

**ANNA UNIVERSITY, CHENNAI**  
**AFFILIATED INSTITUTIONS**  
**R - 2013**  
**B.TECH. BIOTECHNOLOGY**

**PROGRAMME OBJECTIVES:**

This programme will provide students with a solid foundation in Chemical engineering and Biological Sciences to enable them to work on engineering applications in biotechnology as per the requirement of Industries, and also will enable the students to pursue higher studies.

- This programme will enable students to acquire knowledge on the fundamentals of Biochemistry, Cell biology, Microbiology and Molecular biology to enable them to understand emerging and advanced concept in modern biology and help them to taken up their carrier in this field.
- This programme will facilitate the students to acquire knowledge in fields such as genetic engineering, protein engineering, and Bioprocess engineering and associated downstream processing enabling their application through Bioprocess technology
- This programme will aid the students to learn the recent developments in the field of Genomics, Proteomics, Cancer Biology and modern drug discovery approach. It will also empower the students to have advanced focus on the molecular basis of diseases and development of advanced therapeutics.
- This programme will teach students the importance of Bioethics, entrepreneurship, communication and management skills

**PROGRAMME OUTCOME:**

Graduates of the program will be having strong background in interface of modern biology and advanced bioprocess technology and be able to use these tools in industry and/or institutes where ever necessary.

**ANNA UNIVERSITY, CHENNAI**  
**AFFILIATED INSTITUTIONS**  
**R - 2013**  
**B. TECH. BIOTECHNOLOGY**  
**I – VIII SEMESTERS CURRICULUM AND SYLLABUS**

**SEMESTER - I**

CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
HS6151	Technical English - I	3	1	0	4
MA6151	Mathematics – I	3	1	0	4
PH6151	Engineering Physics – I	3	0	0	3
CY6151	Engineering Chemistry – I	3	0	0	3
GE6151	Computer Programming	3	0	0	3
GE6152	Engineering Graphics	2	0	3	4
<b>PRACTICAL</b>					
GE6161	Computer Practices Laboratory	0	0	3	2
GE6162	Engineering Practices Laboratory	0	0	3	2
GE6163	Physics and Chemistry Laboratory - I	0	0	2	1
<b>TOTAL</b>		<b>17</b>	<b>2</b>	<b>11</b>	<b>26</b>

**SEMESTER – II**

CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
HS6251	Technical English - II	3	1	0	4
MA6251	Mathematics - II	3	1	0	4
PH6252	Physics of Materials	3	0	0	3
CY6252	Chemistry for Technologists	3	0	0	3
BT6201	Biochemistry	3	0	0	3
BT6202	Microbiology	3	0	0	3
<b>PRACTICALS</b>					
BT6211	Biochemistry Laboratory	0	0	4	2
BT6212	Microbiology Laboratory	0	0	4	2
<b>TOTAL</b>		<b>18</b>	<b>2</b>	<b>8</b>	<b>24</b>

**SEMESTER – III**

<b>CODE</b>	<b>COURSE TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>THEORY</b>					
MA6351	Transforms and Partial Differential Equations	3	1	0	4
BT6301	Stoichiometry and Fluid Mechanics	3	0	0	3
BT6302	Bioorganic Chemistry	3	0	0	3
BT6303	Cell Biology	3	1	0	4
BT6304	Basic Industrial Biotechnology	3	0	0	3
GE6351	Environmental Science and Engineering	3	0	0	3
<b>PRACTICALS</b>					
BT6311	Cell Biology Laboratory	0	0	4	2
BT6312	Bioorganic Chemistry Laboratory	0	0	4	2
<b>TOTAL</b>		<b>18</b>	<b>2</b>	<b>8</b>	<b>24</b>

**SEMESTER – IV**

<b>CODE</b>	<b>COURSE TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>THEORY</b>					
MA6468	Probability and Statistics	3	1	0	4
BT6401	Analytical Methods and Instrumentation	3	0	0	3
BT6402	Applied Thermodynamics for Biotechnologists	3	0	0	3
BT6403	Heat Transfer Operations	3	1	0	4
BT6404	Enzyme Technology and Biotransformation	3	0	0	3
BT6405	Bioprocess Principles	3	0	0	3
<b>PRACTICALS</b>					
BT6411	Chemical Engineering Laboratory	0	0	4	2
BT6412	Instrumental Methods of Analysis Laboratory	0	0	4	2
<b>TOTAL</b>		<b>18</b>	<b>2</b>	<b>8</b>	<b>24</b>

**SEMESTER – V**

<b>CODE</b>	<b>COURSE TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>THEORY</b>					
BT6501	Protein Structure Function and Proteomics	3	1	0	4
BT6502	Bioprocess Engineering	3	0	0	3
BT6503	Mass Transfer Operation	3	0	0	3
BT6504	Molecular Biology	3	0	0	3
	Elective – I	3	0	0	3
	Elective – II	3	0	0	3
<b>PRACTICALS</b>					
BT6511	Bioprocess Lab – I	0	0	4	2
BT6512	Molecular Biology Lab	0	0	4	2
<b>TOTAL</b>		<b>18</b>	<b>1</b>	<b>8</b>	<b>23</b>

**SEMESTER – VI**

CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
BT6601	Total Quality Management for Biotechnologists	3	0	0	3
BT6602	Immunology	3	0	0	3
BT6603	Genetic Engineering and Genomics	3	1	0	4
BT6604	Chemical Reaction Engineering	3	0	0	3
	Elective III	3	0	0	3
	Elective IV	3	0	0	3
<b>PRACTICALS</b>					
BT6611	Genetic Engineering Laboratory	0	0	4	2
BT6612	Bioprocess Lab – II	0	0	4	2
GE6674	Communication and Soft Skills – Laboratory Based	0	0	4	2
	<b>TOTAL</b>	<b>18</b>	<b>1</b>	<b>12</b>	<b>25</b>

**SEMESTER – VII**

CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
BT6701	Bioinformatics and Computational Biology	3	0	0	3
BT6702	Downstream processing	3	0	0	3
BT6703	Creativity, Innovation and New Product Development	3	0	0	3
	Elective V	3	0	0	3
	Elective VI	3	0	0	3
<b>PRACTICALS</b>					
BT6711	Downstream processing Lab	0	0	4	2
BT6712	Immunology Lab	0	0	4	2
BT6713	Bioinformatics Lab	0	0	4	2
	<b>TOTAL</b>	<b>15</b>	<b>0</b>	<b>12</b>	<b>21</b>

**SEMESTER – VIII**

CODE	COURSE TITLE	L	T	P	C
<b>PRACTICALS</b>					
BT6811	Project Work*	0	0	12	6
	<b>TOTAL</b>	<b>0</b>	<b>0</b>	<b>12</b>	<b>6</b>

**TOTAL NO OF CREDITS : 173**

## LIST OF ELECTIVES

### B. TECH. BIOTECHNOLOGY

#### ELECTIVE I

CODE	COURSE TITLE	L	T	P	C
BT6001	Introduction to Symbolic Mathematics	2	0	2	3
BT6002	Biophysics	3	0	0	3
BT6003	Principles of Food Processing	3	0	0	3

#### ELECTIVE II

CODE	COURSE TITLE	L	T	P	C
BT6004	Advanced Biochemistry	3	0	0	3
BT6005	Biological Spectroscopy	3	0	0	3
BT6006	Biopharmaceutical Technology	3	0	0	3

#### ELECTIVE – III

CODE	COURSE TITLE	L	T	P	C
GE6081	Fundamentals of Nanoscience	3	0	0	3
BT6007	Animal Biotechnology	3	0	0	3
BT6008	Molecular Pathogenesis of Infections Disease	3	0	0	3
BT6009	Cancer Biology and Therapeutics	3	0	0	3

#### ELECTIVE - IV

CODE NO.	COURSE TITLE	L	T	P	C
BT6010	Plant Biotechnology	3	0	0	3
BT6011	Metabolic Engineering	3	0	0	3
BT6012	IPR and Ethical Issues in Biotechnology	3	0	0	3

#### ELECTIVE – V

CODE NO.	COURSE TITLE	L	T	P	C
BT6013	Bioconjugate Technology and Applications	3	0	0	3
BT6014	Bio Industrial Entrepreneurship	3	0	0	3
BT6015	Process Equipment and Plant Design	3	0	0	3
GE6083	Disaster Management	3	0	0	3

#### ELECTIVE – VI

CODE NO.	COURSE TITLE	L	T	P	C
PC6601	Process Instrumentation Dynamics and Control	3	0	0	3
BT6017	Tissue Engineering	3	0	0	3
BT6018	Neurobiology and Cognitive Sciences	3	0	0	3

GE6084	Human Rights	3	0	0	3
--------	--------------	---	---	---	---

**HS6151**

**TECHNICAL ENGLISH – I**

**L T P C**

**3 1 0 4**

**OBJECTIVES:**

- To enable learners of Engineering and Technology develop their basic communication skills in English.
- To emphasize specially the development of speaking skills amongst learners of Engineering and Technology.
- To ensure that learners use the electronic media such as internet and supplement the learning materials used in the classroom.
- To inculcate the habit of reading and writing leading to effective and efficient communication.

**UNIT I**

**9+3**

Listening - Introducing learners to GIE - Types of listening - Listening to audio (verbal & sounds); Speaking - Speaking about one's place, important festivals etc. – Introducing oneself, one's family / friend; Reading - Skimming a reading passage – Scanning for specific information - Note-making; Writing - Free writing on any given topic (My favourite place / Hobbies / School life, etc.) - Sentence completion - Autobiographical writing (writing about one's leisure time activities, hometown, etc.); Grammar - Prepositions - Reference words - Wh-questions - Tenses (Simple); Vocabulary - Word formation - Word expansion (root words / etymology); E-materials - Interactive exercises for Grammar & Vocabulary - Reading comprehension exercises - Listening to audio files and answering questions.

**UNIT II**

**9+3**

Listening - Listening and responding to video lectures / talks; Speaking - Describing a simple process (filling a form, etc.) - Asking and answering questions - Telephone skills – Telephone etiquette; Reading – Critical reading - Finding key information in a given text - Sifting facts from opinions; Writing - Biographical writing (place, people) - Process descriptions (general/specific) - Definitions - Recommendations – Instructions; Grammar - Use of imperatives - Subject-verb agreement; Vocabulary - Compound words - Word Association (connotation); E-materials - Interactive exercises for Grammar and Vocabulary - Listening exercises with sample telephone conversations / lectures – Picture-based activities.

**UNIT III**

**9+3**

Listening - Listening to specific task - focused audio tracks; Speaking - Role-play – Simulation - Group interaction - Speaking in formal situations (teachers, officials, foreigners); Reading - Reading and interpreting visual material; Writing - Jumbled sentences - Coherence and cohesion in writing - Channel conversion (flowchart into process) - Types of paragraph (cause and effect / compare and contrast / narrative / analytical) - Informal writing (letter/e-mail/blogs) - Paraphrasing; Grammar - Tenses (Past) - Use of sequence words - Adjectives; Vocabulary - Different forms and uses of words, Cause and effect words; E-materials - Interactive exercises for Grammar and Vocabulary - Excerpts from films related to the theme and follow up exercises - Pictures of flow charts and tables for interpretations.

**UNIT IV**

**9+3**

Listening - Watching videos / documentaries and responding to questions based on them; Speaking - Responding to questions - Different forms of interviews - Speaking at different types of interviews; Reading - Making inference from the reading passage - Predicting the content of a reading passage; Writing - Interpreting visual materials (line graphs, pie charts etc.) - Essay writing – Different types of essays; Grammar - Adverbs – Tenses – future time reference; Vocabulary - Single word substitutes - Use of abbreviations and acronyms; E-materials - Interactive exercises for Grammar and Vocabulary - Sample interviews - film scenes - dialogue writing.

## UNIT V

9+3

Listening - Listening to different accents, Listening to Speeches/Presentations, Listening to broadcast and telecast from Radio and TV; Speaking - Giving impromptu talks, Making presentations on given topics; Reading - Email communication - Reading the attachment files having a poem/joke/proverb - Sending their responses through email; Writing - Creative writing, Poster making; Grammar - Direct and indirect speech; Vocabulary - Lexical items (fixed / semi fixed expressions); E-materials - Interactive exercises for Grammar and Vocabulary - Sending emails with attachment – Audio / video excerpts of different accents - Interpreting posters.

**TOTAL (L:45+T:15): 60 PERIODS**

### OUTCOMES:

Learners should be able to

- speak clearly, confidently, comprehensibly, and communicate with one or many listeners using appropriate communicative strategies.
- write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.
- read different genres of texts adopting various reading strategies.
- listen/view and comprehend different spoken discourses/excerpts in different accents

### TEXTBOOKS:

1. Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai. 2011

### REFERENCES:

1. Raman, Meenakshi & Sangeetha Sharma. Technical Communication: Principles and Practice. Oxford University Press, New Delhi. 2011.
2. Regional Institute of English. English for Engineers. Cambridge University Press, New Delhi. 2006.
3. Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi. 2005
4. Rutherford, Andrea. J Basic Communication Skills for Technology. Pearson, New Delhi. 2001.
5. Viswamohan, Aysha. English for Technical Communication. Tata McGraw-Hill, New Delhi. 2008.

### EXTENSIVE Reading (Not for Examination)

1. Kalam, Abdul. Wings of Fire. Universities Press, Hyderabad. 1999.

### WEBSITES:

1. <http://www.usingenglish.com>
2. <http://www.uefap.com>

### TEACHING METHODS:

- Lectures
- Activities conducted individually, in pairs and in groups like self introduction, peer introduction, group poster making, grammar and vocabulary games, etc.
- Discussions
- Role play activities
- Short presentations
- Listening and viewing activities with follow up activities like discussion, filling up worksheets, writing exercises (using language lab wherever necessary/possible) etc.

### EVALUATION PATTERN:

#### Internal assessment: 20%

3 tests of which two are pen and paper tests and the other is a combination of different modes of assessment like

- Project
- Assignment

- Reviews
- Creative writing
- Poster making, etc.

All the four skills are to be tested with equal weightage given to each.

- ✓ Speaking assessment: Individual speaking activities, Pair work activities like role play, Interview, Group discussions
- ✓ Reading assessment: Reading passages with comprehension questions graded from simple to complex, from direct to inferential
- ✓ Writing assessment: Writing paragraphs, essays etc. Writing should include grammar and vocabulary.
- ✓ Listening/Viewing assessment: Lectures, dialogues, film clippings with questions on verbal as well as audio/visual content.

**End Semester Examination: 80%**

**MA6151**

**MATHEMATICS – I**

**L T P C  
3 1 0 4**

**OBJECTIVES:**

- To develop the use of matrix algebra techniques this is needed by engineers for practical applications.
- To make the student knowledgeable in the area of infinite series and their convergence so that he/ she will be familiar with limitations of using infinite series approximations for solutions arising in mathematical modeling.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To introduce the concepts of improper integrals, Gamma, Beta and Error functions which are needed in engineering applications.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

**UNIT I MATRICES**

**9+3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues and eigenvectors – Statement and applications of Cayley-Hamilton Theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

**UNIT II SEQUENCES AND SERIES**

**9+3**

Sequences: Definition and examples – Series: Types and Convergence – Series of positive terms – Tests of convergence: Comparison test, Integral test and D’Alembert’s ratio test – Alternating series – Leibnitz’s test – Series of positive and negative terms – Absolute and conditional convergence.

**UNIT III APPLICATIONS OF DIFFERENTIAL CALCULUS**

**9+3**

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes - Evolute as envelope of normals.

**UNIT IV DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES**

**9+3**

Limits and Continuity – Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian and properties – Taylor’s series for functions of two variables – Maxima and minima of functions of two variables – Lagrange’s method of undetermined multipliers.

**UNIT V MULTIPLE INTEGRALS**

**9+3**

Double integrals in cartesian and polar coordinates – Change of order of integration – Area enclosed by plane curves – Change of variables in double integrals – Area of a curved surface - Triple integrals – Volume of Solids.

**TOTAL (L:45+T:15): 60 PERIODS**



**OUTCOMES:**

- This course equips students to have basic knowledge and understanding in one fields of materials, integral and differential calculus.

**TEXT BOOKS:**

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
2. Grewal. B.S, "Higher Engineering Mathematics", 41<sup>st</sup> Edition, Khanna Publications, Delhi, 2011.

**REFERENCES:**

1. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., 2011.
2. Glyn James, "Advanced Modern Engineering Mathematics", 3<sup>rd</sup> Edition, Pearson Education, 2012.
3. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
4. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2008.
5. Sivarama Krishna Das P. and Rukmangadachari E., "Engineering Mathematics", Volume I, Second Edition, PEARSON Publishing, 2011.

**PH6151****ENGINEERING PHYSICS – I****L T P C****3 0 0 3****OBJECTIVES:**

- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

**UNIT I CRYSTAL PHYSICS****9**

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Diamond and graphite structures (qualitative treatment) - Crystal growth techniques –solution, melt (Bridgman and Czochralski) and vapour growth techniques (qualitative)

**UNIT II PROPERTIES OF MATTER AND THERMAL PHYSICS****9**

Elasticity- Hooke's law - Relationship between three moduli of elasticity (qualitative) – stress -strain diagram – Poisson's ratio –Factors affecting elasticity –Bending moment – Depression of a cantilever –Young's modulus by uniform bending- I-shaped girders  
Modes of heat transfer- thermal conductivity- Newton's law of cooling - Linear heat flow – Lee's disc method – Radial heat flow – Rubber tube method – conduction through compound media (series and parallel)

**UNIT III QUANTUM PHYSICS****9**

Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory – Compton effect. Theory and experimental verification – Properties of Matter waves – G.P Thomson experiment -Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box - Electron microscope - Scanning electron microscope - Transmission electron microscope.

**UNIT IV ACOUSTICS AND ULTRASONICS****9**

Classification of Sound- decibel- Weber–Fechner law – Sabine's formula- derivation using growth and decay method – Absorption Coefficient and its determination –factors affecting acoustics of buildings and their remedies.

Production of ultrasonics by magnetostriction and piezoelectric methods - acoustic grating - Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C –scan displays, Medical applications - Sonogram

## **UNIT V PHOTONICS AND FIBRE OPTICS**

**9**

Spontaneous and stimulated emission- Population inversion -Einstein's A and B coefficients - derivation. Types of lasers – Nd:YAG, CO<sub>2</sub>, Semiconductor lasers (homojunction & heterojunction)- Industrial and Medical Applications.

Principle and propagation of light in optical fibres – Numerical aperture and Acceptance angle - Types of optical fibres (material, refractive index, mode) – attenuation, dispersion, bending - Fibre Optical Communication system (Block diagram) - Active and passive fibre sensors- Endoscope.

**TOTAL: 45 PERIODS**

### **OUTCOMES:**

- The students will have knowledge on the basics of physics related to properties of matter, optics, acoustics etc., and they will apply these fundamental principles to solve practical problems related to materials used for engineering applications.

### **TEXT BOOKS:**

1. Arumugam M. Engineering Physics. Anuradha publishers, 2010
2. Gaur R.K. and Gupta S.L. Engineering Physics. Dhanpat Rai publishers, 2009
3. Mani Naidu S. Engineering Physics, Second Edition, PEARSON Publishing, 2011.

### **REFERENCES:**

1. Searls and Zemansky. University Physics, 2009
2. Mani P. Engineering Physics I. Dhanam Publications, 2011
3. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009
4. Palanisamy P.K. Engineering Physics. SCITECH Publications, 2011
5. Rajagopal K. Engineering Physics. PHI, New Delhi, 2011
6. Senthilkumar G. Engineering Physics I. VRB Publishers, 2011.

