SRI VENKATESWARA COLLEGE OF ENGINEERING
(An Autonomous Institution, Affiliated to Anna University, Chennai)
SRIPERUMBUDUR TK.- 602 117
REGULATION – 2016
B. TECH BIOTECHNOLOGY
CURRICULUM AND SYLLABUS (I – VIII Semesters)

SEMESTER I

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	HS16151	Technical English – I	3	1	0	4
2	MA16151	Mathematics – I	3	1	0	4
3	PH16151	Engineering Physics – I	3	0	0	3
4	CY16151	Engineering Chemistry – I	3	0	0	3
5	GE16151	Computer Programming	3	0	0	3
6	GE16152	Engineering Graphics	2	0	3	4
PRACTICALS						
7	GE16161	Computer Practices Laboratory	0	0	3	2
8	GE16162	Engineering Practices Laboratory	0	0	3	2
9	GE16163	Physics and Chemistry Laboratory - I	0	0	2	1
		TOTAL	17	2	11	26

SEMESTER II

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	HS16251	Technical English – II	3	1	0	4
2	MA16251	Mathematics – II	3	1	0	4
3	PH16252	Physics of Materials	3	0	0	3
4	CY16252	Chemistry for Technologists	3	0	0	3
5	BT16201	Biochemistry	3	0	0	3
6	BT16202	Microbiology	3	0	0	3
PRACTICALS						
7	BT16211	Biochemistry Laboratory	0	0	4	2
8	BT16212	Microbiology Laboratory	0	0	4	2
		TOTAL	18	2	8	24

SEMESTER III

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	MA16351	Mathematics - III (Common to all branches)	3	1	0	4
2	BT16301	Stoichiometry and Process Calculations	3	0	0	3
3	BT16302	Bioorganic Chemistry	3	0	0	3
4	BT16303	Cell Biology	3	1	0	4
5	BT16304	Basic Industrial Biotechnology	3	0	0	3
6	GE16451	Environmental Science and Engineering (Common to all branches)	3	0	0	3
PRACTICALS						
7	BT16311	Cell Biology Laboratory	0	0	4	2
8	BT16312	Bioorganic Chemistry Laboratory	0	0	4	2
		TOTAL	18	2	8	24

SEMESTER IV

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	MA16452	Probability and Statistics (Common to BT & CH)	3	1	0	4
2	BT16401	Analytical Methods and Instrumentation	3	0	0	3
3	BT16402	Applied Thermodynamics for Biotechnologists	3	0	0	3
4	BT16403	Heat and Momentum Transfer Operations	3	1	0	4
5	BT16404	Enzyme Technology and Biotransformation	3	0	0	3
6	BT16405	Bioprocess Principles	3	0	0	3
PRACTICALS						
7	BT16411	Chemical Engineering Laboratory	0	0	4	2
8	BT16412	Instrumental Methods of Analysis Laboratory	0	0	4	2
		TOTAL	18	2	8	24

SEMESTER V

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	BT16501	Protein Structure Function and Proteomics	3	1	0	4
2	BT16502	Bioprocess Engineering	3	0	0	3
3	BT16503	Mass Transfer Operation	3	0	0	3
4	BT16504	Molecular Biology	3	0	0	3
5		Elective - I	3	0	0	3
6		Elective - II	3	0	0	3
PRACTICALS						
7	BT16511	Bioprocess Laboratory – I	0	0	4	2
8	BT16512	Molecular Biology Laboratory	0	0	4	2
		TOTAL	18	1	8	23

SEMESTER VI

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	BT16601	Total Quality Management for Biotechnologists	3	0	0	3
2	BT16602	Immunology	3	0	0	3
3	BT16603	Genetic Engineering and Genomics	3	1	0	4
4	BT16604	Chemical Reaction Engineering	3	0	0	3
5		Elective - III	3	0	0	3
6		Elective - IV	3	0	0	3
PRACTICALS						
7	BT16611	Genetic Engineering Laboratory	0	0	4	2
8	BT16612	Bioprocess Laboratory – II	0	0	4	2
9	GE16661	Interview and Career Skills Laboratory (Common to all branches)	0	0	3	2
		TOTAL	18	1	11	25

SEMESTER VII

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	BT16701	Bioinformatics and Computational Biology	3	0	0	3
2	BT16702	Downstream Processing	3	0	0	3
3	BT16703	Creativity, Innovation and New Product Development	3	0	0	3
4		Elective - V	3	0	0	3
5		Elective - VI	3	0	0	3
PRACTICALS						
7	BT16711	Comprehensive Viva Voce	0	0	2	1
8	BT16712	Downstream Processing Laboratory	0	0	4	2
9	BT16713	Immunology Laboratory	0	0	4	2
10	BT16714	Bioinformatics Laboratory	0	0	4	2
		TOTAL	**15**	**0**	**14**	**22**

SEMESTER VIII

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	BT16811	Project Work	0	0	24	12
		TOTAL	0	0	24	12

ELECTIVE I

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	BT16001	Introduction to Symbolic Mathematics	2	0	2	3
2	BT16002	Biophysics	3	0	0	3
3	BT16003	Principles of Food Processing	3	0	0	3

ELECTIVE II

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	BT16004	Advanced Biochemistry	3	0	0	3
2	BT16005	Biological Spectroscopy	3	0	0	3
3	BT16006	Biopharmaceutical Technology	3	0	0	3
4	MG16851	Principles of Management	3	0	0	3

ELECTIVE III

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	BT16007	Animal Biotechnology	3	0	0	3
2	BT16008	Molecular Pathogenesis of Infectious Disease	3	0	0	3
3	BT16009	Cancer Biology	3	0	0	3
4	GE16002	Fundamentals of Nanotechnology	3	0	0	3

ELECTIVE IV

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	BT16010	Plant Biotechnology	3	0	0	3
2	BT16011	Metabolic Engineering	3	0	0	3
3	BT16012	IPR and Ethical Issues in Biotechnology	3	0	0	3
4	GE16004	Accounting for Engineers	3	0	0	3

ELECTIVE V

SL. No	COURSECOD	COURSE TITLE	L	T	P	C
1	BT16013	Bioconjugate Technology and Applications	3	0	0	3
2	BT16014	Bio Industrial Entrepreneurship	3	0	0	3
3	BT16015	Process Equipment, Plant Design and Economics	3	0	0	3
4	BT16016	Disaster Management and Industrial Safety	3	0	0	3
5	GE16005	Marketing Issues for Engineers	3	0	0	3

ELECTIVE VI

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	CH16504	Process Instrumentation Dynamics and Control (Common to BT & CH)	3	0	0	3
2	BT16017	Tissue Engineering	3	0	0	3
3	BT16018	Neurobiology and Cognitive Sciences	3	0	0	3
4	BT16019	Molecular Therapeutics	3	0	0	3

HS16151	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.

REFERENCES:
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
3. Goodale, Malcolm, Professional Presentations Video Pack: A Video Based Course Cambridge University Press; Pap/Vhs edition 1998)
4. Downes, Colm, Cambridge English for Job-hunting, Cambrideg University Press, New Delhi. 2008
5. Murphy, Raymond, Intermediate English Grammar with Answers, Cambridge University Press, 2000.
6. Regional Institute of English. English for Engineers. Cambridge University Press, New Delhi. 2006
7. Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi. 2005.
8. Rutherford, Andrea. J Basic Communication Skills for Technology. Pearson, New Delhi. 2001.
9. Thomson, A.J. Practical English Grammar 1&2 Oxford 1986.

