the effect of coil diameter on heat transfer coefficient.
2. To determine overall heat transfer coefficient using double pipe heat exchanger.
3. To determine overall heat transfer coefficient using shell and tube heat exchanger.
4. To study the effect of open pan evaporation.
5. To evaluate the performance of weirs and notches.
6. To evaluate the performance of centrifugal pump.
7. Experiment on orifice meter.
8. Experiment on venturimeter.
9. To characterize the behavior of fluidized bed.
10. To verify Ergun's equation.
11. To determine the efficiency of screen.
12. Terminal settling velocity – Stoke's law verification.
13. Mixing index.

**Total: 45**

## BT1255 – MICROBIOLOGY LABORATORY

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

### LIST OF EXPERIMENTS

1. Microscopy – Observation of different microbes.
2. Control of microorganisms – Sterilization techniques – Physical, chemical and irradiation techniques.
3. Culture media preparation – Simple media and complex media.
4. Culturing of microorganisms – Spread plate, pour plate, streak plate techniques.
5. Isolation and identification of microbes from soil, water and air.
6. Isolation and identification of microbes from normal flora, pus and urine samples.
7. Antibiotic sensitivity test – Kirby-Bauer method.
8. Microbicidal activity of phenol, dettol and savlon.
9. Bacterial growth curve (*E.coli*).
10. Estimation of milk quality – Methylene blue reduction test (MBRT).
11. Preparation of wine from grapes.
12. Industrial enzyme production – Cellulase and amylase.
13. Agricultural microbiology – Isolation of *Rhizobium* and *Azolla*.

**Total: 45**

## BT1256 – MOLECULAR BIOLOGY LABORATORY

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

### LIST OF EXPERIMENTS

1. Isolation and purification of genomic DNA from bacteria.
2. Isolation and purification of genomic DNA from eukaryotic tissue.
3. Isolation and purification of plasmid DNA.
4. Agarose gel electrophoresis of DNA samples.
5. Estimation of nucleic acids.
6. Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS- PAGE).
7. Western blotting.
8. UV mutagenesis of bacteria.
9.  $\beta$ -galactosidase enzyme assay.
10. Preparation of *E.coli* competent cells.
11. Transformation of bacteria –  $\text{CaCl}_2$  method.
12. Bacterial conjugation.
13. Transduction.

**Total: 45**

## SEMESTER V

### BT1301 – MASS TRANSFER OPERATIONS FOR BIOPROCESSES

L	T	P
4	0	0

#### UNIT I                      DIFFUSION AND MASS TRANSFER                      12

Molecular diffusion in fluids and solids – Interphase mass transfer – Mass transfer coefficients – Analogies in transport phenomena – Mass generation – Enzymatic reactions, plant root nutrient uptake and bacterial growth rate.

#### UNIT II                      GAS LIQUID OPERATIONS                      12

Principles of gas absorption – Single and multi component absorption – Absorption with chemical reaction – Design principles of absorbers – Industrial absorbers – HTU, NTU & HETP concepts – Oxygen uptake rate in cell cultures – Oxygen transfer in fermenters – Measurement methods for  $k_L a$  in fermenters.

#### UNIT III                      VAPOUR LIQUID OPERATIONS                      12

Vapour Liquid Equilibrium – Methods of distillation - Simple, steam, flash distillation, azeotropic, extractive and molecular distillation – Continuous distillation – McCabe –Thiele method. Principles – Industrial distillation equipments.

#### UNIT IV                      EXTRACTION OPERATIONS                      12

L-L equilibrium – Staged and continuous extraction – Solid-liquid equilibrium – Leaching principles.

#### UNIT V                      SOLID FLUID OPERATIONS                      12

Adsorption equilibrium – Batch and fixed bed adsorption – Drying-mechanism – Drying curves – Time of batch drying – Equipments for batch and continuous dryers.

**Total: 60**

#### TEXT BOOKS

1. Johnson A.T., “Biological Process Engineering: An Analogical Approach to Fluid Flow, Heat Transfer, and Mass Transfer Applied to Biological Systems”, Wiley-IEEE, 1998.
2. Treybal R.E., “Mass Transfer Operations”, Third Edition, McGraw Hill, 1981.

#### REFERENCES

1. Doran P.M., “Bioprocess Engineering Principles”, Academic Press, 2005.
2. Geankoplis C.J., “Transport Processes and Unit Operations”, Third Edition, Prentice Hall of India, 2003.
3. Coulson and Richardson's., “Chemical Engineering”, Vol. I & II, Asian Books Pvt. Ltd., 1998.

## BT1302 – BIOPROCESS PRINCIPLES

**L T P**  
**4 0 0**

### **UNIT I OVERVIEW OF FERMENTATION PROCESSES 12**

Fermentation process – Medium requirements – Medium formulation of optimal growth and product formation – Simple and complex media – Design of various commercial media for industrial fermentations – Microbial growth – Applications of fermentation – Microbial biomass – Microbial metabolites – Microbial enzymes – Transformation process – Recombinant products – Main parameters in fermentation processes – Mode of operation of fermentation processes – Basic configuration of fermenter and auxiliaries.

### **UNIT II KINETICS OF IMMOBILIZED ENZYMES AND STERILIZATION 12**

Methods of immobilization – Kinetics of immobilized enzymes – Thermal death kinetics of microorganisms – Batch and continuous heat sterilization of liquid media – Filter sterilization of liquid media – Air sterilization and design of sterilization equipment.

### **UNIT III METABOLIC STOICHIOMETRY AND ENERGETICS 12**

Stoichiometry of cell growth and product formation – Elemental balances – Degrees of reduction of Substrate and Biomass – Available Electron Balances – Yield coefficients of Biomass and Product formation – Maintenance coefficients energetic analysis of microbial growth and product formation – Oxygen consumption and heat evolution in aerobic cultures – Thermodynamic efficiency of growth.

### **UNIT IV KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 12**

Modes of operation – Batch, Fed Batch and Continuous Cultivation – Simple unstructured kinetic models for microbial growth – Monod model – Growth of filamentous organisms – Product formation kinetics – Leudeking-piret models, substrate and product inhibition on cell growth and product formation.

### **UNIT V OPTIMIZATION METHODS 12**

Overview of response surface methodology – Factorial design – Central composite design – Three level design – Plackett-Burman design and Taguchi design of experiments.

**Total: 60**

### **TEXT BOOKS**

1. Stanbury P. F., Hall S. J. and Whitaker A., “Principles of Fermentation Technology”, Science & Technology Books, 1999.
2. Blanch H. W. and Clark D. S., “Biochemical Engineering”, CRC Press, 1997.

### **REFERENCES**

1. Jack P.C. Kleijnen, “Design and Analysis of Simulation Experiments”, Springer, 2008.
2. Anderson M.J. and Whitcomb P.J., “RSM Simplified: Optimizing Processes Using Response Surface Methods for Design of Experiments”, Productivity Press, 2005.
3. Roy R.K., “Design of Experiments Using the Taguchi Approach: 16 Steps to Product and Process Improvement”, Wiley-IEEE, 2001.
4. Shuler M.L. and Kargi F., “Bioprocess Engineering: Basic Concepts”, Second Edition, Prentice Hall, 2001.

## BT1303 – BASIC INDUSTRIAL BIOTECHNOLOGY

L T P  
4 0 0

### UNIT I INTRODUCTION TO INDUSTRIAL BIOPROCESS 12

A historical overview of industrial fermentation process – Traditional and modern biotechnology – A brief survey of organisms, processes, products relating to modern biotechnology – Process flow sheeting – Block diagrams, pictorial representation.

### UNIT II PRODUCTION OF PRIMARY METABOLITES 12

A brief outline of processes for the production of some commercially important organic acids (citric acid, lactic acid, acetic acid) – Amino acids (glutamic acid, phenylalanine, aspartic acid) and alcohols (ethanol, butanol)

### UNIT III PRODUCTION OF SECONDARY METABOLITES 12

Study of production processes for various classes of secondary metabolites – Antibiotics: beta-lactams (penicillin, cephalosporin) – Aminoglycosides (streptomycin) Macrolides (erythromycin), Vitamins and Steroids.

### UNIT IV PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 12

Production of industrial enzymes such as proteases, amylases, lipases, cellulases – Production of biopesticides, biofertilisers, biopreservatives (Nisin), cheese, biopolymers (xanthan gum, PHB), single cell protein.

### UNIT V PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS 12

Production of recombinant proteins having therapeutic and diagnostic applications – Production of vaccines – Production of monoclonal antibodies – Products of plant and animal cell culture.

**Total: 60**

### TEXT BOOKS

1. Prescott S.C. and Dunn C.G., “Industrial Microbiology”, Fourth Edition, AVI Publications, 1982.
2. Casida Jr, L.E., “Industrial Microbiology”, Wiley, 1968.

### REFERENCES

1. Cruger W., Crueger A. and Brock T. D., “Biotechnology: A Textbook of Industrial Microbiology”, Second Edition, Sinauer Associates, 1990.
2. Moo-Young M., “Comprehensive Biotechnology: The Principles, Applications, and Regulations of Biotechnology in Industry, Agriculture, and Medicine”, Pergamon, 1985.

## BT1304 – FOOD TECHNOLOGY

L T P  
4 0 0

### UNIT I FOOD FERMENTATION 12

Technology of conventional and non-conventional fermentation based food products from cereals legumes, fruits, vegetables, milk, fish and meat – Secondary fermentation of waste generated in selected food fermentation – Pilot and large scale fermentation – Continuous and batch culture process monitoring and control.

### UNIT II FOOD SPOILAGE 12

Intrinsic and extrinsic parameters of food that affect microbial growth – Microorganisms in food – Fresh meats and poultry – Processed meats and sea foods – Vegetable and Fruits products – Dairy and non dairy food products – Miscellaneous food products.

### UNIT III MINIMAL FOOD PROCESSING BY THERMAL METHODS 12

Conduction – Convection – Radiation – Aseptic and semi-aseptic processing – Sous-vide processing – Infrared heating – Microwave heating – Inductive electrical heating.

### UNIT IV MINIMAL FOOD PROCESSING BY NON-THERMAL METHODS 12

High pressure processing – Principles, effects, applications, modeling of HP processes and microbiological aspects – Pulsed electric field processing of solid foods, liquid foods and beverages – Enzyme inactivation and food safety by pulsed electric fields – Oscillating magnetic fields – Osmotic dehydration – High intensity pulsed light technology – Radio frequency electric fields – Ultrasound – Irradiation of foods.

### UNIT V FOOD PRESERVATION AND TRANSGENIC FOOD 12

Natural food preservatives – Food preservation with chemicals – Low temperature – High temperature – Drying – Modified atmospheric packaging – Hurdle concepts – Genetically modified food – Beverage and non-beverage food products – Food additives like colour, flavors and vitamins – GMP in Food industry.

**Total: 60**

### TEXT BOOKS

1. Jay J.M., Loessner M.J. and Golden D.A., “Modern Food Microbiology”, Seventh Edition, Springer, 2005
2. Bengtsson N., “Minimal Processing Technologies in the Food Industry”, Woodhead Publishing, 2002.