**CY6151**

**ENGINEERING CHEMISTRY - I**

**L T P C**

**3 0 0 3**

### **OBJECTIVES:**

- To make the students conversant with basics of polymer chemistry.
- To make the student acquire sound knowledge of second law of thermodynamics and second law based derivations of importance in engineering applications in all disciplines.
- To acquaint the student with concepts of important photophysical and photochemical processes and spectroscopy.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- To acquaint the students with the basics of nano materials, their properties and applications.

## **UNIT I POLYMER CHEMISTRY**

**9**

Introduction: Classification of polymers – Natural and synthetic; Thermoplastic and Thermosetting. Functionality – Degree of polymerization. Types and mechanism of polymerization: Addition (Free Radical, cationic and anionic); condensation and copolymerization. Properties of polymers: T<sub>g</sub>, Tacticity, Molecular weight – weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension. Preparation, properties and uses of Nylon 6,6, and Epoxy resin.

## **UNIT II CHEMICAL THERMODYNAMICS**

**9**

Terminology of thermodynamics - Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Clausius inequality. Free energy and work function: Helmholtz and Gibbs free energy functions (problems); Criteria of

spontaneity; Gibbs-Helmholtz equation (problems); Clausius-Clapeyron equation; Maxwell relations – Van't Hoff isotherm and isochore(problems).

**UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9**

Photochemistry: Laws of photochemistry - Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law. Quantum efficiency – determination- Photo processes - Internal Conversion, Inter-system crossing, Fluorescence, Phosphorescence, Chemiluminescence and Photo-sensitization. Spectroscopy: Electromagnetic spectrum - Absorption of radiation – Electronic, Vibrational and rotational transitions. UV-visible and IR spectroscopy – principles, instrumentation (Block diagram only).

**UNIT IV PHASE RULE AND ALLOYS 9**

Phase rule: Introduction, definition of terms with examples, One Component System- water system - Reduced phase rule - Two Component Systems- classification – lead-silver system, zinc-magnesium system. Alloys: Introduction- Definition- Properties of alloys- Significance of alloying, Functions and effect of alloying elements- Ferrous alloys- Nichrome and Stainless steel – heat treatment of steel; Non-ferrous alloys – brass and bronze.

**UNIT V NANO CHEMISTRY 9**

Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Nanoparticles: nano cluster, nano rod, nanotube(CNT) and nanowire. Synthesis: precipitation, thermolysis, hydrothermal, solvothermal, electrode position, chemical vapour deposition, laser ablation; Properties and applications

**TOTAL :45 PERIODS**

**OUTCOMES:**

- The knowledge gained on polymer chemistry, thermodynamics. spectroscopy, phase rule and nano materials will provide a strong platform to understand the concepts on these subjects for further learning.

**TEXT BOOKS:**

1. Jain P.C. and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2010
2. Kannan P., Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009

**REFERENCES:**

1. Dara S.S, Umare S.S, "Engineering Chemistry", S. Chand & Company Ltd., New Delhi 2010
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2008.
3. Gowariker V.R. , Viswanathan N.V. and JayadevSreedhar, "Polymer Science", New Age International P (Ltd.), Chennai, 2006.
4. Ozin G. A. and Arsenault A. C., "Nanotechnology: A Chemical Approach to Nanomaterials", RSC Publishing, 2005.

**GE6151**

**COMPUTER PROGRAMMING**

**LT PC**

**3 0 0 3**

**OBJECTIVES:**

**The students should be made to:**

- Learn the organization of a digital computer.
- Be exposed to the number systems.
- Learn to think logically and write pseudo code or draw flow charts for problems.
- Be exposed to the syntax of C.
- Be familiar with programming in C.
- Learn to use arrays, strings, functions, pointers, structures and unions in C.

**UNIT I INTRODUCTION 8**

Generation and Classification of Computers- Basic Organization of a Computer –Number System – Binary – Decimal – Conversion – Problems. Need for logical analysis and thinking – Algorithm – Pseudo code – Flow Chart.

**UNIT II C PROGRAMMING BASICS 10**

Problem formulation – Problem Solving - Introduction to ‘ C’ programming –fundamentals – structure of a ‘C’ program – compilation and linking processes – Constants, Variables – Data Types – Expressions using operators in ‘C’ – Managing Input and Output operations – Decision Making and Branching – Looping statements – solving simple scientific and statistical problems.

**UNIT III ARRAYS AND STRINGS 9**

Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays. String-String operations – String Arrays. Simple programs- sorting- searching – matrix operations.

**UNIT IV FUNCTIONS AND POINTERS 9**

Function – definition of function – Declaration of function – Pass by value – Pass by reference – Recursion – Pointers - Definition – Initialization – Pointers arithmetic – Pointers and arrays- Example Problems.

**UNIT V STRUCTURES AND UNIONS 9**

Introduction – need for structure data type – structure definition – Structure declaration – Structure within a structure - Union - Programs using structures and Unions – Storage classes, Pre-processor directives.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**At the end of the course, the student should be able to:**

- Design C Programs for problems.
- Write and execute C programs for simple applications.

**TEXTBOOKS:**

1. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. Pradip Dey, Manas Ghosh, “Fundamentals of Computing and Programming in C”, First Edition, Oxford University Press, 2009
3. Yashavant P. Kanetkar. “ Let Us C”, BPB Publications, 2011.

**REFERENCES:**

1. Byron S Gottfried, “Programming with C”, Schaum’s Outlines, Second Edition, Tata McGraw-Hill, 2006.
2. Dromey R.G., “How to Solve it by Computer”, Pearson Education, Fourth Reprint, 2007.
3. Kernighan,B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2006.

**GE6152**

**ENGINEERING GRAPHICS**

**LT P C  
2 0 3 4**

**OBJECTIVES:**

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

**CONCEPTS AND CONVENTIONS (Not for Examination) 1**

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

**UNIT I PLANE CURVES AND FREE HAND SKETCHING 5+9**

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves, Scales: Construction of Diagonal and Vernier scales. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

**UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 5+9**

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

**UNIT III PROJECTION OF SOLIDS 5+9**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method.

**UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+9**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes

**UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+9**

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method .

**COMPUTER AIDED DRAFTING (Demonstration Only) 3**

Introduction to drafting packages and demonstration of their use.

**TOTAL : 75 PERIODS**

**OUTCOMES:**

On Completion of the course the student will be able to

- perform free hand sketching of basic geometrical constructions and multiple views of objects.
- do orthographic projection of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- prepare isometric and perspective sections of simple solids.
- demonstrate computer aided drafting.

**TEXT BOOK:**

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50<sup>th</sup> Edition, 2010.

**REFERENCES:**

1. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern

- Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
3. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2<sup>nd</sup> Edition, 2009.
  4. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.
  5. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
  6. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

**Publication of Bureau of Indian Standards:**

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

**Special points applicable to University Examinations on Engineering Graphics:**

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

**GE6161**

**COMPUTER PRACTICES LABORATORY**

**L T P C  
0 0 3 2**

**OBJECTIVES:**

**The student should be made to:**

- Be familiar with the use of Office software.
- Be exposed to presentation and visualization tools.
- Be exposed to problem solving techniques and flow charts.
- Be familiar with programming in C.
- Learn to use Arrays, strings, functions, structures and unions.

**LIST OF EXPERIMENTS:**

1. Search, generate, manipulate data using MS office/ Open Office
2. Presentation and Visualization – graphs, charts, 2D, 3D
3. Problem formulation, Problem Solving and Flowcharts
4. C Programming using Simple statements and expressions
5. Scientific problem solving using decision making and looping.
6. Simple programming for one dimensional and two dimensional arrays.
7. Solving problems using String functions
8. Programs with user defined functions – Includes Parameter Passing
9. Program using Recursive Function and conversion from given program to flow chart.
10. Program using structures and unions.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

**At the end of the course, the student should be able to:**

- Apply good programming design methods for program development.
- Design and implement C programs for simple applications.
- Develop recursive programs.

**LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:**

Standalone desktops with C compiler      30 Nos.

(or)

Server with C compiler supporting 30 terminals or more.

**GE6162**

**ENGINEERING PRACTICES LABORATORY**

**L T P C**

**0 0 3 2**

**OBJECTIVES:**

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

**GROUP A (CIVIL & MECHANICAL)**

**I      CIVIL ENGINEERING PRACTICE**

**9**

**Buildings:**

- (a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

**Plumbing Works:**

- (a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
- (b) Study of pipe connections requirements for pumps and turbines.
- (c) Preparation of plumbing line sketches for water supply and sewage works.
- (d) Hands-on-exercise:  
Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
- (e) Demonstration of plumbing requirements of high-rise buildings.

**Carpentry using Power Tools only:**

- (a) Study of the joints in roofs, doors, windows and furniture.
- (b) Hands-on-exercise:  
Wood work, joints by sawing, planing and cutting.

**II      MECHANICAL ENGINEERING PRACTICE**

**13**

**Welding:**

- (a) Preparation of arc welding of butt joints, lap joints and tee joints.
- (b) Gas welding practice

**Basic Machining:**

- (a) Simple Turning and Taper turning
- (b) Drilling Practice

**Sheet Metal Work:**

- (a) Forming & Bending:
- (b) Model making – Trays, funnels, etc.
- (c) Different type of joints.

**Machine assembly practice:**

- (a) Study of centrifugal pump
- (b) Study of air conditioner

**Demonstration on:**

- (a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.

- (b) Foundry operations like mould preparation for gear and step cone pulley.
- (c) Fitting – Exercises – Preparation of square fitting and vee – fitting models.

**GROUP B (ELECTRICAL & ELECTRONICS)**

**III ELECTRICAL ENGINEERING PRACTICE 10**

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

**IV ELECTRONICS ENGINEERING PRACTICE 13**

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EOR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- ability to fabricate carpentry components and pipe connections including plumbing works.
- ability to use welding equipments to join the structures.
- ability to fabricate electrical and electronics circuits.

**REFERENCES:**

1. Jeyachandran K., Natarajan S. & Balasubramanian S., “A Primer on Engineering Practices Laboratory”, Anuradha Publications, 2007.
2. Jeyapoovan T., Saravanapandian M. & Pranitha S., “Engineering Practices Lab Manual”, Vikas Publishing House Pvt.Ltd, 2006.
3. Bawa H.S., “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, 2007.
4. Rajendra Prasad A. & Sarma P.M.M.S., “Workshop Practice”, Sree Sai Publication, 2002.
5. Kannaiah P. & Narayana K.L., “Manual on Workshop Practice”, Scitech Publications, 1999.

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

**CIVIL**

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15 Sets.
2. Carpentry vice (fitted to work bench) 15 Nos.
3. Standard woodworking tools 15 Sets.
4. Models of industrial trusses, door joints, furniture joints 5 each
5. Power Tools: (a) Rotary Hammer 2 Nos  
 (b) Demolition Hammer 2 Nos  
 (c) Circular Saw 2 Nos  
 (d) Planer 2 Nos  
 (e) Hand Drilling Machine 2 Nos  
 (f) Jigsaw 2 Nos

**MECHANICAL**



1. Arc welding transformer with cables and holders	5 Nos.
2. Welding booth with exhaust facility	5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5. Centre lathe	2 Nos.
6. Hearth furnace, anvil and smithy tools	2 Sets.
7. Moulding table, foundry tools	2 Sets.
8. Power Tool: Angle Grinder	2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner	One each.

#### **ELECTRICAL**

1. Assorted electrical components for house wiring	15 Sets
2. Electrical measuring instruments	10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4. Megger (250V/500V)	1 No.
5. Power Tools: (a) Range Finder	2 Nos
(b) Digital Live-wire detector	2 Nos

#### **ELECTRONICS**

1. Soldering guns	10 Nos.
2. Assorted electronic components for making circuits	50 Nos.
3. Small PCBs	10 Nos.
4. Multimeters	10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply	

**GE6163**

**PHYSICS AND CHEMISTRY LABORATORY – I**

**LT P C**

**0 0 2 1**

#### **PHYSICS LABORATORY – I**

**OBJECTIVES:**

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

**LIST OF EXPERIMENTS**

(Any FIVE Experiments)

1. (a) Determination of Wavelength, and particle size using Laser  
(b) Determination of acceptance angle in an optical fiber.
2. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
3. Determination of wavelength of mercury spectrum – spectrometer grating
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of Young's modulus by Non uniform bending method
6. Determination of specific resistance of a given coil of wire – Carey Foster's Bridge

**OUTCOMES:**

- The hands on exercises undergone by the students will help them to apply physics principles of optics and thermal physics to evaluate engineering properties of materials.

#### **LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

1. Diode laser, lycopodium powder, glass plate, optical fiber.

2. Ultrasonic interferometer
3. Spectrometer, mercury lamp, grating
4. Lee's Disc experimental set up
5. Traveling microscope, meter scale, knife edge, weights
6. Carey foster's bridge set up  
(vernier Caliper, Screw gauge, reading lens are required for most of the experiments)

## CHEMISTRY LABORATORY- I

### OBJECTIVES:

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by vacometry.

### LIST OF EXPERIMENTS

(Any FIVE Experiments)

- 1 Determination of DO content of water sample by Winkler's method.
- 2 Determination of chloride content of water sample by argentometric method.
- 3 Determination of strength of given hydrochloric acid using pH meter.
- 4 Determination of strength of acids in a mixture using conductivity meter.
- 5 Estimation of iron content of the water sample using spectrophotometer.  
(1,10- phenanthroline / thiocyanate method).
- 6 Determination of molecular weight of polyvinylalcohol using Ostwald viscometer.
- 7 Conductometric titration of strong acid vs strong base.

**TOTAL: 30 PERIODS**

### OUTCOMES:

- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

### REFERENCES:

1. Daniel R. Palleros, "Experimental organic chemistry" John Wiley & Sons, Inc., New York 2001.
2. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel's Textbook of practical organic chemistry", LBS Singapore 1994.
3. Jeffery G.H., Bassett J., Mendham J. and Denny vogel's R.C, "Text book of quantitative analysis chemical analysis", ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
4. Kolthoff I.M., Sandell E.B. et al. "Quantitative chemical analysis", Mcmillan, Madras 1980.

### LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Iodine flask	-	30 Nos
2. pH meter	-	5 Nos
3. Conductivity meter	-	5 Nos
4. Spectrophotometer	-	5 Nos
5. Ostwald Viscometer	-	10 Nos

**Common Apparatus : Pipette, Burette, conical flask, porcelain tile, dropper (each 30 Nos.)**

**OBJECTIVES:**

- To make learners acquire listening and speaking skills in both formal and informal contexts.
- To help them develop their reading skills by familiarizing them with different types of reading strategies.
- To equip them with writing skills needed for academic as well as workplace contexts.
- To make them acquire language skills at their own pace by using e-materials and language lab components.

**OUTCOMES:**

Learners should be able to

- speak convincingly, express their opinions clearly, initiate a discussion, negotiate, argue using appropriate communicative strategies.
- write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.
- read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation.
- listen/view and comprehend different spoken excerpts critically and infer unspoken and implied meanings.

**UNIT I****9 + 3**

Listening - Listening to informal conversations and participating; Speaking - Opening a conversation (greetings, comments on topics like weather) - Turn taking - Closing a conversation (excuses, general wish, positive comment, thanks); Reading - Developing analytical skills, Deductive and inductive reasoning - Extensive reading; Writing - Effective use of SMS for sending short notes and messages - Using 'emojis' as symbols in email messages; Grammar - Regular and irregular verbs - Active and passive voice; Vocabulary - Homonyms (e.g. 'can') - Homophones (e.g. 'some', 'sum'); E-materials - Interactive exercise on Grammar and vocabulary – blogging; Language Lab - Listening to different types of conversation and answering questions.

**UNIT II****9 + 3**

Listening - Listening to situation based dialogues; Speaking - Conversation practice in real life situations, asking for directions (using polite expressions), giving directions (using imperative sentences), Purchasing goods from a shop, Discussing various aspects of a film (they have already seen) or a book (they have already read); Reading - Reading a short story or an article from newspaper, Critical reading, Comprehension skills; Writing - Writing a review / summary of a story / article, Personal letter (Inviting your friend to a function, congratulating someone for his / her success, thanking one's friends / relatives); Grammar - modal verbs, Purpose expressions; Vocabulary - Phrasal verbs and their meanings, Using phrasal verbs in sentences; E-materials - Interactive exercises on Grammar and vocabulary, Extensive reading activity (reading stories / novels), Posting reviews in blogs - Language Lab - Dialogues (Fill up exercises), Recording students' dialogues.

**UNIT III****9 + 3**

Listening - Listening to the conversation - Understanding the structure of conversations; Speaking - Conversation skills with a sense of stress, intonation, pronunciation and meaning - Seeking information – expressing feelings (affection, anger, regret, etc.); Reading - Speed reading – reading passages with time limit - Skimming; Writing - Minutes of meeting – format and practice in the preparation of minutes - Writing summary after reading articles from journals - Format for journal articles – elements of technical articles (abstract, introduction, methodology, results, discussion, conclusion, appendices, references) - Writing strategies; Grammar - Conditional clauses - Cause and effect expressions; Vocabulary - Words used as nouns and verbs without any change in the spelling (e.g. 'rock', 'train', 'ring'); E-materials - Interactive exercise on Grammar and vocabulary - Speed Reading practice exercises; Language Lab - Intonation practice using EFLU and RIE materials – Attending a meeting and writing minutes.

**UNIT IV****9 + 3**

Listening - Listening to a telephone conversation, Viewing model interviews (face-to-face, telephonic and video conferencing); Speaking - Role play practice in telephone skills - listening and responding, -asking questions, -note taking – passing on messages, Role play and mock interview for grasping interview skills; Reading - Reading the job advertisements and the profile of the company concerned – scanning; Writing - Applying for a job – cover letter - résumé preparation – vision, mission and goals of the candidate; Grammar - Numerical expressions - Connectives (discourse markers); Vocabulary - Idioms and their meanings – using idioms in sentences; E-materials - Interactive exercises on Grammar and Vocabulary - Different forms of résumés- Filling up a résumé / cover letter; Language Lab - Telephonic interview – recording the responses - e-résumé writing.

**UNIT V****9 + 3**

Listening - Viewing a model group discussion and reviewing the performance of each participant - Identifying the characteristics of a good listener; Speaking - Group discussion skills – initiating the discussion – exchanging suggestions and proposals – expressing dissent/agreement – assertiveness in expressing opinions – mind mapping technique; Reading - Note making skills – making notes from books, or any form of written materials - Intensive reading; Writing – Checklist - Types of reports – Feasibility / Project report – report format – recommendations / suggestions – interpretation of data (using charts for effective presentation); Grammar - Use of clauses; Vocabulary – Collocation; E-materials - Interactive grammar and vocabulary exercises - Sample GD - Pictures for discussion, Interactive grammar and vocabulary exercises; Language Lab - Different models of group discussion.