EXTENSIVE Reading (Not for Examination)
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:

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.

MA16151	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 the limitations of using infinite series approximations for solutions arising in mathematical modelling.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To introduce the concept of improper integrals of 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
Eigen values and Eigen vectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigen vectors – 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   SEQUENCEANDSERIES   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' test – Series of positive and negative terms – Absolute and conditional convergence.

UNIT III   APPLICATION 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 derivatives – Differentiation of implicit functions – Jacobians 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 the students to have basic knowledge and understanding of fundamental calculus and application of matrices relevant to Engineering problems.

TEXT BOOKS:
1. Erwin Kreyszig, Advanced engineering mathematics, 8th Edition, John Wiley, 1999.
2. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd., (2011).
3. Grewal. B.S, "Higher Engineering Mathematics", 41stEdition, 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", 3rd Edition, Pearson Education,

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.

PH16151　　　　　　　**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, CO2, 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:
- Working knowledge of fundamental physics and basic engineering principles to include advanced knowledge in one or more engineering disciplines
- The ability to formulate, conduct, analyzes, and interprets experiments in engineering physics
- To understand and to compute problems in Quantum Physics
- Use modern engineering physics techniques and tools
- To enhance knowledge about photonics and optical fiber communication system

TEXT BOOKS:
1. Gaur R.K. and Gupta S.L. Engineering Physics. Dhanpat Rai publishers, 2009
2. Arumugam M. Engineering Physics. Anuradha publishers, 2010.

REFERENCES:
1. Searls and Zemansky. University Physics, 2009.
2. Gasiorowicz, Stephen, Quantum Physics, John Wiley & Sons, 2000.
3. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009.
4. Palanisamy P.K. Engineering Physics. SCITECH Publications, 2011.
5. Pandey B.K., Chaturvedi.S. Engineering Physics, Cengage Learning India Pvt.Ltd, 2012.

CY16151	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 application

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: Tg, 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 - Grothus–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   NANOCHEMISTRY   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, electrodeposition, chemical vapour deposition, laser ablation; Properties and applications.

TOTAL: 45 PERIODS

OUTCOMES:
The knowledge acquired on basics of polymer chemistry, second law of thermodynamics, photochemical reactions, basics of spectroscopy, phase diagrams and Nano-materials will enable the students to prepare and take up the further courses in the higher semesters as well as higher studies.

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 Jayadev Sreedhar, "Polymer Science", New Age International P (Ltd.,), Chennai, 2006.

4. Ozin G. A. and Arsenault A. C., "Nanochemistry: A Chemical Approach to Nanomaterials", RSC Publishing, 2005.

GE16151	COMPUTER PROGRAMMING	L	T	P	C
		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

TEXT BOOKS:
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.

GE16152	ENGINEERING GRAPHICS	L	T	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.

5+9

UNIT IV   PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT
OF SURFACES

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 BOOKS:

1.   Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th 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, 2nd 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.   BasantAgarwal 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.
The examination will be conducted in appropriate sessions on the same day

GE16161	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 EQUIPMENT FOR A BATCH OF 30 STUDENTS:
Stand alone desktops with C compiler   30 Nos.
                    (or)
Server with C compiler supporting 30 terminals or more.

GE16162	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, planning 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 Puplishing 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", SreeSai 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 Nos.
7.	Moulding table, foundry tools	2 Nos.
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 Megger (250V/500V)	1 No.
4.	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	

GE16163   PHYSICS AND CHEMISTRY LABORATORY – I   L T 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:

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 viscometry.

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 (phenanthroline / thiocyanate method).
6. Determination of molecular weight of polyvinylalcohol using Ostwald viscometer Conductometric titration of strong acid vs strong base.

TOTAL: 30 PERIODS

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., "Vogels Textbook of practical organic chemistry", LBS Singapore 1994.
3. Jeffery G.H., Bassett J., Mendham J.and Denny vogels 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

HS16251 **TECHNICAL ENGLISH - II** **L T P C**
                                        3 1 0 4

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.

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 'emoticons' as symbols in email messages; Grammar - Regular and irregular verbs - Active and passive voice; Vocabulary - Homonyms (e.g. 'can') - Homophones (e.g. 'some', 'sum'); Ematerials - 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 - resume 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 resumes- Filling up a resume / cover letter; Language Lab - Telephonic interview – recording the responses - e-resume 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; Ematerials- Interactive grammar and vocabulary exercises - Sample GD - Pictures for discussion, Interactive grammar and vocabulary exercises; Language Lab - Different models of group discussion.

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

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.

REFERENCES:
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.
3.   Goodale, Malcolm, Professional Presentations Video Pack: A Video Based Course Cambridge University Press; Pap/Vhs edition 1998).
4.   Downes, Colm, Cambridge English for Job-hunting, Cambrideg University Press, New Delhi. 2008.

5. Murphy,Raymond, Intermediate English Grammar with Answers, Cambridge University Press 2000.

6. Regional Institute of English. English for Engineers. Cambridge University Press, New Delhi. 2006

7. Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi. 2005

8. Rutherford, Andrea. J Basic Communication Skills for Technology. Pearson, New Delhi. 2001

9. Thomson, A.J. Practical English Grammar 1&2 Oxford 1986.

WEBSITES:
1. http://www.usingenglish.com
2. http://www.uefap.com3.
3. https://owl.english.purdue.edu/owl/
4. www.learnenglishfeelgood.com/esl-printables-worksheets.html

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:

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.

MA16251   **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 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 parallelopipeds.

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 FUNCTION   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, $1/z$, $z2$, ez 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(L:45+T:15):60 PERIODS

OUTCOMES:

- The subject helps the student to develop the fundamental and basic concepts in vector calculus, ODE, Laplace Transforms and complex functions. Students will be able to solve

problems related to engineering applications by using these techniques.

TEXT BOOKS:
1. Erwin Kreyszig, Advanced engineering mathematics, 8th Edition, John Wiley, 1999.
2. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth edition, Laxmi Publications Pvt Ltd., (2011).
3. Grewal. B.S, "Higher Engineering Mathematics", 41stEdition, 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", 3rd 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.

PH16252	**PHYSICS OF MATERIALS**	**L**	**T**	**P**	**C**
		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 9
MATERIALS

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

TEXT BOOKS:
1. Pandey B.K., Chaturvedi S., Engineering Physics, Cengage Learning India Pvt, Ltd, 2012.
2. Arumugam M. Physics of Materials. Anuradha Publishers, 2000.

REFERENCES:
1. Raghavan V. Materials Science and Engineering, Prentice Hall of India, 2002.
2. Rajendran, V, Marikani, A., Materials Science, Tata McGraw-Hill, 2009.
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.

CY16252	CHEMISTRY FOR TECHNOLOGISTS	L	T	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.

BT16201	BIOCHEMISTRY	L	T	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 biomolecules and their deviation from normal and their consequences for interpreting clinical problems.

UNIT I   BIOENERGETICS   10

Bioenergetics and Biological oxidation – general concept of oxidation and reduction, biological oxidation, electron transport chain and theories of oxidative phosphorylation, uncouplers, electronegative potential of compounds, High energy compounds & ATP cycle.