### REFERENCES

1. Da-Wen Sun, “Emerging technologies for food processing”, Academic Press, 2005.
2. Barbosa-Cánovas G.V., Tapia M.S. and Cano M.P., “Novel Food Processing Technologies”, CRC Press, 2005.
3. Campbell B., Clapton B. and Tipton C., “Food Technology”, Heinemann, 2002.

**UNIT I INTRODUCTION TO ENZYMES 12**  
General properties of enzymes – Mechanisms of enzyme action – Concept of active site and energetic of enzyme substrate complex formation – Specificity of enzyme action – Principles of catalysis – Collision theory, transition state theory – Thermodynamics of enzyme catalyzed reactions.

**UNIT II ENZYME REACTIONS WITH SINGLE AND MULTIPLE SUBSTRATES 12**  
Kinetics of single-substrate enzyme reactions: Effects of substrate concentration on velocity – The rapid equilibrium model of enzyme kinetics – The steady state model of enzyme kinetics – The Significance of  $k_{cat}$  and  $K_m$  . Experimental Measurement of  $k_{cat}$  and  $K_m$  – Linear Transformations of Enzyme kinetic data – Enzyme reactions with multiple substrates: Bi Bi reaction mechanisms – Distinguishing between random and compulsory ordered mechanisms by inhibition pattern – Isotope exchange studies for distinguishing reaction mechanisms.

**UNIT III ENZYME INHIBITION 12**  
Reversible inhibitors – Modes and equilibrium treatment – Graphic determination of inhibitor type – Dose-response curves of enzyme inhibition – Mutually exclusive binding of two inhibitors – Structure-activity relationships and inhibitor design  
Tight binding inhibitors – Inhibitor type – Determining  $K_i$  for tight binding inhibitors – Application over determination of active enzyme concentration  
Time-dependent inhibition – Progress curves for slow binding inhibitors – Distinguishing between slow binding schemes – Distinguishing between modes of inhibitor interaction with enzyme – Determining reversibility – Examples of slow binding enzyme inhibitors.

**UNIT IV PRODUCTION OF INDUSTRIAL ENZYMES 12**  
Alpha amylase – Glucoamylase - Glucose isomerase – Cellulase – Pectinase – Xylanase – Lipase – Protease – Peroxidases – Chitinase – Invertases – Mannanases.

**UNIT V APPLICATIONS OF ENZYMES 12**  
Applications of enzymes as bulk activities – Laundry detergents, textiles, pulp and paper industry – Applications of enzymes as catalysts – Processes towards basic chemicals, fine chemicals, crop protection and large scale pharma intermediates – Enzyme biosensors.

**Total: 60**

#### **TEXT BOOKS**

1. Pandey A., Webb C., Soccol C.R. and Larroche C., “Enzyme Technology”, Springer, 2006.
2. Copeland R.A., “Enzymes – A Practical Introduction to Structure, Mechanism and Data Analysis”, Second Edition, Wiley-VCH, 2000.

#### **REFERENCES**

1. Bommarius A.S. and Rieben B.R., “Biocatalysis – Fundamentals and Applications”, Wiley-VCH, 2004.
2. Purich D. and Allison D.R., “A Comprehensive Guidebook to Enzyme Nomenclature, Reactions and Methods”, Academic Press, 2002.

## BT1306 – INSTRUMENTAL METHODS OF ANALYSIS

L T P  
4 0 0

- UNIT I BASICS OF MEASUREMENT 12**  
Classification of methods – Calibration of instrumental methods – Electrical components and circuits – Signal to noise ratio – Signal – Noise enhancement.
- UNIT II OPTICAL METHODS 12**  
General design – Sources of radiation – Wavelength selectors – Sample containers – Radiation transducers – Types of optical instruments – Fourier transform measurements.
- UNIT III MOLECULAR SPECTROSCOPY 12**  
Measurement of transmittance and absorbance – Beer's law – Spectrophotometer analysis – Qualitative and quantitative absorption measurements – Types of spectrometers – UV – Visible – IR – Raman spectroscopy – Instrumentation theory.
- UNIT IV THERMAL METHODS 12**  
Thermo-gravimetric methods – Differential thermal analysis – Differential scanning calorimetry.
- UNIT V SEPARATION METHODS 12**  
Introduction to chromatography – Models – Ideal separation – Retention parameters – Van – Deemter equation – Gas chromatography – Stationary phases – Detectors – Kovats indices – HPLC – Pumps – Columns – Detectors – Ion exchange chromatography – Size exclusion chromatography – Supercritical chromatography – Capillary electrophoresis.

**Total: 60**

### TEXT BOOKS

1. Skoog D.A., Holler F.J. and Crouch S.R., "Principles of Instrumental Analysis", Sixth Edition, Thomson Brooks, 2006.
2. Willard H.H., Merritt L.L., Dean J.A and Settle F.A., "Instrumental Methods of Analysis", Seventh Edition, CBS Publishers, 1996.

### REFERENCE

1. Gremlich H. and Yan B., "*Infrared and Raman Spectroscopy of Biological Materials*", CRC Press, 2000

## BT1307 – MASS TRANSFER OPERATIONS LABORATORY

L T P  
0 0 3

### LIST OF EXPERIMENTS

1. Determination of diffusivity of vapour in air at constant temperature.
2. Determination of diffusivity of vapour in air at constant pressure.
3. To determine the drying rate of given solid in tray dryer under atmospheric conditions.
4. Verification of Raleigh's equation.
5. Determination of the efficiency of steam distillation.
6. Determination of stage efficiency using cross current leaching.
7. Determination of stage efficiency of counter current leaching.
8. Determination of breakpoint of adsorption.
9. Verification of Adsorption isotherm by multistage adsorption.
10. Wetted wall column – determination of mass transfer coefficient.

**Total: 45**

### DEMO (OPTIONAL)

1. Ethanol fermentation process.
2. Crystallization of calcium lactate.

## BT1308 – BIOPROCESS LABORATORY I

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

### LIST OF EXPERIMENTS

1. Growth of bacteria – estimation of biomass, calculation of specific growth rate, yield coefficient.
2. Growth of yeast – estimation of biomass, calculation of specific growth rate, yield coefficient.
3. Medium optimization – placket burman design.
4. Medium optimization – response surface methodology.
5. Enzyme kinetics – Michelis Menton Parameters.
6. Enzyme activity – effect of temperature and pH.
7. Enzyme inhibition kinetics.
8. Enzyme immobilization – gel entrapment.
9. Enzyme immobilization – cross linking.
10. Thermal Death Kinetics.

**Total: 45**

### DEMO (OPTIONAL)

1. Optimization of bioprocess – Taguchi methodology.
2. Isolation of amylase and starch hydrolysis.

## BT1309 – INSTRUMENTAL METHODS OF ANALYSIS LABORATORY

L	T	P
0	0	3

### EXPERIMENTS

1. Precision and validity in an experiment using absorption spectroscopy and Validating Lambert-Beer's law using  $\text{KMnO}_4$
2. Finding the molar absorptivity and stoichiometry of the  $\text{Fe}(1,10\text{-phenanthroline})_3$  using absorption spectrometry.
3. Finding the pKa of 4-nirophenol using absorption spectroscopy.
4. UV spectra of nucleic acids.
5. Estimation of sulphate by nephelometry.
6. Estimation of  $\text{Al}^{3+}$  by flourimetry.
7. Chromatography analysis using TLC and Column chromatography.
8. Limits of detection of colorimeter using aluminum-alizarin complex.
9. Job's plot for funding stoichiometry of iron salicylate complex.
10. UV– spectra of proteins.

**Total: 45**

## SEMESTER VI

### BT1351 – PROCESS ECONOMICS AND INDUSTRIAL MANAGEMENT

	<b>L</b>	<b>T</b>	<b>P</b>
<b>UNIT I</b>	<b>4</b>	<b>0</b>	<b>0</b>
<b>VALUE OF MONEY</b>			<b>12</b>
Value of money – Equivalence – Equations for economic studies and equivalence – Amortization – Capital recovery – Depreciation – Depletion.			
<b>UNIT II</b>			<b>12</b>
<b>COST AND ITS EVALUATION</b>			
Capital requirements for process plants – Cost indices – Equipment costs – Service facilities – Capital requirements for complete plants – Balance sheet – Cost – Earnings – Profits and returns – Variable costs – Fixed costs – Income statement – Economic production charts – Capacity factors.			
<b>UNIT III</b>			<b>12</b>
<b>ECONOMICS OF SELECTING ALTERNATES AND ITS BALANCES</b>			
Annual cost methods – Present worth method – Equivalent alternate – Rate of return and payment time – Cash flow analysis – Economic balance in batch operations – Cyclic operations and multiple equipment units.			
<b>UNIT IV</b>			<b>12</b>
<b>PROJECT DESIGN AND DEVELOPMENT</b>			
Choosing a project – Market survey – Importance of techno-economic viability studies – Sourcing of processes – Process alternatives – Fixing most economic processes – Technology – Scanning – Plant location principles – Plant lay out – Process flow sheets – Preparation of budgetary investment and production costs.			
<b>UNIT V</b>			<b>12</b>
<b>COST MANAGEMENT AND MARKETING</b>			
Concepts of management – Principles – Management functions – Scientific management – Advanced techniques management – Bar chart, CPM, Pert technique – Types of organizations – Merits and demerits. Concepts of Marketing – Need – Research – Sales forecasting – Product cycle – Fundamentals of labour management and industries relation.			
			<b>Total: 60</b>

#### TEXT BOOKS

1. Couper, J. R., “Process Engineering Economics”, CRC Press, 2003.
2. White, J. A., Case, K. and Prat, D., “Principles of Engineering Economics Analysis” 4<sup>th</sup> Edition, John – Wiley Publishers, 1997.

#### REFERENCES

1. Towler, G. and Sinnott, R. K., “Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design”, Elsevier, 2007.
2. Brown T., “Engineering Economics and Economic Design for Process Engineers”, CRC Press, 2007.
3. Peters, M. S and Timmerhaus, K. D., “Plant Design and Economics for Chemical Engineering”, 4<sup>th</sup> Edition, McGraw Hill, 1991.

## BT1352 – GENETIC ENGINEERING

L T P  
4 0 0

- UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY 12**  
Introduction to gene cloning – DNA manipulative enzymes – Restriction endonucleases; nomenclature – Restriction mapping of DNA – Ligation strategies.
- UNIT II CLONING VECTORS FOR *E.coli*, *B.subtilis*, YEAST, PLANTS AND ANIMAL CELLS 12**  
Plasmids, ss phage, ds phage, cosmid, phagemid and phasid – PAC and BAC vectors for *E. coli*, cloning vectors for *B.subtilis* – Ti plasmid based vectors for higher plants – Direct transfer of DNA into plants/plant cells and viral vectors for animals/animal cells.
- UNIT III CLONE IDENTIFICATION, DNA SEQUENCING AND DNA AMPLIFICATION 12**  
Introduction of rDNA into living cells – Screening and selection of recombinant clones, immunological screening – Studying the structure of clones by DNA sequencing – *In vitro* cloning by PCR, RFLP, RAPD; DNA chips – DNA fingerprinting techniques.
- UNIT IV APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY 12**  
Transgenic plants – Transgenic animals – Gene therapy – Gene silencing – Antisense RNA and siRNA technologies – Recombinant Proteins and pharmaceuticals.
- UNIT V PROTEIN PRODUCTION AND BIOSAFETY 12**  
Production of insulin, interferon and growth hormones – Biodegradable plastics – Safety guidelines lines for recombinant DNA techniques and waste disposal – Industrial and environmental application of recombinant DNA technology.