**TOTAL: 60 PERIODS****TEXTBOOKS:**

1. Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai. 2011

**REFERENCES:**

1. Anderson, Paul V. Technical Communication: A Reader-Centered Approach. Cengage. New Delhi. 2008
2. Muralikrishna, & Sunita Mishra. Communication Skills for Engineers. Pearson, New Delhi. 2011
3. Riordan, Daniel. G. Technical Communication. Cengage Learning, New Delhi. 2005
4. Sharma, Sangeetha & Binod Mishra. Communication Skills for Engineers and Scientists. PHI Learning, New Delhi. 2009
5. Smith-Worthington, Darlene & Sue Jefferson. Technical Writing for Success. Cengage, Mason USA. 2007

**EXTENSIVE Reading (Not for Examination)**

1. Khera, Shiv. You can Win. Macmillan, Delhi. 1998.

**Websites**

1. <http://www.englishclub.com>
2. <http://owl.english.purdue.edu>

**TEACHING METHODS:**

- Lectures
- Activities conducted individually, in pairs and in groups like individual writing and presentations, group discussions, interviews, reporting, etc
- Long presentations using visual aids
- Listening and viewing activities with follow up activities like discussions, filling up worksheets, writing exercises (using language lab wherever necessary/possible) etc
- Projects like group reports, mock interviews etc using a combination of two or more of the language skills

**EVALUATION PATTERN:**

**Internal assessment: 20%**

3 tests of which two are pen and paper tests and the other is a combination of different modes of assessment like

- Project
- Assignment
- Report
- Creative writing, etc.

All the four skills are to be tested with equal weightage given to each.

- ✓ Speaking assessment: Individual presentations, Group discussions
- ✓ Reading assessment: Reading passages with comprehension questions graded following Bloom's taxonomy
- ✓ Writing assessment: Writing essays, CVs, reports etc. Writing should include grammar and vocabulary.
- ✓ Listening/Viewing assessment: Lectures, dialogues, film clippings with questions on verbal as well as audio/visual content graded following Bloom's taxonomy.

**End Semester Examination: 80%**

**MA6251**

**MATHEMATICS – II**

**L T P C  
3 1 0 4**

**OBJECTIVES:**

- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To acquaint the student with the concepts of vector calculus, needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow the of electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

**UNIT I VECTOR CALCULUS 9+3**  
Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

**UNIT II ORDINARY DIFFERENTIAL EQUATIONS 9+3**  
Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

**UNIT III LAPLACE TRANSFORM 9+3**  
Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

**UNIT IV ANALYTIC FUNCTIONS 9+3**

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping:  $w = z+k$ ,  $kz$ ,  $1/z$ ,  $z^2$ ,  $e^z$  and bilinear transformation.

**UNIT V COMPLEX INTEGRATION**

**9+3**

Complex integration – Statement and applications of Cauchy’s integral theorem and Cauchy’s integral formula – Taylor’s and Laurent’s series expansions – Singular points – Residues – Cauchy’s residue theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

**TOTAL: 60 PERIODS**

**TEXT BOOKS:**

1. Bali N. P and Manish Goyal, “A Text book of Engineering Mathematics”, Eighth Edition, Laxmi Publications Pvt Ltd.,(2011).
2. Grewal. B.S, “Higher Engineering Mathematics”, 41<sup>st</sup> Edition, Khanna Publications, Delhi, (2011).

**REFERENCES:**

1. Dass, H.K., and Er. Rajnish Verma,” Higher Engineering Mathematics”, S. Chand Private Ltd., (2011)
2. Glyn James, “Advanced Modern Engineering Mathematics”, 3<sup>rd</sup> Edition, Pearson Education, (2012).
3. Peter V. O’Neil,” Advanced Engineering Mathematics”, 7th Edition, Cengage learning, (2012).
4. Ramana B.V, “Higher Engineering Mathematics”, Tata McGraw Hill Publishing Company, New Delhi, (2008).
5. Sivarama Krishna Das P. and Rukmangadachari E., “Engineering Mathematics” Volume II, Second Edition, PEARSON Publishing 2011.

**PH6252**

**PHYSICS OF MATERIALS**

**LT PC  
3 0 0 3**

**UNIT I PREPARATION AND PROCESSING OF MATERIALS**

**9**

Phases - Phase rule – binary systems – tie line rule – lever rule – phase diagram – invariant reactions – diffusion Fick’s law - Nucleation – homogeneous and heterogeneous nucleation – Free energy of formation of a critical nucleus – crystal growth – Czochralski, Bridgman, Solution methods - Thin films – preparation: PVD method - Sol-gel method – heat treatment and hardening processes..

**UNIT II PROPERTIES OF CONDUCTING AND SUPER CONDUCTING MATERIALS**

**9**

Classical free electron theory of metals –Fermi function - Schrödinger wave equation - Time independent and time dependent equations. Physical significance of wave function, particle in a box ( in one dimension ) – electrons in a metal - Density of energy states – effect of temperature on Fermi energy – carrier concentration in metals - Superconducting Phenomena, Properties of superconductors – Meissner effect and Isotope effect. Type I and Type II superconductors, High Tc superconductors – Magnetic levitation and SQUIDS.

**UNIT III ELECTRONIC MATERIALS**

**9**

Elemental and compound semiconductors - Origin of band gap in solids (qualitative) - Concept of effective mass of electron and hole – carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Compound semiconductors – Hall effect – Determination of Hall coefficient – LED and Solar cells.

**UNIT IV INSULATING AND MAGNETIC MATERIALS 9**

Dielectric, paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant Magneto Resistance materials. Magnetic bubbles.

**UNIT V CERAMIC AND NEW MATERIALS 9**

Introduction to Ceramics and its applications - Ceramic Fibres - Fibre reinforced Plastics – Fibre reinforced Metal – Metallic glasses – Shape memory alloys – Copper base alloys – Nickel – Titanium alloys – Relaxor- Ferroelectric materials – Electro and magneto rheological fluids - Sensors and Actuators – polymer semiconductos – photoconducting polymers – liquid crystals - Bio-sensors - Scintillation detectors (Position sensitive) –Bio materials – hydroxyapatite – PMMA – Silicone.

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Raghavan. V. Materials Science and Engineering, Prentice Hall of India, 2002.
2. Kumar.J, Moorthy Babu. S and Vasudevan. S., Engineering Physics, Vijay Nicole Imprints, 2006
3. Palanisamy.. P.K., Materials Science, Scitech., 2003.
4. Calister, W.D., Materials Science and Engineering an Introduction, John Wiley, 2003.
5. Raghavan, V., Physical Metallurgy, Prentice Hall of India, 2002.

**CY6252 CHEMISTRY FOR TECHNOLOGISTS LT P C  
3 0 0 3**

**UNIT I WATER 9**

Water quality parameters- determination of hardness (EDTA method), TDS, BOD, COD and iron and their significance. Softening – Zeolite and demineralization processes. Boiler troubles and remedies – removal of oils and silica, internal conditioning. Desalination by electro-dialysis and reverse osmosis. Water quality parameters and standards for textile wet processing.

**UNIT II CHEMISTRY OF INTERFACES 9**

Interface region-curved interfaces-thermodynamics of surfaces - Surface film on liquids-Adsorption of gases on Solids-adsorption isotherms. Applications of adsorption studies-detergency, wetting, foaming , defoaming, spreading, water repellency.

**UNIT III OILS, FATS, SOAPS & LUBRICANTS 9**

Chemical constitution, Chemical analysis of oils and fats – acid, saponification and iodine values, Definitions, determinations and significance.Definition, mechanism of lubrication, preparation of petrolubes, desirable characteristics – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point. Semisolid lubricant – greases, preparation of sodium, lithium, calcium and axle greases and uses, consistency test and drop point test. Solid lubricants – graphite and molybdenum disulphide

**UNIT IV CHEMICALS AND AUXILIARIES 9**

Surfactant Chemistry, bleaching powder, sodium hypochlorite, hydrogen peroxide, chlorine dioxide, preparation, estimation of available chlorine in hypochlorite bleach liquor. determination of strength of hydrogen peroxide.

**UNIT V COLORANTS****9**

Theory of color and constitution: chromophore and auxochrome, classification of dyes based on application. Chemistry and synthesis of , azo dye.

**TOTAL: 45 PERIODS****REFERENCES:**

1. Dhara S. S., "A Text Book of Engineering Chemistry", S. Chand & Co. Ltd., New Delhi, 2002
2. Jain. P.C. and Monica Jain, "Engineering Chemistry", Dhanpet Rai & Sons, New Delhi, 2001
3. Puri B. R., Sharma L. R. and Madhan S. Pathania, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co., Jalandar, 2000
4. Shore J., "Colourants and Auxiliaries: Volume I Colorants", Wood head Publishing Ltd., 2002, ISBN 0 901956 77 5
5. Shore J., "Colourants and Auxiliaries: Volume II Auxiliaries", Wood head Publishing Ltd., 2002, ISBN 0 901956 78 3
6. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", B.I Publishing Pvt. Ltd., New Delhi, 1994
7. Shenai V. A., "Chemistry of Dyes and Principles of Dyeing", Sevak Publications, Mumbai, 1995

**BT6201****BIOCHEMISTRY****LT P C  
3 0 0 3****OBJECTIVES**

- To develop understanding and provide scientific basics of the life processes at the molecular level and explain the structure, function and inter-relationships of bio-molecules and their deviation from normal and their consequences for interpreting and solving clinical problems.

**UNIT I BIOCHEMICAL ORGANIZATION AND BIOENERGETICS****10**

Scope of clinical biochemistry, component of the cell, structure and biochemical functions, membrane structure and functions, transport through biological cell membrane, the concept of free energy, determination of change in free energy from equilibrium constant and reduction potential, bioenergetics and biological oxidation – general concept of oxidation and reduction, electron transport chain, oxidative phosphorylation, uncouplers and theories of biological oxidation and oxidative phosphorylation

**UNIT II BIOMOLECULES****12**

**Carbohydrates** – classification, properties. starch, glycogen, dextrin, inulin, cellulose, metabolism of carbohydrates – gluconeogenesis, glycogenolysis, glycolysis. citric acid cycle and its biological significance, role of sugar in nucleotide biosynthesis and pentose phosphate pathway. **Lipids** – Classification, properties. sterols, essential fatty acids, eicosanoids, phospholipids, sphingolipids, metabolism of lipids, oxidation of fatty acids,  $\alpha, \beta$  - oxidation and biosynthesis of ketone bodies, cholesterol, porphyrin biosynthesis, metabolism of bile pigments. **Proteins and amino acids** – Classification, properties, biosynthesis of amino acids and proteins, essential amino acids, metabolism of amino acids and proteins, Nitrogen balance. **Nucleic acids** – genetic code, nucleic acids, and structure of DNA and RNA, purine biosynthesis and pyrimidine biosynthesis.

**UNIT III BIOENERGETICS****5**

High energy compounds , electronegative potential of compounds , respiratory chain , ATP cycle , Calculation of ATP during oxidation of glucose and fatty acids.

**UNIT IV MACROMOLECULES, VITAMINS, HORMONES, ENZYMES****10**

Physical and chemical properties, structure of haemoglobin, immunoglobulins and nucleoprotein, classification and their properties, occurrence, functions, requirements,





### TEXT BOOKS

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3<sup>rd</sup> Edition, Wm. C. Brown Publishers, 1996.

**BT6211**

**BIOCHEMISTRY LABORATORY**

**L T P C**  
**0 0 4 2**

### OBJECTIVES

- To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules (proteins, carbohydrates, lipids, metabolites etc.,) and laboratory analysis of the same in the body fluids.

### LIST OF EXPERIMENTS

1. Preparation and measurement of pH of standard buffers (phosphate, carbonate, borate, TRIS etc.,).
2. Qualitative analysis of carbohydrates (monosaccharides, disaccharides, polysaccharides etc.,)
3. Enzymatic hydrolysis of glycogen by  $\alpha$  and  $\beta$  amylase
4. Qualitative analysis of proteins
5. Qualitative analysis of lipids (triglycerides, cholesterol, phospholipids etc.,)
6. Quantitative analysis of proteins (Lowry's method, Bradford, UV)
7. Quantitative analysis of carbohydrates (Benedict's method etc.,) lipids
8. Quantitative analysis of lipids (Benedict's method etc.,)
9. Quantitative estimation of blood glucose
10. Acid hydrolysis and action of salivary amylase on starch
11. Estimation of chloride, glucose, ammonia and creatinine in urine.
12. Quantitative analysis of urea in serum
13. Quantitative analysis of serum bilirubin
14. Quantitative estimation of serum cholesterol by Libermann Burchard's method
15. Isolation and assay of glycogen from the liver and skeletal muscle of mice

**TOTAL: 60 PERIODS**

### LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. UV-Visible Spectrophotometers
2. pH meter
3. Centrifuge

### TEXT BOOKS:

1. Gupta R.C. and Bhargavan S. Practical Biochemistry.
2. David T. Phummer. Introduction of Practical Biochemistry (II Edition).

### REFERENCES:

1. Murray R.K., Granner D.K., Mayes P.A. and Rodwell V.W. Harpers Biochemistry, Appleton and Lange, Stanford, Connecticut.
2. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers

**BT6212**

**MICROBIOLOGY LABORATORY**

**L T P C**  
**0 0 4 2**

### LIST OF EXPERIMENTS

1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques;
2. Culture Media-Types and Use; Preparation of Nutrient broth and agar
3. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
4. Microscopy – Working and care of Microscope

5. Microscopic Methods in the Study of Microorganisms; Staining Techniques- Simple, Differential- Gram's Staining
6. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in Soil – TVC
7. Effect of Disinfectants- Phenol Coefficient
8. Antibiotic Sensitivity Assay
9. Growth Curve in Bacteria and Yeast
10. Effect of pH, Temperature, UV radiation on Growth Bacteria

**TOTAL: 60 PERIODS**

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

Autoclave	1
Hot Air Oven	1
Incubators	2
Light Microscopes	4
Incubator Shaker	1
Colorimeter	2
Lamina Flow Chamber	2
Glassware, Chemicals, Media	as required

**REFERENCES:**

1. Cappuccino, J.G. and N. Sherman "Microbiology : A Laboratory Manual", 4<sup>th</sup> Edition, Addison-Wesley, 1999.
2. Collee, J.G. et al., "Mackie & McCartney Practical Medical Microbiology" 4<sup>th</sup> Edition, Churchill Livingstone, 1996.

**MA6351      TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS      L T P C  
3 1 0 4**

**OBJECTIVE:**

To facilitate the understanding of the mathematical principles on transforms and partial differential equations and to cultivate the art of formulating physical problems in the language of mathematics.

**UNIT I      PARTIAL DIFFERENTIAL EQUATIONS      9 + 3**

Formation of partial differential equations – Singular integrals -- Solutions 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 of both homogeneous and non-homogeneous types.

**UNIT II      FOURIER SERIES      9 + 3**

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      APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS      9 + 3**

Classification of PDE – Method of separation of variables - Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).

**UNIT IV      FOURIER TRANSFORMS      9 + 3**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

**UNIT V      Z - TRANSFORMS AND DIFFERENCE EQUATIONS      9 + 3**

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

**TOTAL (L:45+T:15): 60 PERIODS**

**OUTCOMES:**

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Ztransform techniques for discrete time systems.

**TEXT BOOKS:**

1. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
2. Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
3. Narayanan.S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students" Vol. II & III, S.Viswanathan Publishers Pvt Ltd. 1998.

**REFERENCES:**

1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7<sup>th</sup> Edition, Laxmi Publications Pvt Ltd , 2007.
2. Ramana.B.V., "Higher Engineering Mathematics", Tata Mc-GrawHill Publishing Company Limited, NewDelhi, 2008.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3<sup>rd</sup> Edition, Pearson Education, 2007.
4. Erwin Kreyszig, "Advanced Engineering Mathematics", 8<sup>th</sup> Edition, Wiley India, 2007.
5. Ray Wylie. C and Barrett.L.C, "Advanced Engineering Mathematics" Tata Mc Graw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
6. Datta.K.B., "Mathematical Methods of Science and Engineering", Cengage Learning India Pvt Ltd, Delhi, 2013.

**BT6301**

**STOICHIOMETRY AND FLUID MECHANICS**

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

**OBJECTIVES:**

The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics. The objectives are to enable the students

- To perform calculations pertaining to processes and operations.
- To apply fluid mechanics principles to applied problems

**UNIT I INTRODUCTION**

**8**

Units, conversion factors –gas laws- humidity and other physical properties

**UNIT II CONCEPTS IN MATERIAL BALANCES**

**10**

Application problems in unit operations - Material balance in reactions – Application in bioprocesses

**UNIT III CONCEPTS IN ENERGY BALANCES**

**9**

Sensible, Latent heats- Thermo chemical calculations-use of steam tables-examples of simultaneous material and energy balance- Application of energy balance in Bioprocesses

**UNIT IV FLUID PROPERTIES 9**  
Newtonian and Non Newtonian Fluids, Fluid statics, Fluid Flow in pipelines and other flow channels- pressure drop calculations. Flow measurements.

**UNIT V AGITATION, FLOW THROUGH PACKINGS, FLUIDIZATION, FLUID TRANSPORT 9**  
Flow in packed columns, fluidization –valves,pumps gas moving devices, gases – equipments. Agitation – power requirement

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon success completion of this course, the students will be able to:

- Solve problems related to units and conversions and fit the given data using the methodologies
- Solve problems related to material and energy balance concepts and design reactors for biochemical processes
- Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics.
- Acquire knowledge related to fluid statics and dynamics, agitators and applications of various pumps.

**TEXT BOOKS:**

1. Bhatt, B.I. and S.M. Vora “Stoichiometry (SI Units)”, 3<sup>rd</sup> Edition, Tata McGraw-Hill, 1996.
2. Geankoplis, C.J. “Transport Processes and Separation process Principles”, 4<sup>th</sup> Edition, PHI, 2006.

**REFERENCES:**

1. McCabe, W.L., J.C. Smith and P.Harriot “Unit Operations of Chemical Engineering”, 6<sup>th</sup> Edition, Mc Graw Hill, 2001.
2. Himmelblau, D.M. “Basic principles and calculations in Chemical Engineering”, 6<sup>th</sup> Edition, PHI, 2006.
3. Foust, A.S. etal., “ Principles of Unit Operations”, 2<sup>nd</sup> Edition, John Wiley & Sons, 1999.
4. Narayanan, K.V. and Lakshmi Kutty “Stoichiometry and Process Calculations”,PHI, 2006.
5. Coulson, J.M. and etal. “Coulson & Richardson’s Chemical Engineering”, 6<sup>th</sup> Edition, Vol. I & II, Butterworth – Heinman (an imprint of Elsevier), 2004.
6. Perrys Chemical Engineers Hand Book.

**BT6302**

**BIOORGANIC CHEMISTRY**

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

**OBJECTIVES:**

To enable the students

- To know in detail about the elements of atom, charges and their bonding rule.
- To understand the various kinetic properties and types of reaction mechanisms
- To understand the possible bio-organic reactions involved in biosynthesis

**UNIT I BONDING AND STEREOCHEMISTRY 9**  
Atoms Electrons and orbitals - Covalent Bonds - Octet rule - Polar covalent Bonds - Electronegativity- formal charge - Resonance Acids and Bases - Arrhenius and Bronsted Lowry Theories - Acid Base equilibria - SP<sup>3</sup> hybridization - Conformations analysis ethane, butane and cyclohexane - Cis- trans isomerism. Stereochem activity around the tetrahedral carbon – optical activity - Conformation of the peptide bond.

**UNIT II MECHANISMS OF SUBSTITUTION AND ADDITION REACTIONS 9**

SN1 and SN2 reactions on tetrahedral carbon- nucleophiles- mechanism steric effects – nucleophilic addition on Acetals and ketals -Aldehyde and ketone groups – reactions of carbonyl group with amines- acid catalyzed ester hydrolysis – Saponification of an ester- hydrolysis of amides. Ester enolates - claisen .condensation – Michael condensation.