UNIT II   BIOMOLECULES - CARBOHYDRATES AND LIPIDS   12

Carbohydrates– Classification, Properties of 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 of sterols, essential fatty acids, eicosanoids, phospholipids, & sphingolipids. Metabolism of lipids- Oxidation of fatty acids, α, β – oxidation, biosynthesis of ketone bodies & cholesterol Calculation of ATP during oxidation of glucose and fatty acids.

UNIT III BIOMOLECULES – PROTEINS AND NUCLEIC ACIDS 5
Proteins and amino acids – classification, properties and biosynthesis of amino acids and proteins, essential amino acids and nitrogen balance Nucleic acids –genetic code, nucleic acids, and structure of DNA and RNA.

UNIT IV ENZYMES AND HORMONES 10
Hormones-Chemical nature and properties, Enzymes- Nomenclature, enzyme kinetics, classification, properties, mechanism of action, enzyme induction and inhibition, coenzyme significance and enzymes of clinical importance.

UNIT V BIOCHEMISTRY OF CLINICAL DISEASES 8
Diabetes mellitus, atherosclerosis, fatty liver, and obesity, hormonal disorders, aging, inborn errors of metabolism and organ function tests.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Lehninger, A.L., Nelson D.L. & Cox. M.M.Principles of Biochemistry, 4th Ed., CBS publishers, 2009.
2. Murray, R.K., Granner. D.K., Mayes, P.A. & Rodwell, V.W. Harpers Biochemistry, 24th Ed., Stanford publishers, 1996.
3. Thomas, M. Devlin. Textbook of Biochemistry with clinical correlations, 7th Ed., Wiley Liss Publishers, 2010.

REFERENCES:
1. Carl, A.B., Edward, R. A., & Nobert, W. T. Textbook of Clinical chemistry. 3rd Ed., WB. Saunders Company, 1999.
2. Stryer, L. Biochemistry. 5th Ed., W. H. Freeman and company, 2002.
3. Donald, V & Judith, G. V. Biochemistry. 4th Ed., John Wiley and Sons, 2010.
4. Rama, R. Textbook of Biochemistry. 9th Ed., UBS Publishers and Distributors, 1992.
5. Deb, A.C. Textbook of Biochemistry. 10th Ed., New Central Book Agency, 2014.

BT16202	MICROBIOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes.
- To solve the problems in microbial infection and their control.

UNIT I   INTRODUCTION   6

Basics of microbial existence, history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

UNIT II   MICROBES- STRUCTURE AND MULTIPLICATION   12

Structural organization and multiplication of bacteria, viruses, algae and fungi with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.

UNIT III   MICROBIAL NUTRITION, GROWTH AND METABOLISM   12

Nutritional requirements of bacteria, different media used for bacterial culture, growth curve and different methods to quantify bacterial growth, aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

UNIT IV   CONTROL OF MICROORGANISMS   6

Physical and chemical control of microorganisms; host-microbe interactions, anti-bacterial, anti-fungal and anti-viral agents, mode of action and resistance to antibiotics, clinically important microorganisms.

UNIT V   INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY   9

Primary metabolites, secondary metabolites and their applications, preservation of food, production of penicillin, alcohol, vitamin B-12, biogas, bioremediation, leaching of ores by microorganisms, biofertilizers and biopesticides, microorganisms and pollution control, biosensors.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Talaron, K., Talaron, A., Casita, Pelczar. & Reid. Foundations in Microbiology, 1st Ed., W.C. Brown Publishers, 1993.
2. Pelczar, M.J., Chan, E.C.S & Krein, N.R., Microbiology, 5th Ed., Tata McGraw Hill Edition.
3. Prescott, L.M., Harley, J.P & Klein, D.A, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

BT16211   **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 α and β amylase.

4. Qualitative analysis of proteins

5. Qualitative analysis of lipids (triglycerides, cholesterol, phospholipids etc.)

6. Quantitative analysis of proteins (Lowry's or Bradford or UV method)

7. Quantitative analysis of carbohydrates (Benedict's method etc.)

8. Quantitative analysis of lipids

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

TOTAL: 60 PERIODS

TEXT BOOKS:
1. Gupta, R.C.& Bhargavan, S., Practical Biochemistry, CBS Publishers and Distributors, 1985.
2. David, T. Plummer., Introduction of Practical Biochemistry, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, 2008.

REFERENCES:
1. Murray, R.K., Granner D.K., Mayes, P.A. & Rodwell, V.W., Harpers Biochemistry, 25th Edition, Appleton and Lange, 2000.
2. Thomas, M. Devlin., Textbook of Biochemistry with clinical correlations, 6th Edition, Wiley Liss Publishers, 2006.
5. "CAD/CAM: Theory and Practice" by Ibrahim Zeid and Sivasubramanian R, Tata McGraw-Hill Education India, Jun 2009.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:
1. UV-Visible Spectrophotometers
2. pH meter
3. Centrifuge
4. Water Bath

BT16212	MICROBIOLOGY LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:
1. Introduction, laboratory safety and use of equipment, sterilization techniques.
2. Culture media –types, uses, 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 and differential staining (gram's staining).

6. Quantification of microbes: sampling and serial dilution, bacterial count in soil (Total Viable Count).

7. Effect of disinfectants - phenol coefficient.

8. Antibiotic sensitivity assay.

9. Growth curve in bacteria, yeast, fungi and algae.

10. Effect of pH, temperature, UV radiation on growth of bacteria.

TOTAL: 60 PERIODS

REFERENCES:

1. Cappuccino, J.G., and Sherman, N. Microbiology: A Laboratory Manual, 4th Edition, Addison-Wesley, 1999.
2. Collee, J.G., Fraser, A.G., Marmion, B.P., Simmons, A., Mackie & McCartney. Practical Medical Microbiology, 14th Edition, Churchill Livingstone, 1996.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Autoclave	1
2.	Hot Air Oven	1
3.	Incubators	2
4.	Light Microscopes	4
5.	Incubator Shaker	1
6.	Colorimeter	2
7.	Lamina Flow Chamber	2
8.	Glassware, Chemicals, Media as required	

MA16351	MATHEMATICS - III	L	T	P	C
		3	1	0	4

OBJECTIVES:
- To introduce Fourier series analysis this is central to many applications in engineering apart from its uses 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 Z transform techniques for discrete time systems.

UNIT I   PARTIAL DIFFERENTIAL EQUATIONS   12

Formation of partial differential equations – Singular integrals -- Solutions of standard types of first order partial differential equations - Lagrange's linear equation – Linear homogeneous partial differential equations of second and higher order with constant coefficients.

UNIT II   FOURIER SERIES   12

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

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

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 12

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

UNIT V Z -TRANSFORMS AND DIFFERENCE EQUATIONS 12

Z- Transforms - Elementary properties – Inverse Z - transform (using partial fraction, long division method and residues) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

OUTCOMES:
- To understand the mathematical principles on transforms and partial differential equations for providing them the ability to formulate and solve some of the physical problems of engineering.

TEXT BOOKS:
1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2011.
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", 7th Edition, Laxmi Publications Pvt Ltd, 2007.
2. Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2011
3. Veerarajan. T., "Transforms and Partial Differential Equation", Tata Mc Graw Hill Publishing Company Limited, New Delhi, 2012

BT16301	STOICHIOMETRY AND PROCESS CALCUALTIONS	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. Mole concept and mole fraction, weight fraction and volume fraction, molarity, molality, normality, ppm, density and specific gravity. Limiting reactants, excess reactants, degree of completion, conversion, selectivity and yield.