**Total: 60**

### TEXT BOOKS

1. Primrose, S. B. and Twymann, R. H., “Principles of Gene Manipulation: An Introduction to Genetic Engineering”, 6<sup>th</sup> Edition, Blackwell Scientific Publications, 2004.
2. Brown, T. A., “Gene Cloning and DNA Analysis”, 4<sup>th</sup> Edition, Blackwell Scientific Publications, 2003.

### REFERENCES

1. Glick, B. R. and Pasternak, J. J., “Molecular Biotechnology”, 3<sup>rd</sup> Edition, ASM Press, 2003.
2. Greene, J. J. and Rao V. B., “Recombinant DNA Principles and Methodologies”, CRC Press, 1998.
3. Watson J. D., “Recombinant DNA”, 2<sup>nd</sup> Edition, Scientific American Books, 1992.

## BT1353 – BIOPROCESS AND BIOREACTOR ENGINEERING

L T P  
4 0 0

### UNIT I HOMOGENEOUS REACTIONS 12

Basic reaction theory – Reaction thermodynamics – Reaction yield – Reaction rate – Reaction kinetics – Effect of temperature and pressure – Differential and integral methods of analysis – Reaction kinetics for biological systems- zero order – First order kinetics – Performance equation and graphical representation for batch, continuous reactors – Space time – Space velocity concepts.

### UNIT II HETEROGENEOUS REACTIONS 12

Heterogeneous reactions in bioprocessing – Concentration gradients and reaction rates in solid catalysts – Interaction between mass transfer and reaction – Steady state shell mass balance – Zero order kinetics and spherical geometry – Michaelis-Menten kinetics and spherical geometry – Thiele modulus and effectiveness factor

### UNIT III BIOREACTOR DESIGN 12

Background of bioreactors – Type of bioreactors – Airlift bioreactors – Airlift pressure cycle bioreactors – Loop bioreactor – Stirred tank bioreactors – Fluidized bed bioreactor – Trickle bed bioreactor – Bubble column fermenter – Design equations for CSTR fermenter – Monod model for a chemostat – Scale-up of stirred tank bioreactors – Two stage reactors – Reactors with non ideal mixing.

### UNIT IV MODELLING AND SIMULATION OF BIOPROCESSES 12

Study of structured models for analysis of various bioprocesses – Compartmental models, models of cellular energetic and metabolism – Single cell models – Plasmid replication and plasmid stability model – Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

### UNIT V FERMENTATION PROCESS CONTROL 12

Bioreactor controlling probes – Characteristics of bioreactor sensors – Temperature measurement and control – DO measurement and control – pH/redox measurement and control – Detection and prevention of the foam – Biosensors.

**Total: 60**

### TEXT BOOKS

1. Najafpour, G. D., "Biochemical Engineering and Biotechnology", Elsevier, 2007.
2. Doran, P.M., "Bioprocess Engineering Principles", Academic Press, 2005.

### REFERENCES

1. Dunn, I.J., Heinzle, E., Ingham J. and Prenosil, J.E., "Biological Reaction Engineering: Dynamic Modeling Fundamentals with Simulation Examples", 2nd Edition, Wiley-VCH, 2003.
2. Walker, J.M. and Rapley, R., "Molecular Biology and Biotechnology", 4th Edition, Royal Society of Chemistry, 2000.
3. Blanch, H. W. and Clark, D. S., "Biochemical Engineering", Marcel Dekker, Inc., 1999.
4. Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition, John Wiley, 1999.

## BT1354 – PROTEIN STRUCTURE, FUNCTION AND ENGINEERING

L T P  
4 0 0

### UNIT I BONDS AND ENERGIES IN PROTEIN MAKEUP 12

Covalent, ionic, hydrogen, coordinate, hydrophobic and van der Waals interaction in protein structure – Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure.

### UNIT II AMINO ACIDS AND THEIR CHARACTERISTICS 12

Amino acids and their molecular properties – Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups) and peptide synthesis.

### UNIT III PROTEIN ARCHITECTURE 12

Primary structure – Peptide mapping, peptide sequencing – Automated edman method and mass-specs – High-throughput protein sequencing setup – Secondary structure – Alpha, beta and loop structures and methods to determine – Super-secondary structure – Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down and TIM barrel structures nucleotide binding folds, prediction of substrate binding sites – Tertiary structure – Domains, folding, denaturation and renaturation – Overview of methods to determine 3D structures – Quaternary structure – Modular nature, formation of complexes.

### UNIT IV STRUCTURE-FUNCTION RELATIONSHIP 12

DNA-binding proteins – Prokaryotic transcription factors – Helix-turn-Helix motif in DNA binding – Trp repressor – Eukaryotic transcription factors – Zn fingers – Helix-turn-helix motifs in homeodomain – Leucine Zippers – Membrane proteins – General characteristics – Transmembrane segments – Prediction – Bacteriorhodopsin and photosynthetic reaction center – Immunoglobulins – IgG Light chain and heavy chain architecture – Abzymes and Enzymes – Serine proteases – Understanding catalytic design by engineering trypsin, chymotrypsin and elastase – Substrate-assisted catalysis other commercial applications.

### UNIT V PROTEIN ENGINEERING 12

Advantages and purpose – Overview of methods – Underlying principles with specific examples: thermal stability T4-lysozyme – Recombinant insulin to reduce aggregation and inactivation, de novo protein design.

**Total: 60**

### TEXT BOOKS

1. Petsko, G. A. and Ringe, D., “Protein Structure and Function”, New Science Press, 2004.
2. Branden, C. and Tooze, J., “Introduction to Protein Structures”, 2<sup>nd</sup> Edition, Garland Publishing, 1999.

### REFERENCES

1. Buxbaum, E., “Fundamentals of Protein Structure and Function”, Springer, 2007.
2. Primrose, S. B. and Twymann, R. H., “Protein Folding, Evolution and Design”, 2001.
3. Voet, D. and Voet, G., “Biochemistry”, 3<sup>rd</sup> Edition, John Wiley and Sons, 2001.

## BT1355 – GENETIC ENGINEERING LABORATORY

**L T P**  
**0 0 3**

### LIST OF EXPERIMENTS

1. Preparation of genomic DNA and amplification of gene
2. Ligation of DNA into plasmid vector (Construction of rDNA)
3. Primer design for PCR
4. DNA isolation and target gene amplification
5. Cloning the amplified product in His/Taq vector
6. Expression of target protein
7. Purification of expressed protein by IMAC (Immobilized Metal Affinity Chromatography)
8. Site directed mutagenesis of GFP gene.
9. Restriction mapping of  $\lambda$  DNA / clone
10. Southern Blotting

**Total: 45**

### DEMO (OPTIONAL)

1. Multiplex PCR – Pathogenic or non-pathogenic strain.
2. Inclusion bodies.

## BT1356 – BIOPROCESS LABORATORY II

**L T P**  
**0 0 3**

### **LIST OF EXPERIMENTS**

1. Batch sterilization design.
2. Estimation of KLa – Sulphite oxidation method.
3. Estimation of KLa – Power correlation method.
4. Residence time distribution
5. Biodegradation of phenol.
6. Biosynthesis of citric acid.
7. Biosynthesis of antibiotics.
8. Biosynthesis secretary proteases.
9. Ethanol fermentation.

**Total: 45**

### **DEMO (OPTIONAL)**

1. Solid state fermentation.
2. Lab scale fermentor and large scale fermentor.( Distillary industry)

## HS1301 – COMMUNICATION AND SOFT SKILLS LABORATORY

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Common to All Branches of III Year B.E./ B.Tech. students of Anna University Tiruchirappalli and affiliated colleges)

The aim of the course is two-fold: to enable the students to develop communication skills in the language laboratory and to arrange discussions for developing soft skills in the laboratory and/or the classroom. Each laboratory session shall last for three periods.

### **List of activities that are to be carried out: (15 sessions x 3 periods = 45)**

Lab session # 1: Listening and speaking practice exercises with communicative functions. Learning material: the ACD of Spoken English: A Foundation Course for Speakers of Indian Languages (Orient Longman, 2008)

Lab session # 2: Practice with more advanced communicative functions. Learning material: the ACD of Spoken English: A Foundation Course for Speakers of Indian Languages (Orient Longman, 2008)

Lab session # 3: Pronunciation exercises with Oxford Advanced Learners' Dictionary of Current English or any other standard Dictionary

Lab session # 4: Making an oral presentation in English. Learning Material: Professional Presentations VCD (Cambridge University Press)

Lab session # 5: Listening to telephone conversations in English and completing the tasks. Learning material: Essential Telephoning in English ACD (Cambridge University Press)

Lab session # 6: Giving an exposure to and practice with model group discussion and interviews. Learning material: How to Prepare for Group Discussion and Interview Audio Cassette (McGraw-Hill)

Lab session # 7: Giving insights into the format and the task types in the IELTS (International English Language Testing System). Learning Material: Objective IELTS, Intermediate Level (CUP)

Lab session # 8: Understanding the format and the task types in the TOEFL (Test of English as a Foreign Language). Learning Material: Understanding the TOEFL (Educational Testing Services, Princeton)

Lab session # 9: Administering the BEC (Business English Certificate) Diagnostic Test. Learning Material: BEC Practice Materials (British Council, Chennai)

Lab session # 10: Completing the steps involved in Career, Life Planning and Change Management. Learning Material: Developing Soft Skills (Pearson Education)

Lab session # 11: Setting goals and objectives exercises. Learning Material: Developing Soft Skills (Pearson Education)

Lab session # 12: Prioritizing and time planning exercises. Learning Material: Managing Time Multimedia Program CD

Lab session # 13: Taking a Personality Typing/ Psychometric Test Learning Material: 200 Psychometric Test prepared by the CUIC, Anna University Chennai.

Lab session # 14: Critical and creative thinking exercises.

Lab session # 15: Improving body language and cross-cultural communication with pictures. Learning material: Body Language (S. Chand and Co.)