**UNIT III KINETICS AND MECHANISM 9**

Kinetic method – Rate law and mechanism – Transition states- Intermediates – Trapping of intermediates – Microscopic reversibility – Kinetic and thermodynamic reversibility – Isotopes for detecting intermediates. Primary and secondary isotopes – the Arrhenius equation Eyring equation -  $\Delta G$ ,  $\Delta S$ ,  $\Delta H$ , Thermodynamics of coupled reactions.

**UNIT IV CATALYSIS 9**

Reactivity – Coenzymes – Proton transfer – metal ions – Intra molecular reactions – Covalent catalysis – Catalysis by organized aggregates and phases. Inclusion complexation

**UNIT V BIOORGANIC REACTIONS 9**

Timing of Bond formation and fission – Acyl group transfer – C-C bond formation and fission – Catalysis of proton transfer reactions – Transfer of hydride ion – Alkyl group. Transfer – Terpene biosynthesis – Murrfield state peptide synthesis – Sanger method for peptide and DNA sequencing.

**TOTAL : 45 PERIODS**

**OUTCOME:**

On completion of this course, the students will learn the basics principles of chemical Bonding, Stereochemistry of Bio-organic molecules and their kinetics, mechanisms of reactions and catalysis.

**TEXT BOOKS:**

1. Carey, Francis A.” Organic Chemistry”. 7<sup>th</sup> Edition, Tata MCGraw Hill, 2009.
2. Page, M.I. and Andrew Williams “Organic and Bio-organic Mechanisms”. Pearson, 2010.

**REFERENCE:**

1. Dugas, Hermann “ Bioorganic Chemistry : A Chemical Approach to Enzyme Action” 3<sup>rd</sup> Edition, Springer, 2003.

**BT6303**

**CELL BIOLOGY**

**L T P C  
3 1 0 4**

**OBJECTIVES:**

- To provide knowledge on the fundamentals of cell biology
- To help students understand the signalling mechanisms

**UNIT I CELL STRUCTURE AND FUNCTION OF THE ORGANELLES 9**

Eukaryotic, Prokaryotic cells, Subcellular Organelles and Functions Principles of membrane organization membrane proteins, cytoskeletal proteins eg. RBC cytoskeletal contractile proteins Actin, myosin, Actin Polymerization Act- myosin complex, mechanism of myosin-ATpase activity, contraction; microtubules, microfilaments activity in Organelle movement.

**UNIT II CELL DIVISION AND CONNECTION 9**

Cell cycle – Mitosis, Meiosis, Molecules controlling cell cycle, Extra cellular matrix, role of matrix in cell enthore : Gap junctions, Tight junctions, Desmosomes, Hemidesmosomes.

**UNIT III TRANSPORT ACROSS CELL MEMBRANE 9**

Passive and Active Transport, Permeases, Ion channels, ATP pumps. Na<sup>+</sup> / K<sup>+</sup> / Ca<sup>2+</sup> pumps uniport, symport antiporter system. Ligand gated / voltage gated channels, Agonists and Antagonists.

**UNIT IV SIGNAL TRANSDUCTION 9**

Receptors – extracellular signaling, Cell surface / cytosolic receptors and examples, Different classes of receptors antocrine / paracrine / endocrine models, Secondary messengers molecules.

**UNIT V TECHNIQUES USED TO STUDY CELLS 9**

Cell fractionation and flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy. Localization of proteins in cells – Immunostaining.

**TOTAL (L:45 + T:15) : 60 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students

- Would have deeper understanding of cell at structural and functional level.
- Would have broad knowledge on the molecular interaction between cells.
- Would demonstrate a clear understanding of the signal transduction, secondary messengers.
- Would develop skill on working principles of microscopy and identification of cell types.

**TEXT BOOKS:**

1. Lodish, Harvey et al., “Molecular Cell Biology,” 6th Edition. W.H. Freeman, 2008
2. Alberts, Bruce et al., “Essential Cell Biology”, 2nd Edition, Garland Science, 2004

**REFERENCES:**

1. Alberts, Bruce, “Molecular Biology of Cell”, 5th Edition, Garland Science, 2008.
2. Cooper, G.M. “The Cell: A Molecular Approach, 4th Edition, ASM Press, 2007.

**BT6304 BASIC INDUSTRIAL BIOTECHNOLOGY LT P C  
3 0 0 3**

**OBJECTIVES:**

- To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
- The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures.

**UNIT I INTRODUCTION TO INDUSTRIAL BIOPROCESS 10**

Fermentation - Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology - A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting - block diagrams, pictorial representation.

**UNIT II PRODUCTION OF PRIMARY METABOLITES 9**

Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids, alcohols and vitamins.

**UNIT III PRODUCTION OF SECONDARY METABOLITES 9**

Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics and Steroids.

**UNIT IV PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 9**

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers

Biodiesel, Cheese, Beer, SCP & Mushroom culture. Bioremediation.

**UNIT V PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS 8**

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

At the end of the course, the students will be able

- To explain the steps involved in the production of bioproducts and methods to improve modern biotechnology.
- To apply basic biotechnological principles, methods and models to solve biotechnological tasks.
- To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology.
- To design and deliver useful modern biotechnology products to the Society.

**TEXT BOOKS:**

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.
2. Kumar, H.D. "A Textbook on Biotechnology" 2<sup>nd</sup> Edition. Affiliated East West Press Pvt.Ltd., 1998.
3. Balasubramanian, D. etal., "Concepts in Biotechnology" Universities Press Pvt.Ltd., 2004.
4. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" 2<sup>nd</sup> Edition Cambridge University Press, 2001.
5. Dubey, R.C. "A Textbook of Biotechnology" S.Chand & Co. Ltd., 2006.

**REFERENCES:**

1. A.H. Patel " Industrial Microbiology" Macmillan
2. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005.
3. Cruger,Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology", 2<sup>nd</sup> Edition, Panima Publishing, 2000.
4. Moo-Young, Murrey, "Comprehensive Biotechnology", 4 Vols. Pergamon Press, (An Imprint of Elsevier) 2004.
5. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999.
6. K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications.

**GE6351 ENVIRONMENTAL SCIENCE AND ENGINEERING LT P C  
3 0 0 3**

**OBJECTIVES:**

To enable the students

- To the study of nature and the facts about environment
- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

**UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 12**



Definition, scope and importance of Risk and hazards; Chemical hazards, Physical hazards, Biological hazards in the environment – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers-Oxygen cycle and Nitrogen cycle – energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds. Field study of simple ecosystems – pond, river, hill slopes, etc.

## **UNIT II ENVIRONMENTAL POLLUTION 10**

Definition – causes, effects and control measures of: (a) Air pollution (Atmospheric chemistry- Chemical composition of the atmosphere; Chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, oxygen and ozone chemistry;- Mitigation procedures- Control of particulate and gaseous emission, Control of SO<sub>2</sub>, NO<sub>x</sub>, CO and HC) (b) Water pollution : Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters – physical, chemical and biological; absorption of heavy metals - Water treatment processes. (c) Soil pollution - soil waste management: causes, effects and control measures of municipal solid wastes – (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards–role of an individual in prevention of pollution – pollution case studies  
Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

## **UNIT III NATURAL RESOURCES 10**

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Energy Conversion processes – Biogas – production and uses, anaerobic digestion; case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Introduction to Environmental Biochemistry: Proteins – Biochemical degradation of pollutants, Bioconversion of pollutants.  
Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

## **UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7**

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air act – Water act – Wildlife protection act – Forest conservation act –The Biomedical Waste (Management and Handling) Rules; 1998 and amendments- scheme of labeling of environmentally friendly products (Ecomark). enforcement machinery involved in environmental legislation- central and state pollution control boards- disaster management: floods, earthquake, cyclone and landslides.  
Public awareness.

## **UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6**

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- -GIS-remote sensing-role of information technology in environment and human health – Case studies.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

**TEXT BOOKS:**

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2006).

**REFERENCES:**

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia',Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005)

**BT6311**

**CELL BIOLOGY LABORATORY**

**LT P C**

**0 0 4 2**

**OBJECTIVES:**

To demonstrate various techniques to learn the morphology, identification and propagation of cells

**LIST OF EXPERIMENTS**

1. Introduction to principles of sterile techniques and cell propagation
2. Principles of microscopy, phase contrast and fluorescent microscopy
3. Identification of given plant, animal and bacterial cells and their components by microscopy
4. Gram's Staining
5. Leishman Staining
6. Giemsa Staining
7. Thin Layer Chromatography
8. Separation of Peripheral Blood Mononuclear Cells from blood
9. Osmosis and Tonicity
10. Trypan Blue Assay
11. Staining for different stages of mitosis in AlliumCepa (Onion)

**TOTAL : 60 PERIODS**

**OUTCOMES:**

This practical course will facilitate the students

- To understand the basic techniques to work with cells
- To demonstrate working principles of Microscopy
- To understand and perform cell staining techniques

- To identify the various stages of mitosis

#### LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Autoclave	1
Hot Air Oven	1
Incubators	2
Light Microscopes	4
Incubator Shaker	1
Colorimeter	2
Laminar Flow Chamber	2
Glassware, Chemicals, Media	as required

#### REFERENCES:

1. Rickwood, D. and J.R. Harris "Cell Biology : Essential Techniques", Johnwiley, 1996.
2. Davis, J.M. "Basic Cell Culture : A Practical Approach", IRL, 1994.

**BT6312**

**BIOORGANIC CHEMISTRY LABORATORY**

**L T P C  
0 0 4 2**

#### OBJECTIVE:

To train the students in preparation of bioorganic molecules and characterizing them.

#### 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 dicyclohexylinoine 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 : 60 PERIODS**

#### OUTCOME:

On completion of the course, the students will have hands on experience on the synthesis of certain useful bioorganic molecules and be able to analyse their physical and chemical properties.

#### LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Colorimeter 2 No.
2. Glassware, Chemicals, Media as required

#### REFERENCES:

1. Organic Chemistry, Francis A.Carey, VII Edition, Tata MCGraw Hill, Fourth reprint 2009.
2. Organic and Bio-organic Mechanisms, M.I. Page and Andrew Williams. Pearson, First Impression, 2010.



To enable the students

- To have a fundamental knowledge about the Light spectrum, Absorption, Fluorescence NMR, Mass spectroscopy
- To acquire knowledge on the different chromatographic methods for separation of biological products.

**UNIT I INTRODUCTION TO SPECTROMETRY 9**

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements.

**UNIT II MOLECULAR SPECTROSCOPY 9**

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence – Instrumentation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications.

**UNIT III MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY 9**

Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR-spectrometers – applications of  $^1\text{H}$  and  $^{13}\text{C}$  NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values – instrumentation.

**UNIT IV SEPARATION METHODS 9**

General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography - Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography- principles of GC and applications – HPLC- Capillary electrophoresis – Applications.

**UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9**

Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

**TOTAL : 45 PERIODS**

**OUTCOME:**

On completion of the course, students will have a better understanding of spectroscopy and the separation techniques used for biological products.

**TEXT BOOKS:**

1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch "Instrumental Methods of Analysis". Cengage Learning , 2007.
2. Willard, Hobart, etal., "Instrumental Methods of Analysis". 7<sup>th</sup> Edition, CBS, 1986.
3. Braun, Robert D. " Introduction to Instrumental Analysis". Pharma Book Syndicate, 1987.
4. Ewing,G.W. "Instrumental Methods of Chemical Analysis", 5<sup>th</sup> Edition, McGraw-Hill, 1985

**REFERENCES:**

1. Sharma, B.K. "Instrumental Methods of Chemical Analysis : Analytical Chemistry" Goel Publishing House, 1972.
2. Haven, Mary C., etal., "Laboratory Instrumentation ". 4<sup>th</sup> Edition, John Wiley, 1995.

**BT6402**

**APPLIED THERMODYNAMICS FOR BIOTECHNOLOGISTS**

**L T P C**

**3 0 0 3**

**OBJECTIVE:**

To enable the students to learn about basic concepts of classical and statistical thermodynamics

**UNIT I THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS 9**

First Law of thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non ideal behavior; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications.

**UNIT II SOLUTION THERMODYNAMICS 9**

Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation.

**UNIT III PHASE EQUILIBRIA 9**

Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid- liquid equilibria and solid-solid equilibria.

**UNIT IV CHEMICAL REACTION EQUILIBRIA 9**

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.

**UNIT V THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION 9**

Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert –Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

At the end of this course, the student would have the ability

- To explain the theoretical concepts of thermodynamics and how it applies to energy conversion in technological applications and biological systems.
- To demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems.
- To design and carry out bioprocess engineering experiments, and analyze and interpret fundamental data to do the design and operation of bioprocesses.
- To describe the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations microbial growth and product formation.

**TEXT BOOKS:**

1. Smith J.M., Van Ness H.C., and Abbot M.M. "Introduction to Chemical Engineering

- Thermodynamics”, 6<sup>th</sup> Edition. Tata McGraw-Hill, 2003.
- Narayanan K.V. “A Text Book of Chemical Engineering Thermodynamics”, PHI,2003.
  - Christiana D. Smolke, “ The Metabolic Pathway Engineering Handbook Fundamentals”, CRC Press Taylor & Francis Group, 2010.

**REFERENCE:**

- Sandler S.I. “Chemical and Engineering Thermodynamics”, John Wiley,1989.

**BT6403**

**HEAT TRANSFER OPERATIONS**

**L T P C**  
**3 1 0 4**

**OBJECTIVE:**

To enable the students to understand the fundamental principles and concepts of heat transfer. This course will be a prerequisite for certain engineering subjects offered in the subsequent semesters

**UNIT I MIXING AND AGITATION 9**

Dimensional analysis; power for agitation; agitation of liquids; gas-liquid systems; gas-solid suspensions; agitator scale up.

**UNIT II CONDUCTION HEAT TRANSFER 9**

Steady state conduction; combined resistances; unsteady state conduction; lumped heat capacity; extended surfaces; combined conduction and convection.

**UNIT III CONVECTION HEAT TRANSFER 9**

Dimensional analysis; forced and natural convection; convection in flow over surfaces through pipes boiling and condensation.

**UNIT IV RADIATION HEAT TRANSFER 9**

The problem of radiative exchange-Kirchoff’s law, radiant heat exchange between two finite black holes-heat transfer among gray bodies

**UNIT V HEAT TRANSFER EQUIPMENTS 9**

Equipments; overall heat transfer coefficients; heat transfer in fermentors, design of heat exchangers; NTU concept; evaporators; single and multiple effects; mass and enthalpy balances.

**TOTAL (L:45 + T:15) : 60 PERIODS**

**OUTCOMES:**

Upon success completion of this course, the students will be able to understand

- Purpose of mixing and agitation, types of agitators, scale up of agitators and dimensional analysis.
- About different modes of heat transfer, different laws and terms used for design purpose and industrial applications, steady state and transient conduction
- Concept of forced and natural convection, boiling and condensation and radiation heat transfer
- On heat exchangers and its design, NTU concepts, evaporators and its types

**TEXT BOOKS:**

- McCabe, W.L., J.C. Smith and P. Harriott “Unit Operations of Chemical Engineering”, 6<sup>th</sup> Edition, McGraw-Hill, 2001.
- Geankoplis, C.J. “Transport Process and Separation Process Principles”, 4<sup>th</sup> Edition, Prentice Hall of India, 2005.

**REFERENCE:**

- Incropera F.P. “Fundamentals Of Heat And Mass Transfer”, John Wiley,1998.

**OBJECTIVES:**

To enable the students

- To learn enzyme reactions and its characteristics along with the production and purification process
- To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes

**UNIT I INTRODUCTION TO ENZYMES****9**

Classification of enzymes – Mechanisms of enzyme action – Concept of active site and energetics of enzyme substrate complex formation – Specificity of enzyme action – Principles of catalysis – Collision theory and transition state theory – Role of entropy in catalysis.

**UNIT II KINETICS OF ENZYME ACTION****9**

Kinetics of single substrate reactions; estimation of Michelis-Menten parameters – Multi-substrate reactions – Mechanisms and kinetics – Turnover number – Types of inhibition and models for substrate and product – Allosteric regulation of enzyme – Monod Changeux Wyman model – pH and temperature effect on enzymes & deactivation kinetics.

**UNIT III ENZYME IMMOBILIZATION AND BIOSENSORS****9**

Physical and chemical techniques for enzyme immobilization – Adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding and suitable examples – Advantages and disadvantages – Design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

**UNIT IV PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES****9**

Production and purification of crude enzyme extracts from plant, animal and microbial sources – Methods of characterization of enzymes – Development of enzymatic assays

**UNIT V BIOTRANSFORMATION APPLICATIONS OF ENZYMES****9**

Hydrolytic- Ester bond, Amide, Epoxides, Nitriles, Reduction reactions – Aldehydes, Ketones, C=C, Oxidation reactions – Alkanes, Aromatic, Baeyer-Villiger – Enzymes in organic synthesis – esters, amide, peptide – Modified and Artificial Enzymes – Catalytic antibodies

**TOTAL : 45 PERIODS****OUTCOMES:**

- The knowledge on enzyme and enzyme reactions will be the key step in to proceed towards various concepts in biotechnology.
- The theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.
- The process of immobilization has been increased steadily in food, pharmaceutical and chemical industries and thus this study will provide simple and easy method of implementation.
- Ideas on Processing, Production and Purification of enzymes at an industrial scale will be helpful to work technologically.

**TEXT BOOKS:**

1. Pandey A., Webb C., Soccol C. R. and Larroche C., Eds “ Enzyme Technology”, Springer, 2006.



2. Buchholz, K., Kasche, V. and Bornscheuer, U., "Biocatalysts and Enzyme Technology", WILEY-VCH, 2005.

#### REFERENCES:

1. Drauz K., Gröger, H. and May O., "Enzyme Catalysis in Organic Synthesis: A Comprehensive Handbook", Volume 1, Wiley-VCH Verlag & Co, 2012.
2. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997
3. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2<sup>nd</sup> Ed., McGraw Hill, 1986
4. Wiseman, Alan. Hand book of Enzyme Biotechnology, 3<sup>rd</sup> ed., Ellis Harwood 1995.

**BT6405**

**BIOPROCESS PRINCIPLES**

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

#### OBJECTIVES:

- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- To endow the students with the basics of microbial kinetics, metabolic stoichiometry and energetics.

#### **UNIT I OVERVIEW OF FERMENTATION PROCESSES 9**

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in fermentation processes.

#### **UNIT II RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS 9**

Criteria for good medium, medium requirements for fermentation processes- carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements. Medium formulation for optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations- medium optimization methods.

#### **UNIT III STERILIZATION KINETICS 7**

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 - batch and continuous.

#### **UNIT IV METABOLIC STOICHIOMETRY AND ENERGETICS 9**

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 V KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 11**

Batch cultivation and continuous cultivation. Simple unstructured 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. Biomass estimation - Direct and Indirect methods.

**TOTAL : 45 PERIODS**

#### OUTCOMES:

Upon completion of the course in Bioprocess Principles graduates will be able to

- Apply engineering principles to systems containing biological catalysts to meet the needs of the society.
- Convert the promises of molecular biology and genetic engineering into new processes to make bio-products in economically feasible way.

- Interpret the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes.
- Enhance and modify the biological materials to improve its usefulness by finding the optimal formulation materials to facilitate product production.

#### **TEXT BOOKS:**

1. Shuler, Michael L. and Fikret Kargi, "Bioprocess Engineering ", Prentice Hall, 1992.
2. Doran M Pauline "Bioprocess Engineering Principles" ,2<sup>nd</sup> Edition, Elsevier, 2012.
3. Ghasem D.Najafpour, "Biochemical Engineering and Biotechnology", Elsevier, 2007.