UNIT II CONCEPTS IN MATERIAL BALANCES 10

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

9

UNIT III   GAS LAWS

Ideal gas law, Dalton's Law, Amagat's Law, and Average molecular weight and density of gases, Real gas laws, Vapour pressure. Phase rule.

UNIT IV   HUMIDITY CONCEPTS   9

Dew point, Wet and dry bulb temperatures, Percentage saturation, Relative Humidity and Relative saturation, Enthalpy of humid air, and humid heat capacity, Application of Psychrometric Chart.

9

UNIT V   CONCEPTS IN ENERGY BALANCES

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

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 Vora, S.M., "Stoichiometry (SI Units)", 5th Edition, Tata McGraw- Hill, 2010.
2. Himmelblau, D.M and Riggs, J.B., "Basic principles and calculations in Chemical Engineering", 8th Edition, PHI, 2006
3. McCabe, W.L., Smith, J.C and Harriot, P., "Unit Operations of Chemical Engineering", 7th Edition, Mc Graw Hill, 2014

REFERENCES:

1. Narayanan, K.V. and B.Lakshmi Kutty "Stoichiometry and Process Calculations", 1st Edition, PHI, 2013.
2. Coulson, J.M. and Richardson, J.F., "Coulson & Richardson's Chemical Engineering", 5th Edition, Vol. I & II, Butterworth – Heinman (an imprint of Elsevier), 2014.
3. Venkatramani. V, Anatharaman. N and Meera Shariffa Begam "Process Calculations" 2nd Edition, Printice Hall of India, New Delhi, 2011.

BT16302	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 covalant Bonds -

Electronegativity- Formal charge - Resonance Acids and Bases - Arrhenius and Bronsted Lowry Theories - Acid Base equilbria - SP3 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**   **9**
                   REACTIONS

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 - ΔG, ΔS, ΔH, 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 – Murrifield state peptide synthesis – Sanger method for peptide and DNA sequencing.

TOTAL: 45 PERIODS

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

TEXT BOOKS:
1. Bansal, Raj K. "A text book of organic chemistry", 6th Edition, Wiley Eastern Chemistry, 2016.
2. Page, M.I. and Andrew, Williams. "Organic and Bio-organic Mechanisms", 1st Edition, Pearson, 2010.
3. Carey, Francis A. "Organic Chemistry", 7th Edition, Tata MCGraw Hill, 2009.

REFERENCES:
1. Dugas, Hermann. "Bioorganic Chemistry: A Chemical Approach to Enzyme Action", 3rd Edition, Springer, 1999.
2. Norbert, Sewald, Hans-Dieter, Jakubke. "Peptides: Chemistry and Biology", 2nd Edition, Wiley-VCH, 2009
3. Bhupinder, Mehta, Manju, Mehta. "Organic Chemistry", 2nd Edition, Prentice-Hall of India, 2005.

BT16303	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 signaling mechanisms

UNIT I   **CELL STRUCTURE AND FUNCTION OF THE ORGANELLES**   **12**

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   **TRANSPORT ACROSS CELL MEMBRANE**   **12**

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**

Passive and Active Transport, Permeases, Ion channels, ATP pumps. $Na^+/K^+/Ca^{+2}$ pumps uniport, symport antiport system. Ligand gated / voltage gated channels, Agonists and Antagonists.

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

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

UNIT V   **TECHNIQUES USED TO STUDY CELLS**   **12**

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: 60 PERIODS

OUTCOMES:

- At the end of this course, the students could know the basic cell structure, the different organelles and their function, mitosis, meiosis, cell cycle and molecules that control cell cycle.
- Students will acquire knowledge on transport across membranes and modes of cell communication.
- After completing this unit, the students could know the basic fundamental of signal transduction and how the receptor ligand interaction helps in transduction along with various mechanisms of receptors.
- After completing this unit, the students could know the basic fundamental of microscopy, staining techniques and immunological assays.

TEXT BOOKS:

1. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H.,

Matsudaira, P., "Molecular Cell Biology," 6th Edition. W.H.Freeman, 2008.

2. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P., "Essential Cell Biology", 2nd Edition, Garland Science, 2004.

3. Alberts, Johnsons, Lewis, Raff, Roberts and Walter, Molecular Biology of Cell, 5th Edition, Garland Science, 2008.

REFERENCES:

1. Cooper, G.M., The Cell: A Molecular Approach, 4th Edition, ASM Press, 2007.

2. James D. Watson, Tania A Baker, Stephen B. Bell, Alexander Gann, Michael Levine, Richard Losick, Molecular Biology of the Gene, 7th Edition, Cold Spring Harbor Laboratory Press, 2013.

3. Molecular Biology, Robert F. Weaver, 5th Edition, McGraw-Hill Science, 2012.

BT16304	BASIC INDUSTRIAL BIOTECHNOLOGY	L	T	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. Strain Selection for Fermentation. Biochemistry of fermentation. Traditional and Modern Biotechnology. A brief survey of organisms, processes and products. Basic concepts of Upstream and Downstream processing in Bioprocess. Process flow sheeting - Block Diagrams and 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 like 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 cultivation. Bioremediation and its Applications in Modern biotechnology.

UNIT V   PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS   8

Production of recombinant proteins having therapeutic and diagnostic applications. Monoclonal

Antibody production and its Application in the field of Medicine. 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 bio-products 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., 2013.

2. Balasubramanian, D., "Concepts in Biotechnology", Universities Press Pvt. Ltd., 2015.

3. Dubey, R.C., "A Textbook of Biotechnology", S.Chand & Co. Ltd., 2013.

REFERENCES:

1. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2013.

2. Cruger, Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing, 2000.

3. Moo-Young, Murrey, "Comprehensive Biotechnology", 4 Vols. Pergamon Press, 2004.

GE16451	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
	(Common to all Branches)	3	0	0	3

OBJECTIVES:

To enable the students to

- Study nature and the facts about environment.
- Find and implement scientific, technological, economic and political solutions to environmental problems.
- Study the interrelationship between living organism and environment.
- Appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- Study the dynamic processes and understand the features of the earth's interior and surface.
- 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_2, NOX, 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:
- Students will realize the importance of ecosystems and the importance of biodiversity. Further, life can exist on the earth by conservation of biodiversity.
- Effects of Environmental pollution and the importance of control methodologies of various types of pollution. Therefore, they can design the environmental friendly processes/design in Engineering.
- The students will be having sufficient knowledge about the natural resources available and they will be using this knowledge in designing the techniques which require optimum use of natural resources in future.
- Students will get knowledge about the importance of women and child education and HIV /AIDS. Students will know about the existing technology to protect environment.

TEXT BOOKS:
1. Masters, G.M. Introduction to Environmental Engineering and Science, 2nd Ed., Pearson Education, 2004.
2. Joseph, B. Environmental Science and Engineering, 2nd Ed., Tata McGraw-Hill, 2006.
3. Rajagopalan, R. Environmental Studies - From Crisis to Cure, 1st Ed., Oxford University Press, 2005.