For a detailed plan, refer to the topics given below:

## **UNIT I LISTENING AND SPEAKING PRACTICE IN COMMUNICATIVE FUNCTIONS**

Introductions and meetings – Talking about studies and/ or job – Expressing likes and dislikes – Describing daily routines and current activities – Talking about past states and events – Talking about future plans and intentions – Expressing preferences – Giving reasons – Expressing opinions, agreement and disagreement – Seeking and giving advice – Making suggestions

## **UNIT II SPEAKING APPLICATIONS**

Making an oral presentation – Preparing the presentation – Performing the presentation – Beginning – Language – Visual aids and body language – Voice – Ending – Questions – Telephone conversations – Group Discussion and Interview

## **UNIT III UNDERSTANDING AND PREPARING FOR INTERNATIONAL ENGLISH LANGUAGE EXAMINATIONS**

Graded Examinations in Spoken English (GESE) – Spoken English for Work (SEW) – International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Business English Certificate (BEC)

## **UNIT IV SOFT SKILLS (1)**

Preparing for and dealing with change – Motivation, goal-setting and self-esteem – Managing time and stress – Career and life planning – Team work – Leadership traits

## **UNIT V SOFT SKILLS (2)**

Multiple Intelligences – Learning Styles and Personality typing – Critical and creative thinking – People, cultures and self – Intercultural Communication

## **RESOURCES**

1. Kamalesh Sadanand and Susheela Punitha, “Spoken English: A Foundation Course” for Speakers of Indian Languages, Part 2 Audio CD, Hyderabad: Orient Longman, 2008.
2. Malcome Goodale, “Professional Presentations”, (VCD) Cambridge University Press, 2005.
3. Barbara Garside and Tony Garside, Essential Telephoning in English (Audio CD), Cambridge: Cambridge University Press, 2002.
4. Hari Mohan Prasad and Rajnish Mohan, How to Prepare for Group Discussion and Interview (Audio Cassette) Tata McGraw-Hill Publishing.
5. Graded Examinations in Spoken English and Spoken English for Work downloadable materials from Trinity College, London.
6. International English Language Testing System Practice Tests, CUP.
7. Business English Certificate Materials, Cambridge University Press.
8. Personality Development (CD-ROM), Times Multimedia, Mumbai.
9. Interactive Multimedia Programs on Managing Time and Stress.
10. Robert M. Sherfield and et al “Developing Soft Skills” 4th Edition, Pearson Education, 2009.

## ELECTIVES I

### BT1001 – NANOBIO TECHNOLOGY

**L T P**  
**3 0 0**

**UNIT I INTRODUCTION TO NANOTECHNOLOGY 9**  
Background and definition of Nanotechnology – Chemical bonds in Nanotechnology – Scales at the Bio-Nano Interface – Basic capabilities of nanobiotechnology and nanomedicine – Biological tradition and mechanical tradition biotechnology – Applications in biotechnology.

**UNIT II STRUCTURAL AND FUNCTIONAL PRINCIPLES OF BIONANOTECHNOLOGY 9**  
Biomolecular structure and stability – Protein folding – Self-assembly – Self-Organization – Molecular recognition – Flexibility – Information – Driven nanoassembly – Energetics – Chemical transformation – Regulation – Biomaterials – Biomolecular motors – Traffic across membranes – Biomolecular sensing – Self-replication – Machine-phase bionanotechnology.

**UNIT III MICROFLUIDICS MEETS NANO 9**  
Concepts and advantages of microfluidic devices – Materials and methods for the manufacture of microfluidic component – Fluidic structures – Surface modifications – Lab-on-a-Chip for biochemical analysis.

**UNIT IV PROTEIN-BASED NANOSTRUCTURES 9**  
S-Layers – Engineered nanopores – Microbial nanoparticle production – Magnetosomes – Nanoscale magnetic iron minerals in bacteria – Nanoparticle – Biomaterial hybrid systems.

**UNIT V DNA-BASED NANOSTRUCTURES 9**  
DNA-Protein nanostructures – Biomimetic fabrication of DNA based metallic nanowires and networks – DNA-Gold nanoparticle conjugates – Nanoparticles as non-viral transfection agents.

**Total: 45**

#### TEXT BOOKS

1. Niemeyer, C.M and Mirkin C.A., “Nanobiotechnology: Concepts, Applications, and Perspectives”, Wiley-VCH, 2004.
2. Goodsell, D.S., “Bionanotechnology” John Wiley and Sons, Inc., 2004.

#### REFERENCES

1. Shoseyov, O. and Levy, I., “Nanobiotechnology: Bioinspired Devices and Materials of the Future”, Humana Press, 2007.
2. Bhushan, B., “Springer Handbook of Nanotechnology” Springer-Verlag Berlin Heidelberg, 2004.
3. Freitas Jr R. A., “Nanomedicine”, 1<sup>st</sup> Edition, Volume II, Landes Biosciences, 2004.
4. Kohler, M. and Fritzsche, W., “Nanotechnology – An Introduction to Nanostructuring Techniques” Wiley-VCH, 2004.

## BT1002 – BIOCONJUGATE TECHNOLOGY

**L T P**  
**3 0 0**

### **UNIT I FUNCTIONAL TARGETS 9**

Modification of amino acids, peptides and proteins – Modification of sugars, polysaccharides and glycoconjugates – Modification of nucleic acids and oligonucleotides.

### **UNIT II CHEMISTRY OF ACTIVE GROUPS 9**

Amine reactive chemical reactions – Thiol reactive chemical reactions – Carboxylate reactive chemical reactions – Hydroxyl reactive chemical reactions – Aldehyde and ketone reactive chemical reactions – Photoreactive chemical reactions.

### **UNIT III BIOCONJUGATE REAGENTS 9**

Zero length cross linkers – Homobifunctional cross linkers – Heterobifunctional cross linkers – Trifunctional cross linkers – Cleavable reagent systems – Tags and probes.

### **UNIT IV ENZYME AND NUCLEIC ACID MODIFICATION AND CONJUGATION 9**

Properties of common enzymes – Activated enzymes for conjugation – biotinylated enzymes – chemical modification of nucleic acids – Biotin labeling of DNA enzyme conjugation to DNA – Fluorescent of DNA.

### **UNIT V BIOCONJUGATE APPLICATIONS 9**

Preparation of Hapten – Carrier immunogen conjugates – Antibody modification and conjugation – Immunotoxin conjugation techniques – Liposome conjugated and derivatives – Colloidal – Gold – Labeled proteins – Modification with synthetic polymers.

**Total: 45**

### **TEXT BOOKS**

1. Hermanson, G. T., “Bioconjugate Techniques”, 2<sup>nd</sup> Edition, Academic Press, 2008.
2. Meares, C. F., “Perspectives in Bioconjugate Chemistry”, American Chemical Society, 1993.

### **REFERENCES**

1. Schreiber, S., Kapoor, T. M. and Wess G., “Chemical biology: from small molecules to systems biology and drug design”, Vol. 2, Wiley-VCH, 2007.
2. Niemeyer, C. M., “Bioconjugation Protocols: Strategies and Methods” Springer, 2004.
3. Aslam, M. and Alastair, D., “Bioconjugation: Protein Coupling Techniques for the Biomedical Sciences”, Macmillan, 1998.

## BT1003 – PROCESS EQUIPMENT AND PLANT DESIGN

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- UNIT I HEAT EXCHANGERS, CONDENSERS, EVAPORATORS 9**  
Single and multi process exchangers – Double pipe – U-tube heat exchangers – Combustion details supporting structure – Single and vertical evaporation – Single and multi effect evaporators – Forced circulation evaporators.
- UNIT II STORAGE VESSEL FOR VOLATILE AND NON VOLATILE FLUIDS, PRESSURE VESSEL STRUCTURE 9**  
Design of the following equipments as per ASME, ISI codes – Drawing according to scale – monoblock and multiplayer vessels – Combustion details and supporting structure.
- UNIT III EXTRACTOR, DISTILLATION AND ABSORPTION TOWER 9**  
Construction details and assembly drawing – Plate and packed Extraction Towers – Plate and packed adsorption towers – Plate and packed distillation towers.
- UNIT IV PUMPS, MECHANICAL SEALS, VALVES AND SWITCHES 9**  
Various types of pumps – Principle of working – Construction, usages, advantages and disadvantages – Various types of seals – Effectiveness, usages – Pneumatic seals – Gate, globe and butterfly valves, their material of construction – Pneumatically controlled valves.
- UNIT V PIPING, PRINT LAY OUT AND DESIGN 9**  
Various types of piping – Material of construction, their usage – Pipe lay out – Modern plant design and case studies.

**Total: 45**

### TEXT BOOKS

1. Couper, J. R., Penney, W. R., Fair, J. R. and Walas, S., “Chemical Process Equipment: Selection and Design” 2<sup>nd</sup> Edition, Gulf Professional Publishing, 2005.
2. McCabe, W. L. and Smith, J. C., “Unit Operations in Chemical Engineering”, 6<sup>th</sup> Edition, McGraw Hill, 2003.

### REFERENCES

1. Sinnott, R. K., Coulson, J. M. and Richardson, J. F., “Coulson and Richardson's Chemical Engineering”, 4<sup>th</sup> Edition, Butterworth-Heinemann, 2005.
2. Peters, M. S., Timmerhaus, K. D. and West, R. E., “Plant design and economics for chemical engineers”, 5<sup>th</sup> Edition, McGraw-Hill Professional, 2003.
3. Kern, D. Q., “Heat Transfer”, McGraw Hill, 1985.

## BT1004 – SPECTROSCOPY FOR BIOTECHNOLOGY

**L T P**  
**3 0 0**

### **UNIT I ELECTRONIC SPECTRA 9**

Introduction of electronic spectra – Absorption spectra – Ultraviolet spectra of proteins – Nucleic acid spectra – Prosthetic groups – Difference spectroscopy – X-Ray absorption spectroscopy – Fluorescence and phosphorescence – RecBCD – Helicase activity monitored by fluorescence – Fluorescence energy transfer – A Molecular ruler-application of energy transfer to biological systems.

### **UNIT II CIRCULAR DICHROISM, OPTICAL ROTARY DISPERSION, AND FLUORESCENCE POLARIZATION 9**

Introduction - Optical rotary dispersion – Circular dichroism – Optical rotary dispersion and circular dichroism of proteins – Optical rotation and circular dichroism of nucleic acids – Small molecule binding to DNA – Protein folding – Interaction of DNA with zinc finger proteins – Fluorescence polarization – Integration of HIV genome into host genome and alpha – Ketoglutarate.

### **UNIT III VIBRATIONS IN MACROMOLECULES 9**

Introduction – Infrared spectroscopy – Raman spectroscopy – Structure determination with vibrational spectroscopy resonance Raman spectroscopy – Structure of enzyme-substrate complexes.

### **UNIT IV PRINCIPLES AND APPLICATIONS OF NUCLEAR MAGNETIC RESONANCE AND ELECTRON SPIN RESONANCE 9**

Introduction – NMR spectrometers – Chemical shifts – Spin-spin splitting – Relaxation times – Multidimensional NMR – Magnetic resonance imaging – Electron spin resonance – Regulation of DNA transcription – Protein – DNA interactions – Dynamics of protein folding – RNA folding – Lactose permease.

### **UNIT V MASS SPECTROMETRY 9**

Introduction – Mass analysis – Tandem Mass Spectrometry (MS/MS) – Ion detectors – Ionization of the sample – Sample preparation/analysis – Proteins and peptides – Protein folding – Other bio molecules.

**Total: 45**

### **TEXT BOOKS**

1. Hammes, G., “Spectroscopy for the Biological Sciences”, Wiley Publications, 2005.
2. Ramamoorthy, A., “NMR Spectroscopy of Biological Solids”, CRC Press, 2005.