#### **REFERENCES:**

1. Bailey, James E. and David F. Ollis, " Biochemical Engineering Fundamentals", 2<sup>nd</sup> Edition. McGraw Hill , 1986.
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books, 1995.
3. Jens Nielson, John Villadsen and Gunnar Liden, "Bioreaction engineering principles", 2<sup>nd</sup> Edition, Kulwer Academic, 2002
4. Tapobrate Panda, "Bioreactors: Analysis and Design", Tata McGraw Hill, 2011
5. Rajiv Dutta, "Fundamentals of Biochemical Engineering", Springer, 2008

**BT6411**

**CHEMICAL ENGINEERING LABORATORY**

**L T P C  
0 0 4 2**

#### **OBJECTIVES:**

- To provide basic understanding of chemical engineering principles and operations
- Course will enable the students to apply the principles in other chemical engineering and biotechnology subjects offered in higher semesters

#### **LIST OF EXPERIMENTS**

1. Flow measurement a) Orifice meter b) Venturimeter, c) Rotameter
2. Pressure drop flow in pipes
3. Pressure drop in flow through packed column
4. Pressure drop in flow through fluidized beds
5. Chacteristics of centrifuge pump
6. Flate and frame filter press
7. Filtration in leaf filter
8. Heat transfer characteristics in heat exchanger
9. Simple and steam distillation
10. HETP in packed distillation
11. Ternary equilibrium in liquid-liquid extraction
12. Adsorption isotherm
13. Drying characteristics in a pan dryer

**TOTAL : 45 PERIODS**

#### **OUTCOMES:**

Upon completion of this practical course the student will

- Have knowledge on the basic principles of chemical engineering
- Be able to apply the skill of material balance and energy balance in unit operations unit process of chemical engineering and biotechnology
- Be able to analyze the principles of chemical engineering and its applications in chemical, mechanical and biological perspectives
- Understand the design and working principles of fluid moving machinery and transport phenomena

#### **LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

Colorimeter	2 No.
Filter leaf	1 No.
Orifice meter	1 No.
Venturimeter	1 No.
Rotameter	1 No.
Glassware, Chemicals, Media	as required

**BT6412 INSTRUMENTAL METHODS OF ANALYSIS LABORATORY**

**L T P C  
0 0 4 2**

**OBJECTIVES:**

To train the students

- To have a practical hands on experience on Absorption Spectroscopic methods
- To acquire experience in the purification by performing chromatography
- To validate and analysis using spectrometric and microscopic techniques

**LIST OF EXPERIMENTS**

1. Precision and validity in an experiment using absorption spectroscopy .
2. Validating Lambert-Beer's law using  $\text{KMnO}_4$
3. Finding the molar absorptivity and stoichiometry of the Fe (1,10 phenanthroline)<sub>3</sub> using absorption spectrometry.
4. Finding the pKa of 4-nitrophenol using absorption spectroscopy.
5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxalate.
7. Estimation of  $\text{SO}^{2-}$  by nephelometry.
8. Estimation of  $\text{Al}^{3+}$  by Fluorimetry.
9. Limits of detection using aluminium alizarin complex.
10. Chromatography analysis using TLC.
11. Chromatography analysis using column chromatography.

**TOTAL : 60 PERIODS**

**OUTCOME:**

The students would visualize and interpret the theory of spectroscopic methods by hands on experiments.

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

1. Colorimeter 2 No.
2. Glassware, Chemicals, Media as required

**REFERENCES:**

1. Skoog, D.A. etal. "Principles of Instrumental Analysis", 5<sup>th</sup> Edition, Thomson / Brooks – Cole,1998.
2. Braun, R.D. "Introduction to Instrumental Analysis", Pharma Book Syndicate, 1987.
3. Willard, H.H. etal. "Instrumental Methods of Analysis", 6<sup>th</sup> Edition, CBS, 1986.
4. Ewing,G.W. "Instrumental Methods of Chemical Analysis", 5<sup>th</sup> Edition, McGraw-Hill, 1985.

**BT6501 PROTEIN STRUCTURE FUNCTION AND PROTEOMICS**

**L T P C  
3 1 0 4**

**OBJECTIVES:**

To enable the students

- To identify the importance of protein biomolecules.
- To realize the structure-function relationships in proteins.

**UNIT I            BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS            9**

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

**UNIT II            PROTEIN ARCHITECTURE            9**

Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass- spec. 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 & TIM barrel structures nucleotide binding folds.

**UNIT III            TERTIARY STRUCTURE            9**

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, protein-protein interactions and methods to study it: Computer exercise on the above aspects

**UNIT IV            STRUCTURE-FUNCTION RELATIONSHIP            9**

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, Trans-membrane 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 Computer exercise on the above aspects

**UNIT V            PROTEOMICS            9**

Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. Computer exercise on the above aspects

**TOTAL (L:45 + T:15) : 60 PERIODS**

**OUTCOMES:**

Upon completion of this course, students will be able:

- To analyze the various interactions in protein makeup.
- To be familiar with different levels of protein structure.
- To know the role of functional proteins in various field of study.
- To practice the latest application of protein science in their research.

**TEXT BOOKS:**

1. Branden C. and Tooze J., "Introduction to Protein Structured" 2<sup>nd</sup> Edition, Garland Publishing, 1999.
2. Creighton T.E. "Proteins" 2<sup>nd</sup> Edition. W.H. Freeman, 1993.
3. Pennington, S.R and M.J. Dunn, "Proteomics : Protein Sequence to Function". Viva Books, 2002

**REFERENCE:**

1. Liebler, "Introduction to Proteomics" Humana Press, 2002.

**OBJECTIVES:**

- To provide the students with the basics of bioreactor engineering.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

**UNIT I OPERATIONAL MODES OF BIOREACTORS 9**

Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, two stage cultivation. Packed bed reactor, airlift reactor, fluidized bed reactor and bubble column reactor.

**UNIT II BIOREACTOR SCALE – UP 8**

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors – microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.

**UNIT III BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS 8**

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors.

**UNIT IV MODELLING AND SIMULATION OF BIOPROCESSES 11**

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

**UNIT V RECOMBINANT CELL CULTIVATION 9**

Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, yeast *Pichia pastoris*/ *Saccharomyces cerevisiae*, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactor considerations in the above system.

**TOTAL : 45 PERIODS****OUTCOMES:**

Upon completion of Bioprocess Engineering course graduates will be able to

- Select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines and other process criteria.
- Apply modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.
- Plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up.
- Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

**TEXT BOOKS:**

1. Jens Nielson, John Villadsen and Gunnar Liden, "Bioreaction engineering principles", 2<sup>nd</sup> Edition, Kulwer Academic, 2002
2. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc

**REFERENCES:**

1. Anton Moser, "Bioprocess Technology: Kinetics and Reactors", , Springer Verlag 2011.
2. Tapobrate Panda, "Bioreactors: Analysis and Design", Tata McGraw Hill, 2011
3. Shijie Liu "Bioprocess Engineering" Elsevier, 2013
4. Atkinson, B, Mavituna, F, "Biochemical Engineering and Biotechnology Handbook" Macmillan Publishers Ltd, New York, 1992.
5. James E. Bailey & David F. Ollis, "Biochemical Engineering Fundamentals", McGraw Hill.



**REFERENCE:**

1. Coulson and Richardson's Chemical Engineering. Vol I & II, Asian Books Pvt Ltd, 1998.

**BT6504****MOLECULAR BIOLOGY****LT P C  
3 0 0 3****OBJECTIVES:**

Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes. This will be needed for any project work in modern biotechnology.

- By doing this course students will acquire basic fundamental knowledge and explore skills in molecular biology and become aware of the complexity and harmony of the cells.
- This course will emphasize the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.

**UNIT I CHEMISTRY OF NUCLEIC ACIDS 9**

Introduction to nucleic acids: Nucleic acids as genetic material, Structure and physicochemical properties of elements in DNA and RNA, Biological significance of differences in DNA and RNA. Primary structure of DNA: Chemical and structural qualities of 3',5'-Phosphodiester bond. Secondary Structure of DNA: Watson & Crick model, Chargaff's rule, X-ray diffraction analysis of DNA, Forces stabilizes DNA structure, Conformational variants of double helical DNA, Hogsteen base pairing, Triple helix, Quadruple helix, Reversible denaturation and hyperchromic effect. Tertiary structure of DNA: DNA supercoiling.

**UNIT II DNA REPLICATION & REPAIR 9**

Overview of Central dogma. Organization of prokaryotic and eukaryotic chromosomes. DNA replication: Meselson & Stahl experiment, bi-directional DNA replication, Okazaki fragments, Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication, Telomere replication in eukaryotes. D-loop and rolling circle mode of replication. Mutagens, DNA mutations and their mechanism, various types of repair mechanisms.

**UNIT III TRANSCRIPTION 9**

Structure and function of mRNA, rRNA and tRNA. Characteristics of promoter and enhancer sequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteins of RNA synthesis, Fidelity of RNA synthesis, Inhibitors of transcription, Differences in prokaryotic and eukaryotic transcription. Basic concepts in RNA world: Ribozymes, RNA processing: 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.

**UNIT IV TRANSLATION 9**

Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post-translational modifications and its importance.

**UNIT V REGULATION OF GENE EXPRESSION 9**

Organization of genes in prokaryotic and eukaryotic chromosomes, Hierarchical levels of gene regulation, Prokaryotic gene regulation *-lac* and *trp* operon, Regulation of gene

expression with reference to  $\lambda$  phage life cycle.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

By the end of this course, students should be able to:

- Describe the basic structure and biochemistry of nucleic acids and proteins and discriminate between them;
- Identify the principles of DNA replication, transcription and translation and explain how they relate to each other.
- Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.
- Articulate applications of molecular biology in the modern world.

**TEXT BOOKS:**

1. Friefelder, David. "Molecular Biology." Narosa Publications, 1999.
2. Weaver, Robert F. "Molecular Biology" 2nd Edition, Tata McGraw-Hill, 2003.
3. Karp, Gerald "Cell and Molecular Biology : Concepts and Experiments" 4th Edition, John Wiley, 2005.
4. Friefelder, David and George M. Malacinski "Essentials of Molecular Biology" 2<sup>nd</sup> Edition, Panima Publishing, 1993.
5. Lewin's GENES XI, Published by Jones & Bartlett Learning; 11 edition (January 15, 2013).

**REFERENCES:**

1. Tropp, Burton E. "Molecular Biology : Genes to Proteins". 3rd Edition. Jones and Bartlett, 2008.
2. Glick , B.R. and J.J. Pasternak. "Molecular Biotechnology : Principles and Applications of Recombinant DNA" 4th Edition. ASM, 2010.

**BT6511**

**BIOPROCESS LABORATORY – I**

**L T P C  
0 0 4 2**

**OBJECTIVES:**

- To train the students on enzyme characterization, immobilization and medium optimization methods.
- To train on methods to investigate the growth of microorganisms in different systems under different conditions.

**LIST OF EXPERIMENTS**

1. Enzyme kinetics – Determination of Michaelis Menten parameters
2. Enzyme activity – Effect of Temperature and Deactivation Kinetics
3. Enzyme activity – Effect of pH
4. Enzyme inhibition kinetics
5. Enzyme immobilization – Gel entrapment/ Cross linking
6. Enzymatic conversion in Packed bed Column/Fluidized bed Column
7. Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient
8. Growth of Yeast – Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient
9. Medium optimization – Plackett Burman Design
10. Medium optimization – Response Surface Methodology

**TOTAL : 60 PERIODS**

**OUTCOMES:**

At the end of this course, students will be able to:

- Explain about Enzyme kinetics and characterization and how to use them for practical applications.



- Evaluate the growth kinetics of microorganisms and become adept with medium optimization techniques.
- Determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely.
- Demonstrate good lab citizenry and the ability to work in team.

#### LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Autoclave	1
Hot Air Oven	1
Incubators	2
Light Microscopes	4
Rotary Shaker	1
Column	2
Laminar Flow Chamber	2
Optimization Software	2
Calculation	5
Glassware, Chemicals, Media & As. Reagents	5
Principles of Fermentation Technology	1
Science & Technology Books.	1

#### REFERENCES:

1. Bailey and Ollis, " Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.) 1986.
2. Shuler and Kargi, " Bioprocess Engineering ", Prentice Hall, 1992.
3. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications.
4. Peter Swartz, Chemical Media & As. Reagents, Principles of Fermentation Technology, Science & Technology Books.

**BT6512**

**MOLECULAR BIOLOGY LABORATORY**

**L T P C  
0 0 4 2**

#### OBJECTIVES:

Provide hands-on experience in performing basic molecular biology techniques. Introduce students to the theory behind in each technique and to describe common applications of each methodology in biological research. This will facilitate the students to take up specialized project in Molecular biology and will be a pre-requisite for research work.

#### LIST OF EXPERIMENTS

1. Isolation of bacterial DNA
2. Isolation of plant cell and animal cell genomic DNA
3. Agarose gel electrophoresis
4. Restriction enzyme digestion
5. Competent cells preparation
6. Transformation
7. Blue and white selection for recombinants
8. Plating of  $\lambda$  phage
9. Lamda phage lysis of liquid cultures

**TOTAL : 60 PERIODS**

#### OUTCOMES:

By the end of this course, students should be able to:

- Demonstrate knowledge and understanding of the principles underpinning important techniques in molecular biology.
- Demonstrate knowledge and understanding of applications of these techniques.
- Demonstrate the ability to carry out laboratory experiments and interpret the results.
- Students will be aware of the hazardous chemicals and safety precautions in case of emergency.

#### LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Electrophoresis Kit	1
PCR	1
Incubators	2
Light Microscopes	4

Incubator Shaker	1
Spectrophotometer	2
Laminar Flow Chamber	2
Glassware, Chemicals, Media	as required

**REFERENCE:**

1. Sambrook, Joseph and David W. Russell “ The Condensed Protocols : From Molecular Cloning : A Laboratory Manual” Cold Spring Harbor , 2006.

**BT6601      TOTAL QUALITY MANAGEMENT FOR BIOTECHNOLOGISTS      LT P C  
3 0 0 3**

**OBJECTIVES:**

- The course aims to develop skills of the Students in various total quality management Principles, tools and quality systems in the Biotechnology industries.
- To understand the TQM tools for continuous process improvement of ISO and Quality systems

**UNIT I      INTRODUCTION      9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality - Basic concepts of TQM – TQM Framework - Contributions of Quality Gurus – Barriers to TQM – Cost of Quality.

**UNIT II      TQM PRINCIPLES      9**

Quality statements - Customer focus –Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Continuous process improvement – PDCA cycle, 5s, Kaizen- Supplier partnership – Partnering, Supplier selection, Supplier Rating.

**UNIT III      TQM TOOLS & TECHNIQUES I      9**

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

**UNIT IV      TQM TOOLS & TECHNIQUES II      9**

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures - BPR.

**UNIT V      QUALITY SYSTEMS      9**

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Quality Council – Leadership, Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the student will be able

- To know the basic knowledge of total quality management principles and concepts of Current Biotech Industries.
- To know the customer orientated quality and leadership and continuous improvement process and supplier selection and management
- To know the six sigma concept methodology and application and the TQM tools
- To know the design of quality systems of ISO auditing in the field of Biotechnology

**TEXT BOOK:**

1. Dale H.Besterfield, et al., “Total Quality Management”, Pearson Education Asia, Third

Edition, Indian Reprint , 2006.

**REFERENCES:**

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", (6th Edition), South-Western (Thomson Learning), 2005.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition , 2003.
3. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006 .
4. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases",Prentice Hall (India) Pvt. Ltd., 2006.

**BT6602**

**IMMUNOLOGY**

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

**OBJECTIVES:**

- To discuss the structure, functions and integration of immune system.
- To explain the antigen-antibody interactions and how the immune system is protecting the body from foreign pathogens/germs.
- To explain various techniques of monoclonal and engineered antibodies (important therapeutic molecules) production, for treating most of the human diseases.

**UNIT I INTRODUCTION**

**9**

Cells of immune system; innate and acquired immunity; primary and secondary lymphoid organs; antigens: chemical and molecular nature; haptens; adjuvants; types of immune responses; antigen processing and presentation. Theory of clonal selection. monoclonal antibodies: principles and applications.

**UNIT II CELLULAR RESPONSES**

**9**

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; antigen presenting cells; major histocompatibility complex; 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; AIDS and Immunodeficiencies; resistance and immunization; Vaccines.

**UNIT IV TRANSPLANTATION AND TUMOR IMMUNOLOGY**

**8**

Transplantation: genetics of transplantation; laws of transplantation; tumor immunology: tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy.

**UNIT V ALLERGY, HYPERSENSITIVITY AND AUTOIMMUNITY**

**7**

Allergy and hypersensitivity- Types of hypersensitivity, Autoimmunity, Auto immune disorders and diagnosis.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- The students after completing the course would be aware of immune system structure and functions.
- The students would be aware of immunity to various pathogens
- The students would be aware of how to produce the therapeutic/diagnostic molecules.
- The students would be aware of tumour, allergy and hypersensitivity reactions.

**TEXT BOOKS:**

1. Roitt I, Male, Brostoff. Immunology, Mosby Publ., 12<sup>th</sup> edition 2011.

2. Kuby J, Immunology, WH Freeman & Co., 7th Edition 2012.
3. Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 2006.

**REFERENCES:**

1. Coico, Richard "Immunology: A Short Course" 6<sup>th</sup> Edition. John Wiley, 2008.
2. Khan, Fahim Halim "Elements of Immunology" Pearson Education, 2009.

**BT6603 GENETIC ENGINEERING AND GENOMICS**

**L T P C**  
**3 1 0 4**

**OBJECTIVES:**

- To discuss the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
- To explain comparative genomics and proteomics.

**UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY 9**

Manipulation of DNA – Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for yeast, insect and mammalian systems, Prokaryotic and eukaryotic expression host systems, Introduction of recombinant DNA in to host cells and selection methods.

**UNIT II DNA LIBRARIES 9**

Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosome walking, Screening of DNA libraries using nucleic acid probes and antisera.

**UNIT III SEQUENCING AND AMPLIFICATION OF DNA 9**

Maxam Gilbert's and Sanger Coulson's and automated methods of DNA sequencing, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons, Site directed mutagenesis.

**UNIT IV 9**

Organization and structure of genomes, Genome sequencing methods, Conventional and shotgun genome sequencing methods, Next generation sequencing technologies , Ordering the genome sequence, Genetic maps and Physical maps, STS content based mapping, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Optical mapping. ORF finding and functional annotation.

**UNIT V 9**

Current status of genome sequencing projects, Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, DIGE, TOGA, Yeast Two hybrid System, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.

**TOTAL (L:45 + T:15) : 60 PERIODS**

**OUTCOMES:**

- The students after completing this course would be aware of how to clone commercially important genes.

- The students would be aware of how to produce the commercially important recombinant proteins.
- The students would be aware of gene and genome sequencing techniques.
- The students would be aware of microarrays, Analysis of Gene expression and proteomics.

**TEXT BOOKS:**

1. Primrose SB and R. Twyman "Principles Of Gene Manipulation & Geneomics Blackwell Science Publications, 2006.
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, Third Edition (Blackwell Publishing), 2003.

**REFERENCES:**

1. Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology "Greene Publishing Associates, NY, 1988.
2. Berger SI, Kimmer AR, "Methods In Enzymology", Vol 152, Academic Press, 1987.
3. Genomes 3 by T.A.Brown, Third Edition (Garland Science Publishing), 2007.