REFERENCES:
1. Cunningham, W.P., & Cooper, T.H. Environmental Encyclopedia, 1st Ed., Jaico Publishers, 2001.
2. Sengar, D.S. Environmental law, 1st Ed., Prentice Hall of India, 2007.
3. Wright, R.T. & Nebel, B.J. Environmental Science: Toward A Sustainable Future, 8th Ed., Prentice-Hall Of India, 2004.

BT16311	**CELL BIOLOGY LABORATORY**	**L**	**T**	**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 – To differentiate gram positive and gram negative bacteria.
5. Leishman Staining – To differentiate nucleated and non-nucleated blood cells.
6. Giemsa Staining – To stain blood parasites.
7. Thin Layer Chromatography – Isolation of chlorophyll pigments.
8. Separation of Peripheral Blood Mononuclear Cells from blood.
9. Osmosis and Tonicity
10. Trypan Blue Assay – To differentiate live and dead cells.
11. Staining for different stages of mitosis in *Allium Cepa* (Onion).

TOTAL: 60 PERIODS

OUTCOMES:
- At the end of this lab practicals students should know about the sterilization techniques to be followed in the lab and also handling of microscopes.
- Students will procure practical knowledge on different types of staining techniques like simple staining, differential staining, leishman staining, giemsa staining and the handling of microscopes will be practiced.
- Students will procure practical knowledge on the basic cell biology techniques like TLC, osmosis, tonicity, separation of PBMC, tryphan blue assay, mitosis in onion root tip.

REFERENCES:
1. Rickwood, D. & Harris, J.R., "Cell Biology: Essential Techniques", John wiley Publishers, 1996.
2. Davis, J.M. "Basic Cell Culture: A Practical Approach", IRL, 1994.
3. Roitt I., Brostoff J. and Male D. "Immunology", 6th edition, Mosby, 2001.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Autoclave	1
2.	Hot Air Oven	1
3.	Incubators	2
4.	Light Microscopes	4
5.	Incubator Shaker	1
6.	Colorimeter	2
7.	Laminar Flow Chamber	2
8.	Glassware, Chemicals, Media	as required

BT16312	BIOORGANIC CHEMISTRY LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:
- 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 olive oil
5. Preparation of alpha d- glucopyranose pentaacetate using perchloric acid
6. Preparation of 1,2,5,6 dicyclohexylnoine alpha d glucofuranose
7. Isolation of lycopene from tomato paste
8. Preparation of beta d- glucopyranose pentaacetate
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

OUTCOMES:

- At the end of the course the students would have learnt the methodology of synthesis of materials used in Pharma & Biotech industries and be able to analyze their physical and chemical properties. This knowledge can be applied in their project work also.
- After completing this course, the students can acquire the knowledge about the technique for isolation of phytochemicals from the natural sources. It will be helpful to them during their project work.
- On completion of the course, the students will have hands on experience on understanding the mechanism of biochemical reaction by in vitro studies.
- The students could acquire the practical knowledge on stereochemistry of biological molecules and its importance in research and industry.
- The students will learn the basic steps of upstream and downstream processing involved in the production of medicinally important compounds.

TEXT BOOKS:

1. Francis, A. Carey, "Organic Chemistry", 7th Edition, Tata MCGraw Hill, 2009.
2. Page, M. I. and Andrew Williams, "Organic and Bioorganic Mechanisms", 1st Edition, Pearson, 2010.
3. Fummis, B.S., Hannaford, A.J., Smith, P.W.G and Tatchell, A.R., "Vogel's Text Book of Practical Organic Chemistry", Pearson India, 2003.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Colorimeter   2
2. Glassware, Chemicals, Media   As required

MA16452	PROBABILITY AND STATISTICS	L	T	P	C
	(Common to Biotechnology and Chemical Engineering)	3	1	0	4

OBJECTIVES:

- This course aims at providing the required skill to apply the statistical tools in engineering problems.

UNIT I   RANDOM VARIABLES   18

Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions.

UNIT II   TWO - DIMENSIONAL RANDOM VARIABLES   9

Joint distributions – Marginal and conditional distributions – Covariance –Correlation and Linear regression – Transformation of random variables – Central limit theorem (without proof).

UNIT III   TESTING OF HYPOTHESIS   12

Sampling distributions - Estimation of parameters - Statistical hypothesis -Large sample test based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independence) - Goodness of fit.

UNIT IV   DESIGN OF EXPERIMENTS   9

One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design

UNIT V   STATISTICAL QUALITY CONTROL   12

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL: 60 PERIODS

OUTCOMES:
- The students will have a fundamental knowledge of the concepts of probability.
- The students will have knowledge of standard distributions which can describe real life phenomenon.
- The students will have the notion of sampling distributions and statistical techniques used in management problems.

TEXT BOOKS:
1. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
2. Johnson. R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.
3. Papoulis. A and Unni Krishna pillai. S., "Probability, Random Variables and Stochastic Processes" Mc Graw Hill Education India, 4th Edition, NewDelhi, 2010.

REFERENCES:
1. Veerarajan. T, Fundamentals of Mathematical Statistics, Yesdee Publishing Private Limited, 2017.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012
3. Walpole. R.E., Myers. R.H.,Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.

BT16401	ANALYTICAL METHODS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To acquire fundamental knowledge about the Light spectrum, Absoprtion, Fluorescence, NMR, Mass spectroscopy
- To acquaint the student with 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 – Application of FTIR and Raman spectroscopy in the analysis of biological samples.

UNIT III   MAGNETIC RESONANCE SPECTROSCOPY AND MASS   9
SPECTROMETRY

Theory of NMR – Environmental effects on NMR spectra – Chemical shift- NMR spectrometers – Applications of 1^H and 13^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 of chromatography techniques in Biotechnology and Biopharmaceutical industry.

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

OUTCOMES:
- At the end of the course, the students will learn the working principle and application of spectroscopic methods used for biological products.
- At the end of the course, the students will familiar with chromatographic techniques used in various industries such as Biotech/Biopharma/Food/ Etc.,
- At the end of the course, the students will gain the knowledge about the application of advanced microscopic methods in characterizing the biomolecules/ bioproducts.

TEXT BOOKS:
1. Skoog, D.A., James Holler, F. and Stanky, R. Crouch, "Principles of Instrumental Analysis", 6th Edition, Cengage Learning, 2016.
2. Willard, Hobart. H, "Instrumental Methods of Analysis", 7th Edition, CBS, 2004.
3. Braun, Robert, D., "Introduction to Instrumental Analysis", Pharma Book Syndicate, 2012.

REFERENCES:
1. Sharma, B.K., "Instrumental Methods of Chemical Analysis : Analytical Chemistry" Goel Publishing House, 2014.
2. Haven, Mary C., Gregory Tetrault, A. and Jerald Schenken, R., "Laboratory Instrumentation", 4th Edition, John Wiley, 2010.
3. Ewing, G.W., "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw- Hill, 2013.

BT16402   APPLIED THERMODYNAMICS FOR BIOTECHNOLOGISTS   L   T   P   C

                                                                3   0   0   3

OBJECTIVES:

- 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   9
                  AND PRODUCT FORMATION

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. "Chemical Engineering Thermodynamics", 7th Edition. McGraw-Hill, 2010.

2. Narayanan K.V, "A Text Book of Chemical Engineering Thermodynamics", Eastern Economy Ed, PHI, 2015.

3. Christiana D.Smolke, "The Metabolic pathway engineering handbook fundamentals", CRC Press Taylor & Francis Group, 2010.