### **REFERENCES**

1. Gremlich, H. and Yan, B., “Infrared and Raman Spectroscopy of Biological Materials”, CRC Press, 2000.
2. Larsen, B. S. and McEwen, C. N., “Mass spectrometry of Biological materials”, 2<sup>nd</sup> Edition, CRC Press, 1998.
3. Certaines, J. D., Bovée, W. M. M. J. and Podo, F., “Magnetic Resonance Spectroscopy in Biology and Medicine: Functional and Pathological Tissue Characterization”, Pergamon Press, 1992.

## ELECTIVES II

### BT1005 – BIOPHARMACEUTICALS

**L T P**  
**3 0 0**

#### **UNIT I PHARMACEUTICALS OF BIOLOGICAL ORIGIN 9**

Current status and future prospects of biopharmaceuticals – Pharmaceuticals of animal origin, plant origin and microbial origin – Sources of biopharmaceuticals.

#### **UNIT II DRUG DEVELOPMENT PROCESS 9**

Drug discovery – Gene chips – Proteomics – Structural genomics – Pharmacogenetics – Plant as a source of drugs – Microbial drugs – Pre-clinical trial – Pharmacokinetics and Pharmacodynamics – Toxicity studies – Clinical trial – Clinical trial design, trial size and study population – Randomized control studies.

#### **UNIT III GROWTH FACTORS AND HORMONES 9**

Haemopoietic growth factors – Granulocyte and macrophage colony stimulating factor – Insulin like growth factors – Epidermal growth factor – Platelet growth factor – Neurotrophic factors – Hormones of therapeutic interest – Insulin – Glucagon – Human growth hormones – Gonadotrophins.

#### **UNIT IV BLOOD PRODUCTS AND THERAPEUTIC ENZYMES 9**

Disease transmission – Whole blood – Platelets and red blood cells – Blood substitutes – Haemostasis – Antithrombin – Thrombolytic agents – Enzymes of therapeutic value.

#### **UNIT V ANTIBODIES, VACCINES, ADJUVANTS AND ANTI-SENSE TECHNOLOGY 9**

Polyclonal antibody – Monoclonal antibodies – Tumour immunology – Vaccine technology – Adjuvant technology – Anti-sense oligonucleotides – Uses, advantages and disadvantages of ‘oligos’ – Vitravene, an approved antisense agent – Antigene sequences and ribozymes.

**Total: 45**

### **TEXT BOOKS**

1. Walsh, G., “Pharmaceutical Biotechnology: Concepts and Applications”, 2<sup>nd</sup> Edition, John Wiley, 2007.
2. Crommelin, D. J. A., Sindelar, R. D. and Meibohm, B., “Pharmaceutical Biotechnology: Fundamentals and Applications”, 3<sup>rd</sup> Edition, Informa Health Care, 2007

### **REFERENCES**

1. Dutton, R. and Scharer, J., “Advanced Technologies in Biopharmaceutical Processing”, Blackwell Publishing, 2007.
2. Kayser, O. and Müller R. H., “Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications”, Wiley-VCH, 2004.
3. Walsh, G., “Biopharmaceuticals: Biochemistry and Biotechnology”, 2<sup>nd</sup> Edition, John Wiley, 2003.

## BT1006 – DEVELOPMENTAL BIOLOGY

**L T P**  
**3 0 0**

- UNIT I PRINCIPLES OF DEVELOPMENTAL BIOLOGY 9**  
Developmental anatomy – Mathematical modeling – Evolution of developmental patterns – Mosaic and regulative development – Pattern formation – Positional information – Stages of animal development – Experimental embryology.
- UNIT II SYMMETRY AND ORGANIZATION 9**  
Development and axis formation in vertebrates and invertebrates – Setting up the body axis – Dorsoventral and anteroposterior axis – Modes of axes determination – Origins of germ line and germ layers – Gamete formation – Early and later embryonic development.
- UNIT III GENETICS OF AXIS SPECIFICATION 9**  
Hox genes and homeotic genes – Positional information gradient – Gap genes – Segment polarity genes – Pair-rule of maintenance genes – Maternal and zygotic genes – Sex determination.
- UNIT IV OVERVIEW OF PLANT DEVELOPMENT 9**  
Plant life cycles – Gamete production in Angiosperms – Pollination – Fertilization – Embryonic – Development – Dormancy – Germination – Vegetative growth – Vegetative-to-reproductive transition – Senescence.
- UNIT V ENVIRONMENTAL REGULATION OF DEVELOPMENT 9**  
Regulation and disruption of normal development – Conditions of existence – Developmental correlation – Developmental constraints – Evolutionary developmental biology.

**Total: 45**

### TEXT BOOKS

1. Slack, J. M. W., “Essential Developmental Biology”, 2<sup>nd</sup> Edition, Wiley-Blackwell, 2006.
2. Hall, B. K., “Evolutionary developmental biology”, 2<sup>nd</sup> Edition, Birkhäuser, 1998.

### REFERENCES

1. Wolpert, L., Beddington, R., Jessell, T., Lawrence, P., Meyerowitz, E. and Smith, J., “Principles of Development”, 2<sup>nd</sup> Edition, Oxford University Press, 2002.
2. Gilbert, S. F., “Developmental Biology”, 5<sup>th</sup> Edition, Sinauer Associates, 1997.
3. Muller, W. A., “Developmental Biology”, Springer-Verlag, 1997.

## BT1007 – METABOLIC ENGINEERING

**L T P**  
**3 0 0**

### **UNIT I INTRODUCTION 9**

Introduction – Jacob Monod model – Catabolite regulation – Glucose effect – Camp deficiency – Feedback regulation – Regulation in branched pathways – Differential regulation by iso enzymes – Concerted feedback regulation – Cumulative feedback regulation – Amino acid regulation of synthesis – Energy charge regulation permeability control passive diffusion – Active group transportation.

### **UNIT II BIOSYNTESIS OF PRIMARY METABOLITES 9**

Alteration of feedback regulation – Limiting accumulation of end products – Feedback – Resistant mutants – Alteration of permeability – Metabolites.

### **UNIT III BIOSYNTHESIS OF SECONDARY METABOLITES 9**

Precursor effect propphase-niodiophase relationship – Enzyme induction – Feedback regulation – Catabolite regulation by passing control of secondary metabolism – Producer of secondary metabolites.

### **UNIT IV REGULATION OF ENZYME SYNTHESIS 9**

Specificity, yields, factors important to bioconversions – Regulation of enzyme synthesis – Mutation permeability – Co-metabolism – Avoidance of product inhibition – Mixed or sequential bioconversion – Conversion of insoluble substances.

### **UNIT V FERMENTATION DEVELOPMENT 9**

Strain selection – Recognizing growth cycle peak – Induction – Feedback repression – Catabolite repression – Mutants resistant to repression – Gene dosage.

**Total: 45**

### **TEXT BOOKS**

1. Nielsen, J. and Eggeling, L., “Metabolic Engineering”, Springer, 2001.
2. Lee, S. Y. and Papoutsakis, E. T., “Metabolic Engineering”, CRC Press, 1999.

### **REFERENCES**

1. Cortassa, S., “An Introduction to Metabolic and Cellular Engineering”, World Scientific, 2002.
2. Stanbury, P. F., Whitaker, A. and Hall S. J., “Principles of Fermentation Technology”, 2nd Edition, Pergamon Press, 1995.
3. Cruegar, W. and Cruegar, A., “Biotechnology – A Textbook of Industrial Microbiology”, 2nd Edition, Sinauer Associates, 1990.

## BT1008 – MOLECULAR PATHOGENESIS

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3 0 0  
9

### UNIT I OVERVIEW

Historical perspective – Discovery of microscope – Louis Pasteur’s contribution – Robert Koch’s postulates – Early discoveries of microbial toxins – Toxic assays, vaccines, antibiotics and birth of molecular genetics and modern molecular pathogenesis studies – Various pathogen types and modes of entry.

### UNIT II HOST DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES

Attributes and components of microbial pathogenesis – Host defense: skin, mucosa, cilia, secretions, physical movements – Limitation of free iron – Antimicrobial compounds – Mechanism of killing by humoral and cellular defense mechanisms – Complements – Inflammation process – General disease symptoms – Pathogenic adaptations to overcome the above defenses.

### UNIT III MOLECULAR PATHOGENESIS

Virulence – Virulence factors – Molecular genetics and gene regulation in virulence of pathogens – *Vibrio cholerae* – Cholera toxin, co-regulated pili, filamentous phage, survival. *E.coli* pathogens – Enterotoxigenic *E. coli* (ETEC), Entero-pathogenic *E. coli* (EPEC), Enterohaemorrhagic *E. coli* (EHEC), Enteroaggregative *E. coli* (EAEC). *Shigella* – Entry, macrophage apoptosis, induction of macropinocytosis, uptake of epithelial cells, intracellular spread, inflammatory response, tissue damage – Plasmodium – Life cycle and its processes to support the rapidly growing schizont, parasitiparous vacuoles and knob protein transport, antimalarials based on transport processes – Influenza virus – Intracellular stages, neuraminidase and haemagglutinin in entry, M1 and M2 proteins in assembly and disassembly, action of amantidine.

### UNIT IV EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS

Virulence assays – Adherence, invasion, cytopathic, cytotoxic effects – Criteria and tests in identifying of virulence factors, attenuated mutants – Molecular characterization of virulence factors – Signal transduction and host responses.

### UNIT V MODERN APPROACHES TO CONTROL PATHOGENS

Classical approaches based on serotyping – Modern diagnosis based on highly conserved virulence factors, immune and DNA based techniques – New therapeutic strategies based on recent findings on molecular pathogenesis of a variety of pathogens, vaccines – DNA, subunit and cocktail vaccines.

**Total: 45**

### TEXT BOOKS

1. Gyles, C. L., Prescott, J. F., Songer, J. G. and Thoen C. O., “Pathogenesis of bacterial infections in animals”, 3<sup>rd</sup> Edition, Wiley-Blackwell, 2004.
2. McClane, B. A. and Mietzner, T. A., “Microbial Pathogenesis: A Principles Oriented Approach”, Fence Creek Publishers, 1999.

### REFERENCES

1. Groisman, E. A., “Principles of Bacterial Pathogenesis”, Academic Press, 2001.
2. Wagner, E. K. and Hewlett, M. J., “Basic Virology”, Blackwell Science, 1999.
3. Sirica, A. E., “Cellular and Molecular Pathogenesis”, Lippincott-Raven, 1996

## SEMESTER VII

### BT1401 – BIOETHICS AND BIOSAFETY

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4	0	0

#### UNIT I HUMAN VALUES 12

Moral values and ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Value time – Co-operation – Commitment – Empathy – Self confidence – Character – Spirituality.

#### UNIT II BIOETHICS 12

Ethics in biotechnology – Business ethics – Positive and Negative effects – Senses of bioethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral autonomy – Kohlberg's theory – Gilligan's theory – Consensus and controversy – Models of Professional Roles – Theories about right action – Self-interest – Customs and religion – Uses of ethical theories.