**BT6604**

**CHEMICAL REACTION ENGINEERING**

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

**OBJECTIVES:**

- To impart the knowledge of reaction rate theories and reaction mechanisms to derive expressions for rate equations mass and energy balances.
- To provide a core foundation for the analysis and design of chemical reactors.

**UNIT I SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING**

**8**

Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors.

**UNIT II IDEAL REACTORS**

**10**

Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions.

**UNIT III IDEAL FLOW AND NON IDEAL FLOW**

**10**

RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow.

**UNIT IV GAS-SOLID, GAS-LIQUID REACTIONS**

**9**

Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

**UNIT V FIXED BED AND FLUID BED REACTORS**

**8**

G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the student would be able

- To design and conduct an experimental investigation in order to determine rate equations.
- To demonstrate an ability to solve material and energy balances in order to analyze the performance of a reactor.
- To demonstrate an experimental data using standard statistical methods to establish quantitative results.

- To design a reactor for bio based products to achieve production and yield specifications.

**TEXT BOOKS:**

1. Levenspiel O. Chemical Reaction Engineering. 3rd Edition. John Wiley.1999.
2. Fogler H.S. Elements Of Chemical Reaction Engineering. Prentice Hall India.2002

**REFERENCE:**

1. Missen R.W., Mims C.A., Saville B.A. Introduction To Chemical Reaction Engineering and Kinetics. John Wiley.1999

**BT6611**

**GENETIC ENGINEERING LABORATORY**

**L T P C  
0 0 4 2**

**OBJECTIVES:**

- Provide hands-on experience in performing basic recombinant DNA techniques.
- Introduce students to the theory behind in each techniques and to describe common applications of each methodology in biological research.

**LIST OF EXPERIMENTS**

1. Preparation of plasmid DNA
2. Elution of DNA from agarose gels
3. Ligation of DNA into expression vectors
4. Transformation
5. Optimisation of inducer concentration for recombinant protein expression
6. Optimisation of time of inducer for recombinant protein expression
7. SDS-PAGE
8. Western blotting
9. Hybridisation with anti-sera
10. PCR.

**TOTAL : 60 PERIODS**

**OUTCOMES:**

By the end of this course, students should be able to:

- Describe the main principles, methods for preparation and cloning of DNA in various organisms.
- Express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
- Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.
- Students will be aware of the hazardous chemicals and safety precautions in case of emergency.

**REFERENCES:**

1. Old RW, Primrose SB, "Principles Of Gene Manipulation, An Introduction To Genetic Engineering ", Blackwell Science Publications, 1993.
2. Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology ", Greene Publishing Associates, NY, 1988.
3. Berger SI, Kimmer AR, "Methods In Enzymology", Vol 152, Academic Press,1987

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

Electrophoresis Kit	1
PCR	1
Incubators	2

**OBJECTIVES:**

- The course applies earlier learned knowledge about mass transfer in bio reactors and sterilization kinetics.
- Skills and knowledge gained is useful by analogy when solving problems typical for the bio industry or for research.

**LIST OF EXPERIMENTS**

1. Batch Sterilization kinetics
2. Batch cultivation with exhaust gas analysis.
3. Estimation of  $K_L a$  – Dynamic Gassing-out method.
4. Estimation of  $K a$  – Sulphite Oxidation Method
5. Estimation of  $K a$  – Power Correlation Method
6. Fed batch cultivation and Total cell retention cultivation
7. Algal cultivation - Photobioreactor
8. Residence time distribution
9. Estimation of Overall Heat Transfer Coefficient
10. Estimation of Mixing Time in reactor

**TOTAL : 60 PERIODS****OUTCOMES:**

At the end of this course,

- Graduates gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.
- Graduates become creative, innovative and adaptable engineers as leaders or team members in their organizations and society.
- Graduates perform competently in chemical and bioprocess industries and become important contributors to national development.
- Graduates will demonstrate advancement in their careers through increasing professional responsibility and continued life-long learning.

**REFERENCES:**

1. Anton Moser, "Bioprocess Technology, Kinetics and Reactors", , Springer Verlag.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
3. James M. Lee, Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors, Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Decker Inc.

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

Electrophoresis Kit	1
Reactors	6
Incubators	2
Light Microscopes	1
Incubator Shaker	1
Spectrophotometer	2
Glassware, Chemicals, Media	as required
Laminar Flow Chamber	1

**OBJECTIVES:**

To enable learners to,

- Develop their communicative competence in English with specific reference to speaking and listening
- Enhance their ability to communicate effectively in interviews.
- Strengthen their prospects of success in competitive examinations.

**UNIT I LISTENING AND SPEAKING SKILLS 12**

Conversational skills (formal and informal)- group discussion- making effective presentations using computers, listening/watching interviews conversations, documentaries. Listening to lectures, discussions from TV/ Radio/ Podcast.

**UNIT II READING AND WRITING SKILLS 12**

Reading different genres of texts ranging from newspapers to creative writing. Writing job applications- cover letter- resume- emails- letters- memos- reports. Writing abstracts- summaries- interpreting visual texts.

**UNIT III ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS AND PLACEMENTS 12**

International English Language Testing System (IELTS) - Test of English as a Foreign Language (TOEFL) - Civil Service(Language related)- Verbal Ability.

**UNIT IV INTERVIEW SKILLS 12**

Different types of Interview format- answering questions- offering information- mock interviews-body language( paralinguistic features)- articulation of sounds- intonation.

**UNIT V SOFT SKILLS 12**

**Motivation- emotional intelligence**-Multiple intelligences- emotional intelligence- managing changes-time management-stress management-leadership straits-team work- career planning - intercultural communication- creative and critical thinking

**TOTAL: 60 PERIODS**

**Teaching Methods:**

1. To be totally learner-centric with minimum teacher intervention as the course revolves around practice.
2. Suitable audio/video samples from Podcast/YouTube to be used for illustrative purposes.
3. Portfolio approach for writing to be followed. Learners are to be encouraged to blog, tweet, text and email employing appropriate language.
4. GD/Interview/Role Play/Debate could be conducted off the laboratory (in a regular classroom) but learners are to be exposed to telephonic interview and video conferencing.
5. Learners are to be assigned to read/write/listen/view materials outside the classroom as well for gaining proficiency and better participation in the class.

**Lab Infrastructure:**

S. No.	Description of Equipment (minimum configuration)	Qty Required
1	Server	1 No.



	<ul style="list-style-type: none"> <li>• PIV System</li> <li>• 1 GB RAM / 40 GB HDD</li> <li>• OS: Win 2000 server</li> <li>• Audio card with headphones</li> <li>• JRE 1.3</li> </ul>	
2	<b>Client Systems</b> <ul style="list-style-type: none"> <li>• PIII or above</li> <li>• 256 or 512 MB RAM / 40 GB HDD</li> <li>• OS: Win 2000</li> <li>• Audio card with headphones</li> <li>• JRE 1.3</li> </ul>	60 Nos.
3	Handicam	1 No.
4	Television 46"	1 No.
5	Collar mike	1 No.
6	Cordless mike	1 No.
7	Audio Mixer	1 No.
8	DVD recorder/player	1 No.
9	LCD Projector with MP3/CD/DVD provision for Audio/video facility	1 No.

**Evaluation:**

**Internal: 20 marks**

Record maintenance: Students should write a report on a regular basis on the activities conducted, focusing on the details such as the description of the activity, ideas emerged, learning outcomes and so on. At the end of the semester records can be evaluated out of 20 marks.

**External: 80 marks**

- Online Test - 35 marks
- Interview - 15 marks
- Presentation - 15 marks
- Group Discussion - 15 marks

**Note on Internal and External Evaluation:**

1. Interview – mock interview can be conducted on one-on-one basis.
2. Speaking – example for role play:
  - a. Marketing engineer convincing a customer to buy his product.
  - b. Telephonic conversation- fixing an official appointment / placing an order / enquiring and so on.
3. Presentation – should be extempore on simple topics.
4. Discussion – topics of different kinds; general topics, and case studies.

**OUTCOMES:**

**At the end of the course, learners should be able to**

- Take international examination such as IELTS and TOEFL
- Make presentations and Participate in Group Discussions.
- Successfully answer questions in interviews.

#### REFERENCES:

1. **Business English Certificate Materials**, Cambridge University Press.
2. **Graded Examinations in Spoken English and Spoken English for Work** downloadable materials from Trinity College, London.
3. **International English Language Testing System** Practice Tests, Cambridge University Press.
4. Interactive Multimedia Programs on **Managing Time and Stress**.
5. **Personality Development** (CD-ROM), Times Multimedia, Mumbai.
6. Robert M Sherfield and et al. "**Developing Soft Skills**" 4th edition, New Delhi: Pearson Education, 2009.

#### Web Sources:

<http://www.slideshare.net/rohitjsh/presentation-on-group-discussion>  
[http://www.washington.edu/doi/TeamN/present\\_tips.html](http://www.washington.edu/doi/TeamN/present_tips.html)  
<http://www.oxforddictionaries.com/words/writing-job-applications>  
<http://www.kent.ac.uk/careers/cv/coveringletters.htm>  
[http://www.mindtools.com/pages/article/newCDV\\_34.htm](http://www.mindtools.com/pages/article/newCDV_34.htm)

**BT6701 BIOINFORMATICS AND COMPUTATIONAL BIOLOGY**

**LT P C  
3 0 0 3**

#### OBJECTIVES:

- To improve the programming skills of the student
- To let the students know the recent evolution in biological science.

#### UNIT I

**9**

Introduction to Operating systems, Linux commands, File transfer protocols ftp and telnet, Introduction to Bioinformatics and Computational Biology, Biological sequences, Biological databases, Genome specific databases, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL).

#### UNIT II

**9**

Sequence Analysis, Pairwise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment. Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms.

#### UNIT III

**8**

Introduction to phylogenetics, Distance based trees UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure prediction methods, Homology modeling, *abinitio* approaches, Threading, Critical Assessment of Structure Prediction, Structural genomics.

**UNIT IV** **11**  
Machine learning techniques: Artificial Neural Networks in protein secondary structure prediction, Hidden Markov Models for gene finding, Decision trees, Support Vector Machines. Introduction to Systems Biology and Synthetic Biology, Microarray analysis, DNA computing, Bioinformatics approaches for drug discovery, Applications of informatics techniques in genomics and proteomics: Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting.

**UNIT V** **8**  
Basics of PERL programming for Bioinformatics: Datatypes: scalars and collections, operators, Program control flow constructs, Library Functions: String specific functions, User defined functions, File handling.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, students will be able to

- Develop bioinformatics tools with programming skills.
- Apply computational based solutions for biological perspectives.
- Pursue higher education in this field.
- Practice life-long learning of applied biological science.

**TEXT BOOKS:**

1. Lesk, A. K., "Introduction to Bioinformatics" 4<sup>th</sup> Edition, Oxford University Press, 2013
2. Dan Gusfield, "Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology" Cambridge University Press, 1997.
3. Durbin, R., Eddy, S., Krogh, A., and Mitchison, G., "Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids" Cambridge, UK: Cambridge University Press, 1998.
4. Mount, D.W., "Bioinformatics Sequence and Genome Analysis" 2<sup>nd</sup> Edition, Cold Spring Harbor Laboratory Press, 2004
5. Tindall, J., "Beginning Perl for Bioinformatics: An introduction to Perl for Biologists" 1<sup>st</sup> Edition, O'Reilly Media, 2001

**REFERENCE:**

1. Baldi, P. and Brunak, S., "Bioinformatics: The Machine Learning Approach" 2<sup>nd</sup> Edition, MIT Press, 2001.

**BT6702**

**DOWNSTREAM PROCESSING**

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

**OBJECTIVES:**

To enable the students to

- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- Have depth knowledge and hands on experience with on Downstream processes

**UNIT I** **8**  
**DOWNSTREAM PROCESSING**  
Introduction to downstream processing principles characteristics of biomolecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pretreatment and stabilisation of bioproducts.

**UNIT II** **9**  
**PHYSICAL METHODS OF SEPERATION**  
Unit operations for solid-liquid separation - filtration and centrifugation.

**UNIT III** **10**  
**ISOLATION OF PRODUCTS**  
Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

**UNIT IV PRODUCT PURIFICATION 10**  
 Chromatography – principles, instruments and practice, adsorption, reverse phase, ion-exchange, size exclusion, hydrophobic interaction, bioaffinity and pseudo affinity chromatographic techniques.

**UNIT V FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS 8**  
 Crystallization, drying and lyophilization in final product formulation.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon successful completion of this course, the students will be able to:

- Define the fundamentals of downstream processing for product recovery
- Understand the requirements for successful operations of downstream processing
- Describe the components of downstream equipment and explain the purpose of each
- Apply principles of various unit operations used in downstream processing and enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.

**TEXTBOOKS:**

1. Belter, P.A. E.L. Cussler And Wei-Houhu – “Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pub. (1988).
2. Sivasankar, B. “Bioseparations : Principles and Techniques”. PHI, 2005.

**REFERENCES:**

1. R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
2. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.
3. R.K. Scopes – Protein Purification – Principles And Practice, Narosa Pub. (1994).

**BT6703 CREATIVITY, INNOVATION AND NEW PRODUCT DEVELOPMENT LT P C 3 0 0 3**

**OBJECTIVE:**

To impart the knowledge of various aspects of Creativity, Innovation and New Product Development

**UNIT I INTRODUCTION 9**  
 The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - creativity and problem solving - brainstorming - different techniques

**UNIT II PROJECT SELECTION AND EVALUATION 9**  
 Collection of ideas and purpose of project - Selection criteria - screening ideas for new products (evaluation techniques)

**UNIT III NEW PRODUCT DEVELOPMENT 9**  
 Research and new product development - Patents - Patent search - Patent laws - International code for patents - Intellectual property rights (IPR).

**UNIT IV NEW PRODUCT PLANNING 9**  
 Design of proto type - testing - quality standards - marketing research introducing new products

**UNIT V MODEL PREPARATION & EVALUATION 9**  
 Creative design - Model Preparation - Testing - Cost evaluation – Patent application

**TOTAL : 45 PERIODS**

**OUTCOME:**

On completion of the course, students will have gained knowledge on various issues related to Patents, Quality, Creativity, Innovation, New Product Development, Planning and Evaluation.

**TEXT BOOKS:**

1. Twiss, Brian. "Managing Technological Innovation", Pitman Publishing Ltd., 1992.
2. Watton, Harry B. "New Product Planning", Prentice Hall Inc., 1992.

**REFERENCES:**

1. Nystrom, Harry "Creativity and Innovation", John Wiley & Sons, 1979.
2. Khandwalla, N. – "Fourth Eye (Excellence through Creativity) - Wheeler Publishing", 1992.
3. I.P.R. Bulletins, TIFAC, New Delhi, 1997.

**BT6711**

**DOWNSTREAM PROCESSING LABORATORY**

**L T P C**

**0 0 4 2**

**OBJECTIVES:**

To provide hands on training in Down stream processing through simple experimentations in the laboratory. This will be a pre-requisite for project work.

The objectives of this course is to practice the students

- To understand the nature of the end product, its concentration, stability and degree of purification required
- To design processes for the recovery and subsequent purification of target biological products.

**LIST OF EXPERIMENTS**

1. Solid liquid separation – centrifugation, microfiltration
2. Cell disruption techniques – ultrasonication, French pressure cell
3. Cell disruption techniques – dynamill – batch and continuous
4. Precipitation – ammonium sulphite precipitation
5. Ultra filtration separation
6. Aqueous two phase extraction of biologicals
7. High resolution purification – affinity chromatography
8. High resolution purification – ion exchange chromatography
9. Product polishing – spray drying, freeze drying

**TOTAL : 60 PERIODS**

**OUTCOMES:**

Upon success completion of this course, the students would have

- Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
- Learned cell disruption techniques to release intracellular products
- Learned various techniques like evaporation, extraction, precipitation, membrane separation for concentrating biological products
- Learned the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

- |                                 |   |
|---------------------------------|---|
| 1. Centrifuge                   | 1 |
| 2. Cross flow filtration set up | 2 |
| 3. FPLC                         | 1 |
| 4. Sonicator                    | 1 |

**REFERENCES:**

1. P.A. Belter, E.L. Cussler And Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun. (1988).
2. R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
3. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.

**BT6712****IMMUNOLOGY LABORATORY****LT P C  
0 0 4 2****OBJECTIVES:**

- To give practical training in the functioning of immune system.
- To give laboratory training in different immunological and immunotechnological techniques.

**LIST OF EXPERIMENTS**

- 1) Handling of animals, immunization and raising antisera
- 2) Identification of cells in a blood smear
- 3) Identification of blood group
- 4) Immunodiffusion
- 5) Immunoelectrophoresis
- 6) Testing for typhoid antigens by Widal test
- 7) Enzyme Linked ImmunoSorbent Assay (ELISA)
- 8) Isolation of peripheral blood mononuclear cells
- 9) Isolation of monocytes from blood
- 10) Immunofluorescence
- 11) Identification of t cells by T-cell rosetting using sheep RBC.

**TOTAL : 60 PERIODS****OUTCOMES:**

- The students would be aware of immune system cells and tissues.
- The students would have knowledge on immunological /clinical tests.
- The students would be able to isolate lymphocytes and monocytes.
- The students would be able to identify various immune system cells.

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

Elisa reader	1
Microscopes	8
Microwave oven	1
Hot plate	4
Vortex mixer	4
Table top refrigerated Centrifuge	1
Fluorescent microscope	1

**REFERENCES:**

1. Roitt I, Male, Brostoff. Immunology, Mosby Publ., 2002.
2. Kuby J, Immunology, WH Freeman & Co., 2000.
3. Ashim K. Chakravarthy, Immunology, TataMcGraw-Hill, 1998.

**BT6713****BIOINFORMATICS LABORATORY****L T P C  
0 0 4 2****OBJECTIVES:**

- To get qualified with programming knowledge.
- To enable the usage of recent bio-tools.

## LIST OF EXPERIMENTS

### 1. Introduction to UNIX basic commands and UNIX Filters.

### 2. Perl programming and applications to Bioinformatics.

- Basic scripting.
- Regular expressions.
- File i/o & control statement.
- Subroutines & functions.
- Writing scripts for automation.

### 3. Types of Biological Databases and Using it.

- Genbank.
- Protein Data Bank .
- Uniprot.

### 4. Sequence Analysis Tools

- Use of BLAST, FASTA (Nucleic Acids & Proteins).
- Use of Clustal W.
- Use of EMBOSS.

### 5. Phylogenetic Analysis

- Use of Phylip.

### 6. Molecular Modeling

- Homology Modeling – Swissmodeller.
- Any Open Source Software .

**TOTAL : 60 PERIODS**

## OUTCOMES:

Upon completion of this course, students will be able:

- To understand basic commands in UNIX OS.
- To apply Perl programming to develop bioinformatics tools.
- To understand different biological databases.
- To carry out sequence and phylogenetic analysis.

## LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

One computer for every 2 students with the software indicated.

**BT6001**

**INTRODUCTION TO SYMBOLIC MATHEMATICS**

**LT P C  
2 0 2 3**

## OBJECTIVE:

This course will help the students to learn MATLAB, its operators and loops, data flow, Program Design and Development and their virtual instrumentation.