REFERENCES:

1. Gopinath Halder. "Introduction to Chemical Engineering Thermodynamics", PHI, 2009.

2. Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley, 4th Edition, 2006.

3. Rao Y.V.C, "Chemical Engineering Thermodynamics", University Press, 2003.

BT16403   HEAT AND MOMENTUM TRANSFER OPERATIONS   L   T   P   C
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad 3\;\;1\;\;0\;\;4$$

OBJECTIVES:
- 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   CONDUCTION HEAT TRANSFER   9

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

UNIT II   CONVECTION & RADIATION HEAT TRANSFER   9

Dimensional analysis; forced and natural convection; boiling and condensation. The problem of radiative exchange-Kirchoff's law, radiant heat exchange, heat transfer among gray bodies.

UNIT III   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.

UNIT IV   MIXING AND AGITATION   9

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

UNIT V   FLUID PROPERTIES & TRANSPORT   9

Newtonian and non newtonian fluids, flow measurements. Continuity equations, Bernoulli's theorem, Pumps, compressors and valves.

TOTAL: 45 PERIODS

OUTCOMES:

Upon success completion of this course, the students will be able to understand
- 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.
- Purpose of mixing and agitation, types of agitators, scale up of agitators and dimensional

analysis.

TEXT BOOKS:
1. McCabe, W.L., Smith, J.C and Harriot, P., "Unit Operations of Chemical Engineering", 7th Edition, Mc Graw Hill, 2014
2. Geankoplis, C.J., "Transport Processes and Separation process Principles", 4th Edition, PHI, 2015.
3. Sachdeva, R.C., "Fundamentals of Engineering Heat and Mass Transfer" 7th Edition, New Age Solutions, 2015.

REFERENCES:
1. Incropera, F.P., Bergman,T.L., Lavine, A.S., and DeWitt, D. P., "Fundamentals of Heat and Mass Transfer". 7th Edition, John Wiley, 2011.
2. Rajput, R.K. "Heat and Mass Transfer: A Textbook for the Students", 3rd Edition, S. Chand Limited, 2015.

BT16404	ENZYME TECHNOLOGY AND BIOTRANSFORMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:
- 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   8
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   12
Kinetics of single substrate reactions; estimation of Michelis-Menten parameters Multisubstrate 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   8
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   8
**   NATURAL SOURCES**
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 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., "Enzyme Technology", 2nd Ed., Springer, 2010.
2. Buchholz, K., Kasche, V. and Bornscheuer, U., "Biocatalysts and Enzyme Technology", 2nd Ed., WILEY–VCH, 2012.
3. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, Inc, 2nd Ed., 1997.

REFERENCES:
1. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986.
2. Drauz K., Gröger, H. and May O., "Enzyme Catalysis in Organic Synthesis: A Comprehensive Handbook", Volume 3, Wiley-VCH Verlag & Co, 2012.
3. Faber, Kurt, "Biotransformation in Organic Chemistry", Springer – Verlag & Co, 6th Ed. 2011.

BT16405	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   9
             FERMENTATION PROCESS**
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:

- 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, M.L., & Kargi, F. Bioprocess Engineering, 2nd Ed., Prentice Hall, 2003.
2. Pauline, D.M. Bioprocess Engineering Principles, 2nd Ed., Elsevier, 2012.
3. Bailey, J.E., & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986

REFERENCES:
1. Najafpour, G.D. Biochemical Engineering and Biotechnology, 1st Ed., Elsevier, 2007.
2. Nielson, J., Villadsen, J., & Liden, G.“Bioreaction engineering principles, 2nd Ed., Kluwer Academic, 2002.
3. Panda, T. Bioreactors: Analysis and Design, 1st Ed., Tata McGraw Hill, 2011.

BT16411	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. Characteristics of centrifuge pump
6. Plate 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 A BATCH OF 30 STUDENTS:

1	Stop watch	6 Nos.
2	Filter Leaf	1 No.
3	Orifice meter	1 No.
4	Venturimeter	1 No.
5	Rotameter	1 No.
6	Glassware, Chemicals, Media	As required

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C and Harriot, P., "Unit Operations of Chemical Engineering", 7th Edition, Mc Graw Hill, 2014
2. Sachdeva, R.C., "Fundamentals of Engineering Heat and Mass Transfer" 7th Edition, New Age Solutions, 2015.
3. Narayanan K.V, "A Text Book of Chemical Engineering Thermodynamics", Eastern Economy Ed, PHI, 2015.

BT16412   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 techniques

LIST OF EXPERIMENTS:

1. Precision of an experiment using absorption spectroscopy.
2. Validating the Lambert-Beer's law using $KMnO_4$ Solution
3. Finding the molar absorptivity and stoichiometry of the Fe^{3+}-1,10 phenanthroline complex solution using absorption spectrometry
4. Finding the pKa value of 4-nitrophenol using absorption spectroscopy
5. UV determination of nucleic acids spectra
6. UV determination of Proteins spectra
7. Limits of detection of using aluminium alizarin complex
8. Estimation of Thiamine by Flourimetry
9. Limits of detection of absorption using aluminium alizarin complex
10. Chromatography analysis of amino acids using TLC
11. Chromatography analysis of plant pigments using Column chromatography
12. Quantitative analysis of Protein by Dye binding method
13. Quantitative analysis of Starch by Anthrone method
14. Quantitative estimation of DNA by Diphenylamine method
15. Quantitative estimation of RNA by Orcinol Method

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of advanced biochemistry, students will be able

- To visualize and interpret the theory of colorimeter, nephloemeteric and flurometric technique through hands on experiments.
- To acquire experience in chromatography techniques.
- To validate and analyse UV and Visible spectrometric techniques.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1	Colorimeter	4 Nos
2	UV Spectrophotometer	1 No
3	Fluorimeter	1 No
4	Nephelometer	1 No
5	Glassware, Chemicals, Media	As required

TEXT BOOKS:

1. Braun, R.D. Introduction to Instrumental Analysis. 2nd Ed., B. S. Publications., 2014.
2. Skoog. D. A., James H.F. & Stanley, R. C. Principles of Instrumental Analysis. 6th Ed., Thomson & Brooks Cole., 2007.
3. Gray N. Instrumental Methods of Analysis, CBS Publishers, 2011.

REFERENCES:
1. Mark F. V. Chromatography: Principles and Instrumentation. Wiley Publication, 2016.
2. Sharma, B. K. Instrumental Methods of Chemical Analysis.24th Ed, Goel Publishing House, 2005.
3. Shivaraja S. Y.M. Laboratory Manual for Practical Biochemistry. 2nd Ed., Jaypee Publication, 2012.

BT16501	PROTEIN STRUCTURE FUNCTION AND PROTEOMICS	L T P C
		3 1 0 4

OBJECTIVES:
- Enable student to understand the importance of protein biomolecules.
- To acquaint the student with the structure-function relationships in proteins.

UNIT I   BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS   12

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 STRUCTURE   12

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   12

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. Computer exercise on the above aspects

UNIT IV   STRUCTURE-FUNCTION RELATIONSHIP   12

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, 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   12

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: 60 PERIODS

OUTCOMES:

- At the end of the course, the students will learn to analyze the various interactions in protein makeup.
- At the end of the course, the students will familiar with different levels of protein structure.
- At the end of the course, the students will gain the knowledge about the role of functional proteins in various field of study and practice the latest application of protein science in their research

TEXT BOOKS:

1. Branden, C. and Tooze J., "Introduction to Protein Structures", 2nd Ed., Garland Publishing Inc, 1999.
2. Creighton T.E., "Proteins", 2nd Ed., W.H. Freeman, 1993.
3. Twyman, R.M., "Principles of Proteomics", 2nd Ed., Taylor & Francis Group, 2004.