#### UNIT III BIOSAFETY 12

Biosafety regulations national and international guidelines – rDNA guidelines – IBSC guidelines and its scope – Bio-safety levels, bio-safety guidelines, characterization of the organisms – Effects of pathogenicity, toxigenicity, allergenicity – Substantial equivalence – Effects related to gene transfer and marker genes – Ecological effects – Field testing of genetically modified organism - Field trials.

#### UNIT IV GLOBAL ISSUES 12

Multinational corporations – Environmental ethics – Computer ethics – Weapons development – Engineers as managers – Consulting engineers as expert witness and advisors – Moral leadership – Sample code of Ethics.

#### UNIT V INTELLECTUAL PROPERTY RIGHTS 12

Intellectual property rights – Origin of the patent regime – Early patents act and Indian pharmaceutical industry – Types of patents – Patent requirements – Application preparation, filing and prosecution – Patentable subject matter – TRIPS agreement – Requirements of TRIPS – Implementation in developing countries.

**Total: 60**

#### TEXT BOOKS

1. Shaleesha, A. S., "Bioethics", Wisdom Educational Service, 2008.
2. Nap, J. P., Atanasov, A. I. and Stiekema, W. J., "Genomics for Biosafety in Plant Biotechnology", IOS Press, 2003.

#### REFERENCES

1. Taylor, F. W., "The Principles of Scientific Management", Cosimo Classics, 2006.
2. Birgitte, A., "Intellectual Property Rights: Innovation, Governance, and the Institutional Environment", Edward Elgar Publishing, 2006.
3. Hambleton, P., Melling, J. and Salusbury, T. T., "Biosafety in industrial biotechnology", Springer, 1994.

## BT1402 – DOWNSTREAM PROCESSING

**L T P**  
**4 0 0**

### **UNIT I                      DOWNSTREAM PROCESSING                      12**

Introduction to downstream processing – Stages of downstream processing – Basic principles of engineering analysis – Process and product quality – Cell disruption for product release – Mechanical and chemical methods – Flocculation – Electrical double layer – Flocculation rate – Polymer flocculants.

### **UNIT II            PHYSICAL METHODS OF SEPARATION                      12**

Filtration – Conventional filtration – Cross flow filtration – Filter media and equipment – Membrane fouling – Centrifugation – Tubular bowl centrifugation – Disk centrifuge and ultracentrifugation.

### **UNIT III           ISOLATION OF PRODUCTS                                      12**

Extraction – Phase separation and partition equilibria – Countercurrent stage calculations – Aqueous two-phase extraction – Membrane separation – Ultra filtration and reverse osmosis – Dialysis – Precipitation of proteins by different methods.

### **UNIT IV           PRODUCT PURIFICATION    12**

Adsorption – Fixed-bed adsorption, agitated bed adsorption – Adsorbent types – Silica based resins – Polymer based resins – Chromatographic techniques – Principles and practice – Reversed-phase – Ion-exchange – Size exclusion – Hydrophobic interaction – Affinity and immobilized metal affinity.

### **UNIT V            FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS   12**

Crystallization – Principles, batch crystallizers, process crystallization of proteins – Drying – Water in biological solids and in gases – Lyophilisation in final product formulation.

**Total: 60**

### **TEXT BOOKS**

1. Harrison, R.G., Todd, P., Rudger, S.R. and Petrides, D.P., “Bioseparation Science and Engineering”, Oxford University Press, 2003.
2. Belter, P.A., Cussler, E.L. and Wei, S.H., “Bioseparation - Downstream Processing for Biotechnology”, Wiley Interscience Publication, 1988.

### **REFERENCES**

1. Desai, M.A., “Downstream Processing of Proteins: Methods and Protocols” Springer, 2000.
2. Garcia, A. A., “Bioseparation Process Science”, Wiley-Blackwell, 1999.
3. Asenjo, J.A., “Separation Processes in Biotechnology”, CRC Press, 1990.

## BT1403 – COMPUTATIONAL BIOLOGY

L T P  
4 0 0

### UNIT I COMPUTER AND OPERATING SYSTEM 12

Introduction to shell programming – Linux – Windows – Mac OS X – VM ware – Cyg Win – Sed, Awk – Perl and Bioperl.

### UNIT II BIOLOGICAL DATABASES AND DATA IMPORT 12

Biological databases – XML, HTML and CML – Bioinformatics Toolbox – Sim biology – FASTA, PDB, SCF, SBML, Affymetrix, GenePix and ImaGene – Retrieving data from online databases – MathWorks products for computational biology – GenBank, EMBL, NCBI BLAST and PDB.

### UNIT III ANALYSING AND VISUALIZING DATA 12

Sequence analysis – Microarray analysis – Mass spectrometry analysis – Biomarkers in MALDI or SELDI mass spectrometry – Cellular and molecular Imaging – Systems biology – Physiological modelling.

### UNIT IV SEQUENCE ASSEMBLY 12

Shotgun sequencing – Sequencing by hybridization – DNA and protein sequence analysis – Tree representation of a sequence – Sequence comparison – Hashing and statistical content.

### UNIT V SEQUENCE ALIGNMENT 12

Multiple sequence alignment – Hidden markov models – RNA secondary structures – Combinatorics – Trees and sequences.

**Total: 60**

### TEXT BOOKS

1. Wunschiers, R., “Computational Biology”, Springer Verlag Publications, 2004.
2. Waterman, M.S., “Introduction to Computational Biology: Maps, Sequence and Genomes”, CRC Press, 1995.

### REFERENCES

1. Srinivas, A., “Handbook of Computational Molecular Biology”, CRC Press, 2006.
2. Jiang, T. and Xu, Y., “Current Topics in Computational Molecular Biology”, MIT Press, 2002.
3. Pevzner, P., “Computational Molecular Biology: an Algorithmic Approach”, Second Edition, MIT Press, 2000.

## BT1404 – IMMUNOLOGY

**L T P**  
**4 0 0**

### **UNIT I INTRODUCTION 12**

Cells of immune system – Innate and acquired immunity – Primary and secondary lymphoid organs – Antigens – Chemical and molecular nature – Haptens – Adjuvants – Types of immune responses – Theory of clonal selection.

### **UNIT II CELLULAR RESPONSES 12**

Development, maturation, activation and differentiation of T-cells and B-cells – TCR – Antibodies – Structure and functions – Antibodies – Genes and generation of diversity – Antigen-antibody reactions – Monoclonal antibodies – Principles and applications – Antigen presenting cells – Major Histocompatibility Complex (MHC) – Antigen processing and presentation – Regulation of T-cell and B-cell responses.

### **UNIT III INFECTION AND IMMUNITY 12**

Injury and inflammation – Immune responses to infections – Immunity to viruses, bacteria, fungi and parasites – Cytokines – Complement – Immunosuppression – Tolerance – Allergy and hypersensitivity – AIDS and Immunodeficiencies – Resistance and immunisation – Vaccines.

### **UNIT IV TRANSPLANTATION AND TUMOR IMMUNOLOGY 12**

Transplantation – Tests for histocompatibility – Prolongation of grafts – Tumor immunology – Tumor antigens – Tumor immune response – Tumor Immunodiagnosis – Tumor Immunotherapy.

### **UNIT V IMMUNOTECHNOLOGY 12**

Monoclonal antibodies – Production and characterization – Application of PCR technology to produce antibodies and other immunological reagents immunotherapy with genetically engineered antibodies – Western blot analysis – Immunoelectrophoresis – SDS-PAGE – Purification and synthesis of antigens – ELISA and Radioimmunoassay (RIA) – Principles and applications.

**Total: 60**

### **TEXT BOOKS**

1. Goldsby R. A., Kindt T. J., Osborne B. A. and Kuby J., “Immunology”, 5<sup>th</sup> Edition, Freeman and Company, 2003.
2. Roitt, I., Brostoff J. and Male, D., “Immunology”, 6<sup>th</sup> Edition, Mosby Publishers, 2001.

### **REFERENCES**

1. Chakravarty, A. K., “Immunology and Immunotechnology”, Oxford University Press, 2006.
2. Male, R.I. and Brostoff, J., “Immunology”, Mosby Publications, 2002.
3. Kuby, J., “Immunology”, W.H. Freeman and Co., 2000.
4. Benjamini, E., Sunshine, G. and Leskowitz S., “Immunology: A Short Notes”, 3<sup>rd</sup> Edition, Wiley-Liss, 1996.

## BT1405 – DOWNSTREAM PROCESSING LABORATORY

L	T	P
0	0	3

### LIST OF EXPERIMENTS

1. Solid liquid separation – Centrifugation, dialysis.
2. Cell disruption techniques – Ultrasonication, lysozyme EDTA for bacteria.
3. Cell disruption techniques – Osmolysis for RBC.
4. Precipitation – Ammonium sulphite precipitation
5. Aqueous two phase extraction of biologicals
6. High resolution purification – Affinity chromatography (Dye affinity)
7. High resolution purification – Ion exchange chromatography.
8. Product polishing – Gel filtration chromatography.
9. Product polishing – Freeze drying.
10. Isoelectric precipitation of casein.

**Total: 45**

### DEMO (OPTIONAL)

1. Disruption of plant cells.
2. Crystallization of urease from Jack bean meal.

## BT1406 – COMPUTATIONAL BIOLOGY LABORATORY

L	T	P
0	0	3

### LIST OF EXPERIMENTS

1. Study of Internet resources in Computational Biology.
2. Internet protocols.
3. Basic Programming Tags with XML, HTML and CML.
4. Algorithm used in Data Base.
5. BLAST.
6. FASTA.
7. Prediction of DNA sequence.
8. Prediction of protein sequence.
9. Perl.
10. Bioperl.

**Total: 45**

### DEMO (OPTIONAL)

1. Phylogenetic analysis.
2. Shell Programming.

## **BT1407 – IMMUNOLOGY LABORATORY**

**L T P**  
**0 0 3**

### **LIST OF EXPERIMENTS**

1. Identification of cells in a blood smear.
2. Identification of blood group.
3. Pregnancy, ASO and RPR.
4. Immunodiffusion & immunoelectrophoresis.
5. Testing for typhoid antigens by Widal test.
6. Enzyme Linked Immuno Sorbent Assay (ELISA).
7. Isolation of peripheral blood mononuclear cells.
8. Isolation of monocytes from blood.
9. Identification of T-cells by T-cell rosetting using sheep RBC.
10. Lymphocyte proliferation in-vitro.

**Total: 45**

### **DEMO (OPTIONAL)**

1. Handling of animals, immunization and raising antisera.
2. Immunofluorescence.

## SEMESTER VIII

### MG1352 – TOTAL QUALITY MANAGEMENT

**L T P**  
**4 0 0**

#### **UNIT I INTRODUCTION 12**

Definition of quality – Dimensions of quality – Quality planning – Quality costs – Analysis techniques for quality costs – Basic concepts of total quality management – Historical review – Principles of TQM – Leadership – Concepts – Role of senior management – Quality council – Quality statements – Strategic planning – Deming Philosophy – Barriers to TQM implementation.