## UNIT I INTRODUCTION TO MATLAB

**9**

Introduction - Operations with variables – Arrays - Multidimensional Arrays - Element by Element operations - Polynomial operations using arrays - Cell Arrays - Structure arrays - Writing script files - Logical variables and operators- Flow control- Loop operators- Writing functions- Input/ output arguments- Function visibility, path.- Simple graphics- 2D plots- Figures and subplots

**UNIT II DATA AND DATA FLOW IN MATLAB 9**  
Data types- Matrix, string -cell and structure- Creating, accessing elements and manipulating of data of different types - File Input-Output- Matlab files- Text files- Binary files - Mixed text- binary files- Communication with external devices- Serial port- Parallel port- Sound card- Video input

**UNIT III FUNCTIONS & FILES 9**  
Elementary Mathematical Functions - User Defined Functions - Advanced Function Programming - Working with Data Files, Introduction to Numerical Methods -Linear algebra- numerical integration and differentiation- solving systems of ODE's and interpolation of data.

**UNIT IV PROGRAMMING TECHNIQUES & DATA VISUALIZATION AND STATISTICS 9**  
Program Design and Development - Relational Operators and Logical Variables Logical Operators and Functions - Conditional Statements -Loops - Basic statistical tools in Matlab, XY- plotting functions - Subplots and Overlay plots - Special Plot types - Interactive plotting - Designing GUI interfaces using Matlab's GUIDE interface.

**UNIT V FUNDAMENTALS OF VIRTUAL INSTRUMENTATION & DATA ACQUISITION 9**  
Concept of virtual instrumentation (VI)– LabVIEW software- basics- Creating, Editing and debugging a VI in LabVIEW- Creating a sub VI- Loops and charts- data acquisition with LabVIEW- plug-in DAQ boards- Organization of the DAQ VI System- Performing analog input and analog output- Scanning multiple analog channels- Driving the digital I/Os- Buffered data acquisition

**TOTAL : 45 PERIODS**

**OUTCOME:**

Upon completion of this course, students will be able design programs and understand virtual instrumentation and data design.

**TEXT BOOKS**

1. Essential Matlab for Engineers and Scientists (Fourth Edition). Copyright © 2010 Elsevier Ltd. Author(s): Brian H. Hahn and Daniel T. Valentine ISBN: 978-0-12-374883-6
2. Rahman, and Herbert Pichlik,, 'LabVIEW – Applications and Solutions', National Instruments Release, ISBN 01309642392. National Instruments LabVIEW Manual

**ONLINE MATLAB TUTORIALS AND REFERENCES:**

1. Tutorials offered by The Mathworks .The creators of Matlab.
2. Introductory Matlab material from Indiana University
3. A practical introduction to Matlab from Michigan Tec
4. Links to Matlab tutorials, references, books, packages, etc. -- from the Math Department at UIC

**MATLAB GUIDES PROVIDED WITH THE MATLAB INSTALLATION:**

1. Getting Started with Matlab
  2. Using Matlab
  3. Using Graphs in Matlab
  4. Using GUIs in Matlab
- For links to these documents visit Dr. Randy Jost's web page (USU ECE Department). For other links related to Matlab,



**OBJECTIVES:**

To enable the students

- To gain structural knowledge of biological systems.
- To understand transport and dynamic properties of biological systems.

**UNIT I MOLECULAR STRUCTURE OF BIOLOGICAL SYSTEMS 9**

Intramolecular bonds – covalent – ionic and hydrogen bonds – biological structures – general features – water structure – hydration – interfacial phenomena and membranes – self assembly and molecular structure of membranes.

**UNIT II CONFORMATION OF NUCLEIC ACIDS 9**

Primary structure – the bases – sugars and the phosphodiester bonds- double helical structure – the a b and z forms – properties of circular DNA – topology – polymorphism and flexibility of DNA – structure of ribonucleic acids – hydration of nucleic acids.

**UNIT III CONFORMATION OF PROTEINS 9**

Conformation of the peptide bond – secondary structures – Ramachandran plots – use of potential functions – tertiary structure – folding – hydration of proteins – hydrophathy index.

**UNIT IV CELLULAR PERMEABILITY AND ION – TRANSPORT 9**

Ionic conductivity – transport across ion channels – mechanism - ion pumps-proton transfer – nerve conduction – techniques of studying ion transport and models.

**UNIT V ENERGETICS & DYNAMICS OF BIOLOGICAL SYSTEMS 9**

Concepts in thermodynamics – force and motion – entropy and stability – analyses of fluxes – diffusion potential – basic properties of fluids and biomaterials – laminar and turbulent flows.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, students will be able:

- To analyze the various forces responsible for biological molecular structure.
- To be familiar with different levels of conformation in biomolecules.
- To gain the knowledge of cellular permeability and ion transport.
- To understand the dynamics of biological systems.

**TEXTBOOKS:**

1. Glaser R., "Biophysics" Springer Verlag , 2000.
2. Duane R., "Biophysics: Molecules In Motion" Academic Press, 1999.

**REFERENCE:**

1. Charles C.R., and Schimmel P.R., "Biophysical Chemistry" 1-3 Vols, W.H. Freeman & Co., 1980.

**BT6003**

**PRINCIPLES OF FOOD PROCESSING**

**LT P C  
3 0 0 3**

**OBJECTIVES:**

To enable the students

- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms, which spoil food and food borne diseases.
- To know different techniques used for the preservation of foods.

**UNIT I FOOD AND ENERGY 9**

Constituents of food – carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics.

**UNIT II FOOD ADDITIVES 9**  
Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.

**UNIT III MICROORGANISMS ASSOCIATED WITH FOOD 9**  
Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; fermented foods and food chemicals, single cell protein.

**UNIT IV FOOD BORNE DISEASES 9**  
Classification – food infections – bacterial and other types; food intoxications and poisonings – bacterial and non-bacterial; food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.

**UNIT V FOOD PRESERVATION 9**  
Principles involved in the use of sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning; frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Through this subject the student can understand about

- Different constituents present in food and microorganism involved in processing of food.
- Principles and different preservations techniques of food can also be known.
- Unit operations in modern food processing and impact of the process on food quality

**TEXTBOOKS:**

1. T.P. Coultate – Food – The Chemistry Of Its Components, 2<sup>nd</sup> Edn. Royal Society, London, 1992.
2. B. Sivasanker – Food Processing And Preservation, Prentice-Hall Of India Pvt. Ltd. New Delhi 2002.

**REFERENCES:**

1. W.C. Frazier And D.C. Westhoff – Food Microbiology, 4<sup>th</sup> Ed., Mcgraw-Hill Book Co., New York 1988.
2. J.M. Jay – Modern Food Microbiology, Cbs Pub. New Delhi, 1987.

**BT6004**

**ADVANCED BIOCHEMISTRY**

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

**OBJECTIVES:**

- To orient towards the application of knowledge acquired in solving clinical problems.
- To provide a base for molecular modelling and drug designing

**UNIT I METABOLISM OF AMINO ACIDS 10**

Biosynthesis of Gly, Ser and Cys; Biosynthesis of six essential amino acids (Met, Thr, Lys, Ile, Val, Leu) and regulation of branched chain amino acids (concerted inhibition, allosteric regulation and enzyme multiplicity, sequential feed back) from oxaloacetate and pyruvate; Biosynthesis of aromatic amino acids. Metabolic disorders associated with branched chain and aromatic amino acid degradation. Important molecules derived from amino acids (auxins, DOPA, Serotonin, porphyrins, T3, T4, Adrenaline, Noradrenaline, histamine, GABA, polyamines etc)

**UNIT II PROTEIN TRANSPORT AND DEGRADATION 5**

Protein targeting, signal sequence, secretion; Folding, Chaperons and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.

**UNIT III METABOLISM OF NUCLEIC ACIDS, POLYSACCHARIDES AND LIPIDS 12**

Biosynthesis of nucleotides, denovo and salvage pathways for purines and pyrimidines, regulatory mechanisms: Degradation of nucleic acid by exo and endo nucleases. Biosynthesis and degradation of starch and glycogen. Triacylglycerol and phospholipid biosynthesis and degradation; Cholesterol biosynthesis and regulation and targets and action of cholesterol lowering drugs.

**UNIT IV VITAMINS AND COENZYMES 9**

Fat Soluble Vitamins, provitamins (A, D, E and K). Structure, physiological significance and deficiency symptoms. Water soluble vitamins, structure, coenzyme role and deficiency symptoms. Thiamine, riboflavin, pyridoxine, niacin, folic acid, biotin and Vitamin B12. Recommended dietary intake. Coenzymes: Their role in metabolic pathways. NAD, FAD, TPP, PLP, carboxy biotin

**UNIT V HORMONES 9**

Introduction. Effects of Hormones. Chemical classification of hormones. Peptide hormone- vasopressin, protein hormone- insulin. Lipid and phospholipid derived hormones- prostaglandin and phospholipids. Steroid hormones- testosterone, estrogen, cortisol. Monoamines: thyroxine, adrenaline. Mechanism of action of the different classes of hormones.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon completion of advanced biochemistry, students will be able

- To recognize how fundamental chemical principles and reactions are utilized in biochemical Processes.
- To apply knowledge gained in food and drug industries.
- To define various metabolic concepts for applying them to solve clinical problems.
- To summarize the knowledge of biomolecules to use them in biotechnology industry

**TEXT BOOKS:**

1. Nelson, D.L et al., "Lehninger's Principles of Biochemistry"
2. Stryer, Lubert. "Biochemistry". 4th Edition, W.H Freeman & Co., 2000.
3. Voet, D.J and J.G. Voet and C.W. Pratt "Principles of Biochemistry" 3<sup>rd</sup> Edition, John Wiley & Sons Inc., 2008.
4. Murray, R.K., et al., "Harper's Illustrated Biochemistry". 27th Edition. McGraw-Hill, 2006.

**REFERENCES:**

1. Creighton. T.E., "Proteins: Structure and Molecular Properties" 2<sup>nd</sup> Edition, W.H.Freeman and Co., 1993.
2. Salway, J.G., "Metabolism at a Glance". 2nd Edition, Blackwell Science Ltd., 2000.

**BT6005**

**BIOLOGICAL SPECTROSCOPY**

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

**OBJECTIVES:**

- To deliver the knowledge of spectroscopic techniques and its functions
- To provide the technical information of spectroscopy for biological applications

**UNIT I OPTICAL ROTATORY DISPERSION AND FLUORESCENC POLARIZATION 9**

Polarized light – optical rotation – circular dichroism – circular dichroism of nucleic acids and proteins – Fluorescence polarization – Integration of HIV genome into host genome and alpha- Ketoglutarate.

**UNIT II NUCLEAR MAGNETIC RESONANCE 9**

Chemical shifts – Spin-spin coupling – Relaxation mechanisms – Nuclear overhauser effect multidimensional nmr spectroscopy – Determination of macromolecular structure by NMR – Magnetic resonance imaging.

**UNIT III MASS SPECTROMETRY 9**

Ion sources sample introduction – Mass analyzers and ion detectors – Biomolecule mass sepectrometry – Analysis of peptide and protein, carbohydrates and small molecules – Applications of mass spectrometry.

**UNIT IV X-RAY DIFFRACTION 9**

Scattering by x- rays – Diffraction by a crystal – Measuring diffraction pattern – Bragg reflection – Unit cell – Phase problems – Anomalous diffraction – Determination of crystal structure – Electron and neutron diffraction.

**UNIT V SPECIAL TOPICS AND APPLICATIONS 9**

Electron microscopy – Transmission and scanning electron microscopy – Scanning tunneling and atomic force microscopy – Combinatorial chemistry and high throughput screening methods.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the student would be able understand

- Basics of optical rotary dispersion methods and nuclear magnetic resonance
- Principles and applications of mass spectrometry and X-ray diffraction
- About the microscopic techniques and applications
- And apply the spectroscopic techniques for various biological applications

**TEXT BOOKS:**

1. Hammes G.G., "Spectroscopy for the Biological Sciences", Wiley-Inter Science, First Edition, 2005.
2. Ramamoorthy A., "NMR Spectroscopy of Biological Solids", CRC Press, 2005.

**REFERENCES:**

1. Campbell I.D and Dwek R.A., " Biological Spectroscopy ", Benjami Cummins and Company, 1986.
2. Pretsch E., Bühlmann P. and Badertscher M., "Structure Determination of Organic compounds: Tables of Spectral Data", Springer, Fourth Edition, 2009.
3. Gremlich H. and Yan B., "Infrared and Raman Spectroscopy of Biological Materials", CRC Press, 2000.
4. Greve J., Puppels G.J. and Otto C., "Spectroscopy of Biological Molecules: New Directions Springer", First Edition, 1999.

**BT6006**

**BIOPHARMACEUTICAL TECHNOLOGY**

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

**OBJECTIVES:**

The aim of the course is to give strong foundation and advanced information on biopharmaceutical aspects in relation to drug development.

- This course provides core responsibilities for the development and monitoring of the drug and the preparation of medicines according to the norms.
- To gain knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>7</b>
Pharmaceutical industry & development of drugs ; types of therapeutic agents and their uses; economics and regulatory aspects .		
<b>UNIT II</b>	<b>DRUG ACTION, METABOLISM AND PHARMACOKINETICS</b>	<b>9</b>
Mechanism of drug action; physico-chemical principles of drug metabolism; radioactivity; pharmacokinetics.		
<b>UNIT III</b>	<b>MANUFACTURE OF DRUGS, PROCESS AND APPLICATIONS</b>	<b>7</b>
Types of reaction process and special requirements for bulk drug manufacture.		
<b>UNIT IV</b>	<b>PRINCIPLES OF DRUG MANUFACTURE</b>	<b>15</b>
Compressed tablets; dry and wet granulation; slugging or direct compression; tablet presses; coating of tablets; capsule preparation; oval liquids – vegetable drugs – topical applications; preservation of drugs; analytical methods and other tests used in drug manufacture; packing techniques; quality management; GMP.		
<b>UNIT V</b>	<b>BIOPHARMACEUTICALS</b>	<b>7</b>
Various categories of therapeutics like vitamins, laxatives, analgesics, contraceptives, antibiotics, hormones and biologicals.		

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- The knowledge gained in this course would be used to understand and evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market.
- This course paves a ways to the students to acquire knowledge on novel biotechnological and pharmaceutical products, current medicines and their applications in therapeutic and diagnostic fields.

The course would facilitate the students to

- Demonstrate knowledge and understanding of current topical and newly emerging aspects of pharmaceutical biotechnology.
- Understand the legal steps involved in progressing a new drug to market. Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries.

**TEXT BOOKS:**

1. Finkel, Richard, et al., “Lippincott’s Illustrated Reviews Pharmacology” 4<sup>th</sup> Edition. Wolters Kluwer / Lippincott Williams & Wilkins, 2009.
2. Shayne Cox Gad. Pharmaceutical Manufacturing Handbook, Published by John Wiley & Sons, Inc., 2008.
3. Bernd Meibohm. Pharmacokinetics and Pharmacodynamics of biotech drugs, Published by Wiley-VCH, 2006.

**REFERENCES:**

1. Gareth Thomas. Medicinal Chemistry. An introduction. John Wiley. 2000.
2. Katzung B.G. Basic and Clinical Pharmacology, Prentice Hall of Intl. 1995.

**GE6081**

**FUNDAMENTALS OF NANOSCIENCE**

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

**OBJECTIVE:**

To learn about basis of nanomaterial science, preparation method, types and application

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>8</b>
Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).		
<b>UNIT II</b>	<b>GENERAL METHODS OF PREPARATION</b>	<b>9</b>
Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.		
<b>UNIT III</b>	<b>NANOMATERIALS</b>	<b>12</b>
Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO <sub>2</sub> ,MgO, ZrO <sub>2</sub> , NiO, nanoalumina, CaO, AgTiO <sub>2</sub> , Ferrites, Nanoclays-functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications		
<b>UNIT IV</b>	<b>CHARACTERIZATION TECHNIQUES</b>	<b>9</b>
X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation		
<b>UNIT V</b>	<b>APPLICATIONS</b>	<b>7</b>
NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechnology: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery		
<b>TOTAL : 45 PERIODS</b>		

**OUTCOMES:**

Upon completing this course, the students

- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Will develop knowledge in characteristic nanomaterial

**TEXT BOOKS:**

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, "Nanoscale charecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000

**REFERENCES:**

1. G Timp (Editor), "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia (Editor), "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

- To provide the fundamentals of animal cell culture, details of the diseases and therapy
- To offer the knowledge about the micromanipulation and transgenic animals

**UNIT I ANIMAL CELL CULTURE 12**

Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell cultures, their maintenance and preservation; various types of cultures-suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures.

**UNIT II ANIMAL DISEASES AND THEIR DIAGNOSIS 10**

Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, *in-situ* hybridization; northern and southern blotting; RFLP.

**UNIT III THERAPY OF ANIMAL DISEASES 12**

Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; vaccines and their applications in animal infections; gene therapy for animal diseases.

**UNIT IV MICROMANIPULATION OF EMBRYO'S 6**

What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; *in vitro* fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

**UNIT V TRANSGENIC ANIMALS 5**

Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this subject the student will be able to

- Understand the animal cell culture, animal diseases and its diagnosis
- Gain the knowledge for therapy of animal infections
- Know the concepts of micromanipulation technology and transgenic animal technology
- Use the knowledge gained in this section to apply in the field of clinical research

**TEXT BOOKS:**

1. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
2. Ramadass P, Meera Rani S. Text Book of Animal Biotechnology. Akshara Printers, 1997.

**REFERENCES:**

1. Freshney, R.I., "Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications", 6<sup>th</sup> Edition, John Wiley & Sons, 2010.
2. Portner, R., "Animal Cell Biotechnology: Methods and Protocols", 2<sup>nd</sup> Edition, Humana Press, 2007
3. Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000

**BT6008 MOLECULAR PATHOGENESIS OF INFECTIONS DISEASES L T P C  
3 0 0 3**

**OBJECTIVES:**

To enable the students

- To understand about the microbial toxins and modern molecular pathogenesis
- To know about the host pathogen interaction and identifying virulence factors
- To control pathogens by modern approaches.

**UNIT I OVERVIEW 5**

Historical perspective - discovery of microscope, Louis Pasteur's contributions, 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 8**

Attributes & 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 (WITH SPECIFIC EXAMPLES) 16**

Virulence, virulence factors, virulence-associated factors and virulence lifestyle 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), labile & stable toxins, Entero- pathogenic *E.coli* (EPEC), type III secretion, cytoskeletal changes, intimate attachment; Enterohaemorrhagic *E.coli* (EHEC), mechanism of bloody diarrhoea and Hemolytic Uremic Syndrome, Enteroaggregative *E.coli* (EAEC). Shigella: Entry, macrophage apoptosis, induction of macropinocytosis, uptake by epithelial cells, intracellular spread, inflammatory response, tissue damage Plasmodium: Life cycle, erythrocyte stages, transport mechanism and processes to support the rapidly growing schizont, parasitiparous vacuoles, and knob protein transport, Antimalarials based on transport processes. Influenza virus: Intracellular stages, Neuraminidase & Haemagglutinin in entry, M1 & M2 proteins in assembly and disassembly, action of amantidine.

**UNIT IV EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS 8**

Virulence assays: adherence, invasion, cytopathic, cytotoxic effects. Criteria & tests in identifying virulence factors, attenuated mutants, molecular characterization of virulence factors, signal transduction & host responses

**UNIT V MODERN APPROACHES TO CONTROL PATHOGENS 8**

Classical approaches based on serotyping. Modern diagnosis based on highly conserved virulence factors, immuno & 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 PERIODS**

**OUTCOMES:**

Upon completion of this course, the student will be able to understand the

- Host pathogen interactions at the level of cellular and molecular networks.
- Diagnosis of diseases through the examination of molecules.
- Modern therapeutic strategies on various pathogens.

**TEXTBOOKS:**

1. Iglewski B.H and Clark V.L " Molecular basis of Bacterial Pathogenesis ", Academic Press, 1990.
2. Eduardo A. Groisman, Principles of Bacterial Pathogenesis, Academic Press, 2001.