REFERENCES:

1. Wilson, K. and Walker, J., "Principles and Techniques of Biochemistry and Molecular Biology", 7th Ed., Cambridge University Press, 2010.
2. Palzkill, T., "Proteomics", Kluwer Academic Publishers, 2002.
3. Pennington, S.R. and Dunn, M.J., "Proteomics: Protein Sequence to Function", Viva Books, 2002.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C	A	A	A	A	C	C		C			A	C	A
CO2	C	A	A	A	A	C	C		C			A	C	A
CO3		A	B	A	A	C	C		C			A		B

A – Strong; B – Moderate; C - Weak

Assessment Methods

1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   - Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16502	BIOPROCESS ENGINEERING	L T P C 3 0 0 3

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 bioprocesses – 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* and *Saccharomyces cereviseae*, 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.

TEXT BOOKS:

1   Jens. N, John. V and Gunnar. L, "Bioreaction engineering principles", 2nd Edition, Kulwer Academic, 2002
2   Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, 2nd Edition, Marcel Dekker Inc. 2002
3   Shuler. M, Kargi. M., and Delisa. M, "Bioprocess Engineering: Basic Concepts", 3rd, revised, Pearson Education, 2017

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, 1996.
6. James M. Lee, "Biochemical Engineering", PHI, USA 2002.
7. E. Heinzle, A. Biwer and C.Cooney "Development of Sustainable Bioprocesses" John Wiley & sons, 2006.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	B	A	A		B	A	B		C	A	B		C	C
CO2	B		A	A	B		C	B	A			A	C	B
CO3		A		C		A		B		C			A	A

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16503	MASS TRANSFER OPERATION	L T P C
		3 0 0 3

OBJECTIVES:
- To define the principles of absorption, distillation, leaching & extraction, adsorption and drying operations.
- To begin the concept of membrane separation process and develop skills of the students in the area of mass transfer operations with emphasis on separation and purification of products.

UNIT I   DIFFUSION AND MASS TRANSFER   9

Molecular diffusion in fluids and solids; Inter phase Mass Transfer; Mass Transfer coefficients; Theories of Mass Transfer; Analogies in Transport Phenomenon.

UNIT II   GAS LIQUID OPERATIONS   9

Principles of gas absorption; Single and Multi component absorption; Absorption with Chemical Reaction; Design principles of absorbers; Industrial absorbers; HTU, NTU concepts.

UNIT III   VAPOUR LIQUID OPERATIONS   9

V-L Equilibria; Simple, Steam and Flash Distillation; Continuous distillation; McCabe-Thiele

& Ponchon-Savarit Principles; Industrial distillation equipments, HETP, HTU and NTU concepts.

UNIT IV   EXTRACTION OPERATIONS   9

L-L equilibria, Staged and continuous extraction, Industrial extraction equipments, Solid-liquid equilibria, Leaching Principles, Industrial leaching equipments.

UNIT V   SOLID FLUID OPERATIONS   9

Adsorption equilibria – Batch and fixed bed adsorption; Introduction to membrane separation process; Drying-Mechanism-Drying curves-Time of Drying; Batch and continuous dryers, Industrial drying equipments.

TOTAL: 45 Periods

OUTCOMES:

Upon completion of this course the students will be able:

- To demonstrate about gas -liquid, vapour- liquid and solid- liquid and liquid–liquid equilibrium.
- To classify and use the accurate engineering correlations of diffusion and mass transfer coefficients to model a separation process.
- To investigate a multi-stage equilibrium separation processes, simultaneous phase equilibrium and mass balances in continuous separation processes (absorbers, strippers, and distillation columns) and sizing continuous separation units.
- To design and construction with operating principles of process economics of separating equipments

TEXT BOOKS:

1. Treybal R.E., Mass Transfer Operations, 3rd Edition, McGraw-Hill, 1981.
2. Patil, K. D., Principles and Fundamentals of Mass Transfer Operations – I, 4th Edition, Nirali Prakashan, 2010.
3. Gavhane, K.A., Mass Transfer – II, 6th Edition, Nirali Prakashan, 2006.

REFERENCES:

1. Coulson and Richardson, Chemical Engineering. Vol. I & II, Asian Books Pvt. Ltd, 1998.
2. Geankoplis C.J., Transport Processes and Unit Operations, 3rd Edition, Prentice Hall of India, 2002.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C	A	C	C	C	C	C	-	C	-	C	C	C	C
CO2	A	B	C	C	C	C	C	-	C	-	C	C	C	B
CO3	A	B	A	A	C	C	C	-	B	-	C	A	A	A
CO4	A	B	A	A	C	C	C	-	B	-	C	A	A	A

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internals - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

		L T P C
BT 16504	**MOLECULAR BIOLOGY**	**3 0 0 3**

OBJECTIVES: The objective of this unit is to impart the students the deep knowledge on transcription process and protein synthesis of both Prokaryotes and Eukaryotes

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 λ phage life cycle

TOTAL: 45 PERIODS

OUTCOMES:
- To understand the basics of nucleic acids and proteins

- To study the details of bacterial molecular mechanism
- To apply the molecular biology of microorganisms in the Research work

TEXT BOOKS:
1. Friefelder, David. Molecular Biology. Narosa Publications, 1999.
2. Weaver and Robert F. Molecular Biology, 5th Edition, Tata McGraw-Hill, 2012
3. Karp, Gerald Cell and Molecular Biology: Concepts and Experiments" 8th Edition, John Wiley publications, 2016
4. Jocelyn E Krebs, Benjamin, Lewin, Stephen T Kilpatrick, Elliott S Goldstein, Lewin's GENES XI, Published by Jones & Bartlett Learning; 11th edition, 2014.
5. Jocelyn E Krebs, Benjamin, Lewin, Stephen T Kilpatrick, Elliott S Goldstein, Lewin's GENES XI, Published by Jones & Bartlett Learning; 11th edition, 2014.

REFERENCES:
1. Tropp and Burton E. Molecular Biology: Genes to Proteins. 4th Edition, Jones & Bartlett Publishers, 2011.
2. Glick, B.R. and Pasternak,J.J. Molecular Biotechnology : Principles and Applications of Recombinant DNA, 4th Edition. ASM, 2010.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	A	B	C	B	B	C			B		C			
CO2	B	A	A	A	B	A	B	A	B	A	A	B		A
CO3	A	B	A	B	A	B	A	A	A	B	A	B	A	A

A – Strong; B – Moderate; C – Weak

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16511	**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
6.	Enzymatic conversion in Packed 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
11.	Enzyme Activity – Effect of Enzyme Concentration, Effect of Substrate Concentration

OUTCOMES:

At the end of the course,

- The students would have learnt about Enzyme kinetics and characterization and how to use them for practical applications.

- The students can evaluate the growth kinetics of microorganisms and become adept with medium optimization techniques.

- They can determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely.