#### **UNIT II TQM PRINCIPLES 12**

Customer satisfaction – Customer perception of quality – Customer complaints – Service quality – Customer retention – Employee involvement – Motivation, empowerment, teams, recognition and reward – Performance appraisal – Benefits – Continuous process improvement – Juran trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering and sourcing – Supplier selection – Supplier Rating – Relationship development – Performance measures – Basic concepts – Strategy – Performance measures.

#### **UNIT III STATISTICAL PROCESS CONTROL (SPC) 12**

The seven tools of quality – Statistical fundamentals – Measures of central tendency and dispersion – Population and sample – Normal curve – Control charts for variables and attributes – Process capability – Concept of six sigma – New seven management tools.

#### **UNIT IV TQM TOOLS 12**

Benchmarking – Reasons to Benchmark – Benchmarking process – Quality function deployment (QFD) – House of quality – QFD process – Benefits – Taguchi quality loss function – Total productive maintenance (TPM) – Concept, improvement needs – FMEA – Stages of FMEA.

#### **UNIT V QUALITY SYSTEMS 12**

Need for ISO 9000 and other quality systems, ISO 9000:2000 – Quality system – Elements – Implementation of quality system – Documentation – Quality auditing – QS 9000, ISO 14000 – Concept, requirements and benefits.

**Total: 60**

#### **TEXT BOOKS**

1. Kanishka, B., “Quality Management”, Oxford University Press, 2007.
2. Ross, J. E. and Perry, S., “Total Quality Management: Text, Cases and Readings”, 3<sup>rd</sup> Edition, CRC Press, 1999.

#### **REFERENCES**

1. Oakland, J. S., “Total Quality Management: Text with Cases”, 3<sup>rd</sup> Edition, Butterworth Heinemann, 2003.
2. Evans, J. R. and Lidsay W. M., “The Management and Control of Quality”, 5<sup>th</sup> Edition, South-Western (Thomson Learning), 2002.
3. Dale H. B., “Total Quality Management”, Pearson Education Asia, 1999.

## **BT1455 – PROJECT WORK**

**L T P**  
**0 0 12**

The project may be considered as the ultimate exercise presented to the final semester student before graduation to measure accumulated engineering knowledge and experience. At the same time, the project itself should provide the students with some new skills, innovation and information, and strengthen the acquired ones.

The project programme consists of different assignment, allotted time, submission of report under internal faculty guidance and evaluation by external member along with internal faculty.

The activities performed during a project may cover one or more of the following:

- Data collection
- Critical literature review
- Laboratory experiments and tests
- Mathematical modeling
- Software application
- Industrial visits
- Design and/or assembly
- Process analysis

The topic project may be assigned to individual student. The project topic allotted may be of theoretical, experimental or industrial projects to be carried out under the supervision of internal guide and external guide (in case of industrial projects).

The projects are to be executed strictly as per the project schedule prepared during VIII semester. A committee of departmental faculty members comprising the project guide, one more faculty member and the head of department will monitor and review the progress achieved by the student at various stages. The internal assessment will be done by the committee based on the progress achieved on completion of the project work.

On completion of the project work, each student has to prepare a project report and submit the same in triplicate to the department. The project work and the report will be evaluated by the internal assessment committee for a total of 100 marks. The external university examination, which carries a total of 100 marks, will have report evaluation and viva voce examination conducted by a committee of one external examiner and one internal examiner appointed by the university.

## ELECTIVES III

### BT1009 – ENVIRONMENTAL BIOTECHNOLOGY

**L T P**  
**3 0 0**

#### **UNIT I BIOGEOCHEMICAL ROLE OF SOIL MICROORGANISMS 9**

Microbial flora of soil – Interactions among soil microorganisms – Nitrogen cycle – Carbon cycle, Sulfur cycle – Phosphorous cycle.

#### **UNIT II BIODEGRADATION 9**

Aerobic degradation of recalcitrant organic compounds by microorganisms – Growth associated degradation of aliphatic – Diversity of aromatic compounds – Co-metabolic degradation of organopollutants – Degradative capacities of fungi.

Anaerobic degradation of organic compounds – Degradation of hydrocarbons – Alkyl compounds – ketones – Aromatic compounds – Halogenated organics – Sulfonates – Nitroorganics.

#### **UNIT III BIOREMEDIATION TECHNOLOGIES 9**

Remediation technologies – Bioventing – Biosparging and bioslurping – Phytoremediation, Biodesulphurization of coal and oil – Microbial transformation of heavy metals – Bioleaching, bioaccumulation – Biosorption and bioprecipitation of heavy metals.

#### **UNIT IV ECO-FRIENDLY BIOPRODUCTS FROM RENEWABLE SOURCES 9**

Fundamentals of composting process – Composting technologies – Composting systems – Compost quality – Biofertilizers – Biopesticides – Scientific aspects and prospects of biofuel production – Bioethanol – Biohydrogen and biodiesel.

#### **UNIT V BIOLOGICAL TREATMENT OF WASTEWATER 9**

Biological processes for wastewater treatment – Physico-chemical characteristics of wastewater – Activated sludge process – Trickling filter – Rotating biological contactors – Fluidized bed reactor – Upflow anaerobic sludge blanket reactor (UASB) – High-rate anaerobic wastewater treatment – Comparison between aerobic and anaerobic processes.

**Total: 45**

#### **TEXT BOOKS**

1. Jordening, H. J. and Winter, J., “Environmental Biotechnology: Concepts and Application”, Wiley-VCH Verlag, 2005.
2. Evans, G. M. and Furlong, J. C., “Environmental Biotechnology: Theory and Application”, John Wiley and Sons, 2003.

#### **REFERENCES**

1. Bhattacharya, B. C. and Banerjee, R., “Environmental Biotechnology”, Oxford University Press, 2007.
2. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R., “Microbiology”, Tata McGraw-Hill, 2005.
3. Rittmann, B. E. and McCarty, P. L., “Environmental Biotechnology: Principles and Applications”, McGraw-Hill, 2001.

## **BT1010 – PLANT AND ANIMAL BIOTECHNOLOGY**

**L T P**  
**3 0 0**

### **UNIT I INTRODUCTION 9**

Scope of plant and animal biotechnology – Structure and function of mitochondria – Light and dark reaction - Genetic material – Rubisco synthesis and assembly – Coordination, regulation and transport of proteins – Mitochondria Genome, cytoplasmic male sterility and import of proteins – Animal biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins.

### **UNIT II AGROBACTERIUM AND PLANT VIRUSES 9**

Pathogenesis – Crown gall disease – Genes involved in the pathogenesis – Ti plasmid – T-DNA – Importance in genetic engineering – Plant viruses and different types – Viral Vectors – Gemini virus – Cauliflower mosaic virus – Benefits of viral vectors – Molecular diagnosis of plant diseases.

### **UNIT III CELL CULTURE TECHNOLOGY 9**

Culturing of cells – Primary and secondary cell lines – Cell culture – Scaling up of animal cell culture – Monolayer culture – Suspension culture – Various bioreactors used for animal cell culture – Roller bottle culture – Bioreactor process control – Stirred Animal Cell Culture – Air Lift Fermenter – Chemostat – Turbidostat – High technology vaccines – Hybridoma technology – Cell lines and their applications.

### **UNIT IV GENETIC ENGINEERING 9**

Biology of animal viral vectors – SV40, adeno virus, retrovirus, vaccinia virus, herpes virus and baculo virus. Gene therapy – Prospects and problems – Knockout mice and mice model for human genetic disorder – Baculo virus in bio-control – Enzymes technology – Somatic manipulation of DNA – Nucleic acid hybridization and probes in diagnosis – Preparation of probes evaluation and applicators.

### **UNIT V APPLICATIONS 9**

Outline of plant tissue culture – Transgenic plants – Herbicide and pest resistant plants – Molecular pharming – Therapeutic products – Functional genomics – Whole genome sequencing project eg. Arabidopsis, RNAi.

Rumen manipulation – Probiotics – Embryo transfer technology – In vitro fertilization – Transgenesis methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods – Biopharming transgenic animals (Mice Cows, Pigs, Sheep, Goat, Buds and Insects) – Artificial insemination and embryo transfer.

**Total: 45**

**TEXT BOOKS**

1. Chawla, H. S., "Introduction to Plant Biotechnology", Science Publishers, 2002.
2. Chirikjian, J. G., "Biotechnology: Plant Biotechnology, Animal Cell Culture, Immunobiotechnology", Jones and Bartlett Publishers, 1995.

**REFERENCES**

1. Srivastava, S., Narula, A. and Bhojwani, S. S., "Plant Biotechnology and Molecular markers", Springer, 2004.
2. Glick, B. R. and Pasternack, J. J., "Molecular Biotechnology", 3rd Edition, ASM Press, 2003.
3. Holland, A. and Johnson, A., "Animal Biotechnology and Ethics", Springer, 1998.

## BT1011 – GENOMICS AND PROTEOMICS

**L T P**  
**3 0 0**

### **UNIT I OVERVIEW OF GENOME OF BACTERIA, ARCHAE AND EUKARYOTA 9**

Organisation of genes – Coding, non-coding chromosomes and high order structures – Genomes relatedness.

### **UNIT II PHYSICAL MAPPING TECHNIQUES 9**

Top down and bottom up approach – Linking and jumping of clones – Genome sequencing – Placing small fragments on map – STS assembly – Gap closure – Pooling strategies – Cytogenetic mapping techniques.

### **UNIT III FUNCTIONAL GENOMICS 9**

Gene finding – Annotation – ORF and functional prediction – Subtractive DNA library screening – Differential display and representational difference analysis – SAGE – TOGA.

### **UNIT IV PROTEOMICS TECHNIQUES 9**

Protein level estimation – Edman protein microsequencing – Protein cleavage – 2D gel electrophoresis – Metabolic labeling – Detection of proteins on SDS gels – Pattern analysis – Mass spectrometry – Principles of MALDI-TOF – Tandem MS-MS – Peptide mass fingerprinting.

### **UNIT V PROTEIN PROFILING 9**

Post translational modification – Protein-protein interaction – Glycoprotein analysis – Phosphoprotein analysis.

**Total: 45**

### **TEXT BOOKS**

1. Primrose, S.B. and Twyman, R.H., “Principles of Genome Analysis and Genomics”, Blackwell Publishing Co., 2003.
2. Liebler, D.C., “Introduction to Proteomics”, Humana Press, 2002

### **REFERENCES**

1. Pennington, S.R. and Dunn, M.J., “Proteomics”, BIOS Scientific Publishers, 2001.
2. Hunt, S.P., Livesey, R. and Livesey, F.J., “Functional Genomics: A Practical Approach” Oxford University Press, 2000.
3. Suhai S., “Genomics and Proteomics: Functional and Computational Aspects”, Springer, 2000.
4. Cantor, C.R. and Smith, C.L., “Genomics: The Science and Technology behind the Human Genome Project”, Wiley and Sons, 1999.

## BT1012 – MOLECULAR MODELING AND DRUG DESIGN

**L T P**  
**3 0 0**

### **UNIT I INTRODUCTION TO CLASSICAL MECHANICS 9**

Newtons laws of motion – Time intervals – Algorithms.