**REFERENCES:**

1. Peter Williams, Julian Ketley & George Salmond, "Methods in Microbiology : Bacterial Pathogenesis, Vol. 27", Academic Press, 1998.
2. Recent reviews in Infect. Immun., Mol. Microbiol., Biochem. J., EMBO etc
3. Nester, Anderson, Roberts, Pearsall, Nester, "Microbiology: A Human Perspective", Mc



Graw Hill, 3<sup>rd</sup> Edition, 2001.

4. Brenda B. Wilson, Abigail A. Salyers, Dixie D. Witt, Malcolm E. Winkler, "Bacterial Pathogenesis", ASM press, 3<sup>rd</sup> Edition, 2011.

**BT6009**

**CANCER BIOLOGY AND THERAPEUTICS**

**L T P C**

**3 0 0 3**

**OBJECTIVES:**

To enable the students to understand

- Basic biology of cancer
- Impact of antibodies against cancer in the human body leading to more effective treatments
- Enhanced immunology based detection methods and imaging techniques
- Development of cell based and cytokine based immunotherapy against cancer.

**UNIT I OVERVIEW AND ELEMENTS OF THE CANCER IMMUNOLOGY 5**

Role of Immune system in cancer – role of individual immune cell types against cancer – role of cytokines in immune cell programming against cancer.

**UNIT II CANCER ANTIGENS 10**

Source of cancer antigens – clonal (viral)/mutational origin – detection and processing by immune cell types through MHC - T-cell receptor - B-cell receptor and cytokines involved - cancer cell death strategies induced by immune cells.

**UNIT III ANTIBODY DEVELOPMENT AGAINST CANCER ANTIGENS 12**

Role of VDJ recombination – Causes for the failure to recognize cancer antigen – roles and mechanism of immune self-tolerance machinery and Immune surveillance – Correlating pathway specific deregulations in self-tolerance machinery and Immune surveillance as a risk factor/potential target towards autoimmune disorders and cancer.

**UNIT IV IMMUNE EVASION BY CANCER 8**

Cytokines involved – Role of T regulatory and Th17 cells – Role of cancer microenvironment in influencing immune response.

**UNIT V MEDICAL APPLICATIONS OF CANCER THERAPEUTICS 10**

Use of cancer antigens in cancer detection/classification – Cancer antigen based vaccines – Monoclonal antibodies in cancer diagnosis, imaging and immunotherapy – use of cytokines as biological response modifiers – cell based therapy against cancer.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

The course would facilitate the students

- To appreciate the role of immune system in cancer
- To describe self – tolerance machinery and immune surveillance
- To understand the cancer microenvironment and its influence on immune cells
- To have awareness on medical applications of cytokines and immune cells against cancer

**TEXT BOOKS:**

1. Thomas J. Kindt, Barbara A. Osborne and Richard Goldsby. Kuby Immunology, 6<sup>th</sup> edition. W.H. Freeman, 2007
2. Stella Pelengaris and Michael Khan. The Molecular Biology of Cancer, 2<sup>nd</sup> edition. Wiley – Blackwell, 2013

**REFERENCES:**

1. Roitt I., Brostoff J. and Male D. Immunology, 6<sup>th</sup> ed. Mosby, 2001
2. Tannock I. and Hill. R.P. The basic science of oncology, 3<sup>rd</sup> ed. McGraw-Hill, 1998

**BT6010****PLANT BIOTECHNOLOGY****L T P C  
3 0 0 3****OBJECTIVES:**

- To give the details of plant cells and its functions
- To provide the basics of agrobacterium and applications of plant biotechnology

**UNIT I ORGANIZATION OF GENETIC MATERIAL 9**

Genetic material of plant cells – nucleosome structure and its biological significance; junk and repeat sequences; outline of transcription and translation.

**UNIT II CHLOROPLAST & MITOCHONDRIA 9**

Structure, function and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins.

**UNIT III NITROGEN FIXATION 9**

Nitrogenase activity, nod genes, nif genes, bacteroids.

**UNIT IV AGROBACTERIUM & VIRAL VECTORS 9**

Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid – t-DNA, importance in genetic engineering. Viral Vectors: Gemini virus, cauliflower mosaic virus, viral vectors and its benefits.

**UNIT V APPLICATION OF PLANT BIOTECHNOLOGY 9**

Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming, therapeutic products.

**TOTAL : 45 PERIODS****OUTCOMES:**

Upon completion of the course, the student would be able

- To understand the fundamentals of plant cells, structure and functions
- To learn the nitrogen fixation mechanism and significance of viral vectors
- To gain the knowledge about the plant tissue culture and transgenic plants
- To use of the gained knowledge for the development of therapeutic products

**TEXT BOOKS:**

1. Chawla, H.S., "Introduction to Plant Biotechnology", 3<sup>rd</sup> Edition, Science Publishers, 2009.
2. Gamburg OL, Philips GC, Plant Tissue & Organ Culture fundamental Methods, Narosa Publications. 1995.

**REFERENCES:**

1. Stewart Jr., C.N., "Plant Biotechnology and Genetics: Principles, Techniques and Applications" Wiley-Interscience, 2008.
2. Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.
3. Ignacimuthu .S, Applied Plant Biotechnology, Tata McGraw Hill. 1996.

**BT6011****METABOLIC ENGINEERING****L T P C  
3 0 0 3****OBJECTIVES:**

- To provide a quantitative basis, based on thermodynamics, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level.
- To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner.

**UNIT I SUCCESSFUL EXAMPLES OF METABOLIC ENGINEERING 9**

Product over production examples: amino acids, polyhydroxyalkanoic acids, By-product minimization of acetate in recombinant *E. coli*, Extension of substrate utilization range for organisms such as *S. cerevisiae* and *Z. mobilis* for ethanol production, Improvement of cellular properties, Altering transport of nutrients including carbon and nitrogen and xenobiotic degradation.

**UNIT II METABOLIC FLUX ANALYSIS 9**

Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, metabolic flux analysis. MFA of exactly determined systems, over determined systems.

**UNIT III CONSTRAINT BASED GENOMIC SCALE METABOLIC MODEL 9**

Underdetermined systems- linear programming, sensitivity analysis, Development of Genomic scale metabolic model, Flux balance analysis, Regulatory on-off Minimization and Minimization of metabolic adjustments and Opt knock tool development, Elementary mode analysis, Extreme pathways.

**UNIT IV METABOLIC FLUX ANALYSIS BY ISOTOPIC LABELLING 9**

Methods for the experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation-analytical techniques. Validation of flux estimates by <sup>13</sup>C labeling studies in mammalian cell culture.

**UNIT V METABOLIC CONTROL ANALYSIS AND NETWORK ANALYSIS 9**

Fundamental of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations. Control of flux distribution at a single branch point, grouping of reactions, optimization of flux amplification.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

After completion of metabolic engineering, students will be able

- To learn stoichiometry and energetics of metabolism.
- To apply practical applications of metabolic engineering in chemical,energy,medical and environmental fields.
- To integrate modern biology with engineering principles.
- To design a system, component, or process to meet desired needs.

**TEXT BOOKS:**

1. Stephanopoulos, G.N. "Metabolic Engineering : Principles and Methodologies". Academic Press / Elsevier, 1998.
2. Lee, S.Y. and Papoutsakis, E.T. "Metabolic Engineering". Marcel Dekker, 1998.
3. Nielsen, J. and Villadsen, J. "Bioreaction Engineering Principles". Springer, 2007.

**REFERENCES:**

1. Voit, E.O. "Computational Analysis of Biochemical Systems : A Practical Guide for Biochemists and Molecular Biologists". Cambridge University Press, 2000.
2. Scheper, T. "Metabolic Engineering" Vol 73 (Advances in Biochemical Engineering Biotechnology) Springer, 2001.
3. S. Cortassa, M.A.Aon,A.A.Iglesias and D.Llyod, " An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.
4. Christiana D. Smolke, " The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.

5. Boris N. Kholodenko and Hans V. Westerhoff “Metabolic Engineering in the Post Genomic Era”, Horizon Bioscience, 2004.

**BT6012**                      **IPR AND ETHICAL ISSUES IN BIOTECHNOLOGY**                      **L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To create awareness about IPR and engineering ethics
- To follow professional ethics and practices in their careers
- To create awareness and responsibilities about the environment and society

**UNIT I                      ENGINEERING ETHICS                      9**

Senses of ‘Engineering Ethics’ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.

**UNIT II                      ENGINEERING AS SOCIAL EXPERIMENTATION                      9**

Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study

**UNIT III                      ENGINEER’S RESPONSIBILITY FOR SAFETY                      9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – Risk communication, management and assessment. The Government Regulator’s Approach to Risk - Chernobyl and Bhopal Case Studies. Case studies on basumethi rice, turmeric and neem

**UNIT IV                      RESPONSIBILITIES AND RIGHTS                      9**

Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) - Discrimination.

**UNIT V                      GLOBAL ISSUES                      9**

Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the student would be able

- To understand the ethics and responsibility for safety
- To create awareness for the professional responsibilities and rights
- To offer the importance of intellectual property rights for the technologies

**TEXT BOOKS:**

1. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw Hill, New York (2005)
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Thompson Learning, (2000).
3. Kankanala C., Genetic Patent law & strategy .First edition .Manupatra ,Information Solution Pvt.Ltd., 2007.

**REFERENCES:**

1. Charles D Fleddermann, “Engineering Ethics”, Prentice Hall, New Mexico, (1999).
2. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education,

- (2003)
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethic for Scientists and Engineers", Oxford University Press, (2001)
  4. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective", Biztantra, New Delhi, (2004)
  5. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003)

**BT6013**

**BIOCONJUGATE TECHNOLOGY AND APPLICATIONS**

**LT P C**

**3 0 0 3**

**OBJECTIVES:**

To enable the students

- To understand the functional targets and chemistry of active groups.
- To gain knowledge about the linkers and cleavable reagent systems.
- To know about enzyme, nucleic acid modification and its application in bioconjugation

**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 PERIODS**

**OUTCOMES:**

Upon completion of this course, the student would know about

- Joining of two molecules to form a hybrid conjugate with the help of linkers.
- Active groups of various chemical reactions and targets of the functional groups.
- Antibody modification and conjugation.

**TEXTBOOK:**

1. Bioconjugate Techniques, G.T. Hermanson, Academic Press, 1999.

**BT6014**

**BIO- INDUSTRIAL ENTREPRENEURSHIP**

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

**OBJECTIVES:**

- To enable the students to understand the sources of innovation opportunities and development of the skills to identify and analyze these opportunities for entrepreneurship and innovation.
- To develop personal skills set for creativity, innovation and entrepreneurship and specific concepts and tools for combining and managing creativity in organization.

**UNIT I**

**9**

- Should You Become an Entrepreneur?
- What Skills Do Entrepreneurs Need?
- Identify and Meet a Market Need
- Entrepreneurs in a Market Economy
- Select a Type of Ownership

**UNIT II**

**9**

- Develop a Business Plan

**UNIT III**

**9**

- Choose Your Location and Set Up for Business
- Market Your Business
- Hire and Manage a Staff

**UNIT IV**

**9**

- Finance, Protect and Insure Your Business
- Record Keeping and Accounting
- Financial Management

**UNIT V**

**9**

- Meet Your Legal, Ethical, Social Obligations
- Growth in Today's Marketplace

**TOTAL : 45 PERIODS**

**OUTCOMES:**

At the end of this course, the students will be able to

- Determine relevant licensing and regulatory issues for a specific small business plan.
- Develop the marketing plan component for a specific bio – industry and the operation plan component for a bio-industry.
- Develop the customer service plan component and to present and defend business reports in a professional manner.
- Develop strategies for ongoing personal and professional development and advancement.

**TEXT BOOK:**

1. Entrepreneurship Ideas in Action—South-Western, 2000.

**BT6015**

**PROCESS EQUIPMENTS AND PLANT DESIGN**

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

**OBJECTIVES:**

- To develop key concepts and techniques to design, process equipment in a process plant.
- To train the students to utilize these key concepts to make design and operating decisions.

**UNIT I**

**HEAT EXCHANGERS, CONDENSERS, EVAPORATORS**

**10**

Single and multi process exchangers, double pipe, U tube heat exchangers, combustion details supporting structure. Single and vertical tube 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 absorption Towers; Plate and Packed Distillation Towers.

**UNIT IV PUMPS, MECHANICAL SEALS, VALVES AND SWITCHES 8**

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, PLANT 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 PERIODS**

**OUTCOMES:**

Upon success completion of this course, the students

- Will understand the working principles of heat exchanger, condensers and evaporators and develop a data sheet
- Will acquire basic knowledge to draw and design of storage vessel and pressure vessel as per ASME and ISI codes
- Will understand the construction and assembly drawing of extraction towers, distillation towers and absorption towers
- Would have learned working principles, constructions, usage of various pump, seals , valves and pipes

**TEXTBOOKS:**

1. Brownbell I.E., Young E.H.. "Chemical Plant Design" 1985.
2. Kern D.Q. "Heat Transfer". McGraw Hill, 1985.

**REFERENCE:**

1. McCabe, W.L., J.C. Smith and P. Harriott "Unit Operations of Chemical Engineering", 6<sup>th</sup> Edition, McGraw-Hill, 2001

**GE6083**

**DISASTER MANAGEMENT**

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

**OBJECTIVES:**

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

**UNIT I INTRODUCTION TO DISASTERS**

**9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

**UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9**

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

**UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

**UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

**UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9**

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

The students will be able to

- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarios in the Indian context,
- Disaster damage assessment and management.

**TEXTBOOKS:**

1. Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IAS and Sage Publishers, New Delhi, 2010.

**REFERENCES**



1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy,2009.

**PC6601      PROCESS INSTRUMENTATION, DYNAMICS AND CONTROL**

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

**OBJECTIVE:**

To introduce of open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation.

**UNIT I      INSTRUMENTATION**

**9**

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

**UNIT II      OPEN LOOP SYSTEMS**

**9**

Laplace transformation and its application in process control. First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

**UNIT III      CLOSED LOOP SYSTEMS**

**10**

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

**UNIT IV      FREQUENCY RESPONSE**

**9**

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules.

**UNIT V      ADVANCED CONTROL SYSTEMS**

**8**

Introduction to advanced control systems, cascade control, feed forward control, Smith predictor, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

**TOTAL : 45 PERIODS**

**OUTCOME:**

Students will Understand and discuss the importance of process control in process operation and the role of process control engineers They know the design of modern hardware and instrumentation needed to implement process control.

**TEXT BOOKS:**

1. Stephanopoulos, G., "Chemical Process Control", Prentice Hall of India, 2003.
2. Coughnowr, D., " Process Systems Analysis and Control ", 3rd Edn., McGraw Hill, New York, 2008.

**REFERENCES:**

1. Marlin, T. E., " Process Control ", 2nd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edn., John Wiley, New York, 1997.
3. Jason L.Speyer,Walter H.Chung,"Stochastic Processes,Estimation, and Control", PHI Ltd (2013).

**OBJECTIVES:**

To enable the students

- To learn the fundamentals of tissue engineering and tissue repairing
- To acquire knowledge on clinical applications of tissue engineering
- To understand the basic concept behind tissue engineering focusing on the stem cells, biomaterials and its applications

**UNIT I INTRODUCTION 9**

Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular component, ECM component, mechanical measurements and physical properties.

**UNIT II TISSUE ARCHITECTURE 9**

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix & Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

**UNIT III BIOMATERIALS 9**

Biomaterials: Properties of biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology.

**UNIT IV BASIC BIOLOGY OF STEM CELLS 9**

Stem Cells : Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pluripotent stem cells.

**UNIT V CLINICAL APPLICATIONS 9**

Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, Stem cells and Gene therapy Physiological models, tissue engineered therapies, product characterization, components, safety, efficacy. Preservation –freezing and drying. Patent protection and regulation of tissue-engineered products, sethical issues.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students would get

- Ability to understand the components of the tissue architecture
- Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
- Awareness about the properties and broad applications of biomaterials
- Overall exposure to the role of tissue engineering and stem cell therapy in organogenesis

**TEXT BOOKS:**

1. Bernhard O. Palsson, Sangeeta N. Bhatia, "Tissue Engineering" Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. Fundamentals of Tissue

**REFERENCES:**

1. Bernard N. Kennedy (editor). New York : Nova Science Publishers, 2008.Stem cell transplantation, tissue engineering, and cancer applications
2. Raphael Gorodetsky, Richard Schäfer. Cambridge : RSC Publishing, c2011.Stem cell-based tissue repair.
3. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two-Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, 2004, Academic Press.
4. R. Lanza, J. Gearhart et al (Eds), Essential of Stem Cell Biology, 2006, Elsevier Academic press.
5. J. J. Mao, G. Vunjak-Novakovic *et al* (Eds), Translational Approaches In Tissue Engineering & Regenerative Medicine” 2008, Artech House, INC Publications.
6. Naggy N. Habib, M.Y. Levicar, , L. G. Jiao,,and N. Fisk, Stem Cell Repair and Regeneration, volume-2, 2007, Imperial College Press.

**BT6018**

**NEUROBIOLOGY AND COGNITIVE SCIENCES**

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

**OBJECTIVES:**

To enable the students

- To know the general organization of brain and physiological and cognitive processes.
- To apply the molecular, cellular, and cognitive bases of learning and memory.

**UNIT I NEUROANATOMY**

**9**

What are central and peripheral nervous systems; Structure and function of neurons; types of neurons; Synapses; Glial cells; myelination; Blood Brain barrier; Neuronal differentiation; Characterization of neuronal cells; Meninges and Cerebrospinal fluid; Spinal Cord.

**UNIT II NEUROPHYSIOLOGY**

**9**

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission; information representation and coding by neurons.

**UNIT III NEUROPHARMACOLOGY**

**9**

Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function.

**UNIT IV APPLIED NEUROBIOLOGY**

**9**

Basic mechanisms of sensations like touch, pain, smell and taste; neurological mechanisms of vision and audition; skeletal muscle contraction.

**UNIT V BEHAVIOUR SCIENCE**

**9**

Basic mechanisms associated with motivation; control of feeding, sleep, hearing and memory; Disorders associated with the nervous system.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, students will be able:

- To know the anatomy and organization of nervous systems.
- To understand the function of nervous systems.
- To analyze how drugs affect cellular function in the nervous system.
- To understand the basic mechanisms associated with behavioral science.

**TEXTBOOKS:**

1. Mathews G.G. Neurobiology, 2<sup>nd</sup> edition, Blackwell Science, UK, 2000.
2. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University Press, USA, 1994

**REFERENCE:**

1. Mason P., Medical Neurobiology, Oxford University Press, 2011.

**GE6084**

**HUMAN RIGHTS**

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

**OBJECTIVES :**

- To sensitize the Engineering students to various aspects of Human Rights.

<b>UNIT I</b>	<b>9</b>
Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.	
<b>UNIT II</b>	<b>9</b>
Evolution of the concept of Human Rights Magna carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.	
<b>UNIT III</b>	<b>9</b>
Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.	
<b>UNIT IV</b>	<b>9</b>
Human Rights in India – Constitutional Provisions / Guarantees.	
<b>UNIT V</b>	<b>9</b>
Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.	

**TOTAL : 45 PERIODS**

**OUTCOME :**

- Engineering students will acquire the basic knowledge of human rights.

**REFERENCES:**

1. Kapoor S.K., "Human Rights under International law and Indian Laws", Central Law Agency, Allahabad, 2014.
2. Chandra U., "Human Rights", Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.