### **UNIT II INTRODUCTION TO STATISTICAL MECHANICS 9**

Boltzman's Equation – Ensembles – Distribution law for non interacting molecules – Statistical mechanics of fluids.

### **UNIT III QUANTUM MECHANICS 9**

Photoelectric effect – De Broglies hypothesis – Uncertainty principle – Schrodingers time independent equation – Particle on a one-dimensional box.

### **UNIT IV GROMOS, GROMACS, AMBER AND DOCK 9**

Energy mitigation, application of fourier transformer – Force fields – Principal components analysis –RMSD calculation – Application – Dynamics of molecules – Concepts of paralyzing work.

### **UNIT V GAUSSIAN 98 9**

Methods – Basic sets – Model chemistrix – Inputs – Outputs – Uses.

**Total: 45**

### **TEXT BOOKS**

1. Hinchliffe, A, "Molecular Modeling for Beginners" John Wiley and Sons, 2003.
2. Larsen, P.K. and Liljefors, T., "Textbook of Drug Design and Discovery" 3<sup>rd</sup> Edition, CRC Press, 2002.

### **REFERENCES**

1. Holtje, H.D., Wolfgang, S., Folkers, G. and Rognan, D., "Molecular Modeling: Basic Principles and Applications" 22<sup>nd</sup> Edition, Wiley-VCH, 2003.
2. Flower, D.R., "Drug Design: Cutting Edge Approaches" 2<sup>nd</sup> Edition, Royal Society of Chemistry, 2002.
3. Cohen N. C., "Guide Book on Molecular Modeling in Drug Design", Academic Press, 1996.

## ELECTIVES IV

### BT1013 – CANCER BIOLOGY

**L T P**  
**3 0 0**

#### **UNIT I FUNDAMENTALS OF CANCER BIOLOGY 9**

Regulation of cell cycle – Mutations that cause changes in signal molecules – Effect on receptor – Signal switches – Tumor suppressor genes – Modulation of cell cycle in cancer – Different forms of cancers, diet and cancer – Cancer screening and early detection – Detection using biochemical assays – Tumor markers – Molecular tools for early diagnosis of cancer.

#### **UNIT II PRINCIPLES OF CARCINOGENESIS 9**

Theory of carcinogenesis – Chemical carcinogenesis – Metabolism of carcinogenesis – X-ray radiation – Mechanism of radiation carcinogenesis.

#### **UNIT III PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER 9**

Signal targets and cancer – Activation of kinases – Oncogenes – Identification of oncogenes – Retroviruses and oncogenes – Detection of oncogenes – Oncogenes/proto oncogene activity – Growth factors related to transformation – Telomerases.

#### **UNIT IV PRINCIPLES OF CANCER METASTASIS 9**

Clinical significances of invasion – Heterogeneity of metastatic phenotype – Metastatic phenotype – Metastatic cascade – Basement membrane disruption – Three step theory of invasion – Proteinases and tumor cell invasion.

#### **UNIT V NEW MOLECULES FOR CANCER THERAPY 9**

Different forms of therapy – Chemotherapy – Radiation therapy – Detection of cancers – Prediction of aggressiveness of cancer – Advances in cancer detection – Use of signal targets towards therapy of cancer.

**Total: 45**

#### **TEXT BOOKS**

1. Weinberg, R. A., “The Biology of Cancer”, Taylor and Francis, Garland Science, 2007.
2. Pelengaris, S. and Khan, M., “The Molecular Biology of Cancer”, Blackwell Publishing, 2006.

#### **REFERENCES**

1. Macdonald, F. and Ford, C. H. J., “Molecular Biology of Cancer”, BIOS Scientific Publication, 1997.
2. King, R. J. B., “Cancer Biology”, Addison Wesley Longman, 1996.
3. Ruddon, R. W., “Cancer Biology”, 2<sup>nd</sup> Edition, Oxford University Press, 1995.

## BT1015 – CRYOPRESERVATION IN BIOTECHNOLOGY

**L T P**  
**3 0 0**

### **UNIT I PRINCIPLES OF LARGE SCALE CRYOPRESERVATION 9**

Principles in the freezing and thawing of cells – Intracellular ice formation – Freeze thaw phenomena – Cryoconcentration effects – Osmotic effects – Cell concentration effects – Cell Damage by mechanical stress and freeze thaw cycles – Physicochemical phenomena of the freezing process – Estimate and analysis of freezing and melting process.

### **UNIT II LARGE SCALE FREEZING AND THAWING 9**

Freezing – Thermodynamics of Protein cold denaturation – Dendritic ice growth – Concentration phenomena – Interaction of solutes with ice liquid interface – Media used in bioseparations – Operational considerations of purification methods – Systems validation – Media validation – Cleaning validation.

### **UNIT III LYOPHILIZATION OF PROTEIN PHARMACEUTICALS 9**

The freeze drying cycle – Optimization of formulations, freezing step, primary and secondary drying – Functional limitations of lyophilizers – Acute stabilization of proteins during freezing and drying – Optimizing formulations for long term storage stability.

### **UNIT IV CRYOPRESERVATION OF MAMMALIAN CELLS AND MICROORGANISMS 9**

Procedures for the preservation of mammalian cells – Cryoprotectant additives – Preparing cells to freeze – Cooling – Recovery – Procedures for the preservation of bacteria and virus infected cells – Safety issues.

### **UNIT V CRYO PRESERVATION TECHNIQUES 9**

Overview of cryopreservation techniques – Deep freeze – Lyophilization – Biological cooling system – Germplasm storage – Packaging of biological materials.

**Total: 45**

### **TEXT BOOKS**

1. Avis, K.E. and Wagner, C.M., “Cryopreservation: Applications in Pharmaceuticals and Biotechnology”, Informa Health Care, 1999.
2. Avis, K.E. and Wu, V.L., “Biotechnology and Biopharmaceutical Manufacturing, Processing, and Preservation”, CRC Press, 1996

### **REFERENCES**

1. Day, J.G. and Stacey, G.N., “Cryopreservation and Freeze-Drying Protocols”, 2nd Edition, Humana Press, 2007.
2. Arora, C.P., “Refrigeration and Air-conditioning”, 2nd Edition, Tata McGraw Hill, 2000.
3. Bajaj. Y. P. S., “Cryopreservation of Germplasm I”, Birkhauser, 1995.

## BT1014 – BIOSENSORS AND TRANSDUCERS

**L T P**  
**3 0 0**

### **UNIT I BIOLOGICAL SENSORS 9**

Study of biological sensors in the human body and their basic mechanism action organization of nervous system – Neuronal mechanism and circuit processing – Study of various corpuscles like pacinian – Functions and modeling – Chemoreceptors – Hot and cold receptors – Barro receptors – Sensors for smell, sound, vision, osmolality and taste.

### **UNIT II CHEMICAL TRANSDUCERS 9**

Chemical Transducers – Transducers for the measurement of ions and dissolved gases – Reference electrodes – Hydrogen electrodes – Silver-silver chloride electrodes – Calomel electrodes – Measurement of pH – Glass pH electrodes – Measurement of pO<sub>2</sub> – Measurement of pCO<sub>2</sub> – Catheter type electrodes for the measurement of pO<sub>2</sub> and pCO<sub>2</sub>.

### **UNIT III BIOSENSORS 9**

Biosensors – Ion exchange membrane electrodes – Oxygen electrodes – CO<sub>2</sub> electrodes enzyme electrode – Construction – ISFET for glucose and urea – Electrolytic sensors – Optical sensor – Fiber optic sensors.

### **UNIT IV TRANSDUCTION PRINCIPLES 9**

Different Transduction principles – Temperature transducers – Thermo resistive transducers, thermoelectric, p-n junction, chemical thermometry – Displacement transducers – Potentiometer – Resistive strain gauges – Inductive displacement – Capacitive displacement transducer – Pressure transducer – Indirect method – Measurement of blood pressure using sphygmomanometer – Instrument based on Korotkof sound, strain gauge and LVDT transducers – Capacitive and piezo electric type, catheter tip transducers – Measurement of intracranial pressure – Catheter tip – Implantable type.

### **UNIT V TRANSDUCER MEASUREMENT 9**

Flow measurement transducer – Electromagnetic flow meters and ultrasonic blood flow meters – Fibre optic flow transducers and transducers for light – Electrodes for ECG, EEG, EMG Electrode – Electrolyte interface – Electrode potential – Electrode impedance – Surface electrodes – Subdermal electrodes – Micro electrodes.

**Total: 45**

#### **TEXT BOOKS**

1. Cooper, J. and Cass, A. E. G., “Biosensors”, 2<sup>nd</sup> Edition, Oxford University Press, 2004.
2. Wise, D. L., “Applied Biosensors”, Butterworth, London, 1989.

#### **REFERENCES**

1. Khandpur, R. S., “Handbook of Biomedical Instrumentation” Tata McGraw Hill, 2001.
2. Kress-Rogers, E., “Handbook of Biosensors and Electronic Noses: Medicine, Food and the Environment”, CRC Press, 1997
3. Cobbold, R. S. C., “Transducers for Biomedical Instruments”, Prentice Hall, 1986.

## BT1016 – TECHNOLOGY MANAGEMENT

L T P  
3 0 0

### UNIT I OVERVIEW OF TECHNOLOGY MANAGEMENT 9

Concept and meaning of technology – Evolution and growth of technology – Role and significance of technology management – Impact of technology on society and business – Forms of technology – Process technology and product technology.

### UNIT II COMPETITIVE ADVANTAGES THROUGH NEW TECHNOLOGIES 9

Product development from scientific breakthrough to marketable product – Role of government in technology development – Linkage between technology, development and competition – Managing research and development (R&D) – Managing intellectual property.

### UNIT III TECHNOLOGICAL FORECASTING 9

Exploratory: Intuitive – Extrapolation – Growth curves – Technology monitoring – Normative: Relevance tree – Morphological analysis – Mission flow diagram.

### UNIT IV TECHNOLOGY ASSESSMENT 9

Technology choice – Technological leadership and followership – Technology acquisition – Meaning of innovation and creativity – Innovation management.

### UNIT V TECHNOLOGY STRATEGY AND TRANSFER MANAGEMENT 9

Concept, types, key principles, framework for formulating technology strategy – Technology forecasting: Techniques and application – Technology transfer management – Technology transfer process – Outsourcing strategic issues – Joint ventures and technology sourcing.

**Total: 45**

### TEXT BOOKS

1. Betz, F., “Strategic Technology Management” 2nd Edition, Imperial College Press, 2003.
2. Tarek, M.K., “Management of Technology”, 1st Edition, McGraw-Hill, 1999.

### REFERENCES

1. Burgelman, R.A., Christensen, C.M. and Wheelwright, S.C., “Strategic Management of Technology and Innovation”, McGraw-Hill, 2008.
2. Narayanan, V.K., “Managing Technology and Innovation for Competitive Advantage”, Prentice-Hall, 2001.
3. Gehani, R.R., “Management of Technology and Operations”, John Wiley and Sons, 1998.
4. Gaynor, G.H., “Handbook of Technology Management”, Vol.49, McGraw-Hill, 1996.