REFERENCES

1. Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill 2nd Ed.1986.
2. Shuler and Kargi, "Bioprocess Engineering ", Prentice Hall, 2nd Ed, 1992.
3. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications.3rd Ed, 2017.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, 3rd Ed, Principles of Fermentation Technology, Science & Technology Books, 2013.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Autoclave	1
2.	Hot Air Oven	1
3.	Incubators	2
4.	Light Microscopes	4
5.	Colorimeter	2
6.	Laminar Flow Chamber	2
7.	Optimization software	1
8.	Glassware, Chemicals, Media	As required

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	B	A		A	B		C	C	A	C	B	A	B	A
CO2	C		B	A		B	C		A		C		C	
CO3	C	A		A	A		C	C	A	B	C	B	C	A

A – Strong; B – Moderate; C – Weak

Course Requirements
  1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. Model Practical exam   - 25 Marks
5. End Semester exam   - 25 Marks

BT16512	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 λ phage
  9.   Lamda phage lysis of liquid cultures

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.

REFERENCES

1. Sambrook, Joseph and David, W. Russell. "The Condensed Protocols: From Molecular Cloning: A Laboratory Manual" 1st Edition, Cold Spring Harbor, 2006.
2. Old, RW, Primrose, SB. "Principles Of Gene Manipulation, An Introduction to Genetic Engineering", 3rd Edition, Blackwell Science Publications, 1993.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Electrophoresis Kit	1
2.	PCR	1
3.	Incubators	2
4.	Light Microscopes	4
5.	Incubator Shaker	1
6.	Spectrophotometer	2
7.	Laminar Flow Chamber	2
8.	Glassware, Chemicals, Media	As required

Mapping CO – PO- PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2
CO 1	B	A		B	B	A		A			A	A
CO 2		B	A		A	A	B		B		A	B
CO 3	A		C	A				A	A		B	A
CO 4	B		A	A		B	B		A		A	B

A – Strong; B – Moderate; C – Weak

Course Requirements

1. Scientific Calculator

Assessment Methods

1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. Model Practical Exam   - 25 Marks
5. End semester exam   - 25 Marks

BT16601 | **TOTAL QUALITY MANAGEMENT FOR BIOTECHNOLOGISTS** | **L T 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**

Customer complaints, Customer retention, Continuous process improvement – PDCA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection and Supplier Rating.

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

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

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

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM: Concepts and 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 BOOKS:

1. Dale, H. Besterfiled et al., "Total Quality Management", Pearson Education Asia, 3rd 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, 3rd 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.

Mapping CO – PO - PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2
CO 1	A	B	B		B	A	A	A	A		A	A
CO 2	A	A		A	B		C		A	B	A	A
CO 3	B	B		A	B	B	C	B	A	B	A	A
CO 4	B	B	C	C	B			B	B	A	B	A

A – Strong; B – Moderate; C – Weak

Course Requirements
    1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

	L	T	P	C
BT16602 **IMMUNOLOGY**	3	0	0	3

OBJECTIVES:
- To discuss the structure, function 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.

UNIT II   **CELLULAR RESPONSES**   **9**

Development, maturation, activation and differentiation of T-cells and B-cells. TCR. Antibodies - Structure and Functions. 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 virus, bacteria, fungi and parasites. Cytokines, Complement, Immunosuppression and Tolerance. AIDS and Immunodeficiency Diseases. Resistance and immunization. Vaccines.

UNIT IV   TRANSPLANTATION AND TUMOR IMMUNOLOGY   6

Transplantation - Genetics of transplantation and Laws of transplantation. Tumor immunology, Tumor antigens, Tumor immune response, Tumor diagnosis and Tumor immunotherapy.

UNIT V   ALLERGY, HYPERSENSITIVITY AND AUTOIMMUNITY   9

Allergy and Hypersensitivity - Types of Hypersensitivity. Autoimmunity, Autoimmune Disorders. Systemic lupus Erythematosus, Hashimoto thyroiditis, Rheumatoid Aarthritis, Juvenile (Type 1) Diabetes, polymyositis, Addison disease, Pernicious anemia, Glomerulonephritis, and Pulmonary fibrosis.

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.

TEXT BOOKS:
1. Roitt I, Male, Brostoff." Immunology", Mosby Publ., 12th 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", 7th Edition. John Wiley, 2015.
2. Khan, Fahim Halim, "Elements of Immunology", Pearson Education, 2009.
3. Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, "Cellular and Molecular Immunology", 8th Edition, Elsevier, 2014.

Mapping CO – PO - PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	B	A	A	A	B	A	B	A	-	A	B	A	B	A
CO 2	C	A	A	A	B	A	-	B	A	B	-	A	C	A
CO 3	A	A	B	-	A	A	B	C	B	-	B	A	A	A

A – Strong; B – Moderate; C – Weak

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

	L T P C
BT16603 **GENETIC ENGINEERING AND GENOMICS**	**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**   **12**

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**   **12**

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

UNIT III   **SEQUENCING AND AMPLIFICATION OF DNA**   **12**

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   **WHOLE GENOME SEQUENCING**   **12**

Organization and structure of genomes, Genome sequencing methods, Conventional and shotgun genome sequencing methods, Next generation sequencing technologies , Ordering the genome sequence, Chromosome walking, Genetic maps and Physical maps, STS content based mapping, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Optical mapping, Current status of genome sequencing projects

UNIT V   **GENOMICS**   **12**

Introduction to Functional genomics, ORF finding and functional annotation, 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 & Genomics", Blackwell Science Publications, 2006.
2. S.B. Primrose and R.M. Twyman, "Principles of Genome Analysis and Genomics", 3rd Edition Blackwell Publishing, 2003.
3. Bernard J. Glick, Jack J. Pasternak, Cheryl L. Patten, "Molecular Biotechnology: Principles and Applications of Recombinant DNA", 4th Edition, ASM Press, 2010.

REFERENCES:

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

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	B	B	A	B	A							B	C	A
CO2	B	B	A	B	A							B	C	A
CO3	B	B	A	B	A							B	C	A
CO4	B	B	A	B	A							B	C	A

A – Strong; B – Moderate; C – Weak

Course Requirements

1. Scientific Calculator is needed for problem solving units

Assessment Methods

1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16604	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   8
REACTION ENGINEERING**

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. Models for non-ideal flow.

UNIT IV   GAS-SOLID, GAS-LIQUID REACTIONS   9

Models for fluid-particle reactions; Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

UNIT V   SOLID - FLUID OPERATIONS   8

G/l reactions on solid catalysis; Resistances and rate equations; 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, 4th Edition, Prentice Hall India, 2006.

REFERENCES:

1. Missen, R.W., Mims C.A., Saville B.A. "Introduction to Chemical Reaction Engineering and Kinetics", John Wiley, 1999.
2. Srivastava, R.P.S. Elements of Reaction Engineering, Khanna Publishers, 2000.
3. Gavhane, K.A. Chemical Reaction Engineering, Nirali Prakashan, 2011.
4. Pandey, G.N and Srivastava, S.N. Fundamentals of Chemical Reaction Engineering, Galgotia Publications, 2004.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	A	A	A	A	A	C	-	-	C	C	B	A	A	A
CO2	A	A	A	A	A	C	-	-	C	C	B	A	A	A

CO3	A	A	A	A	A	C	-	-	C	C	B	A	A	A
CO4	A	A	A	A	A	C	-	-	C	C	B	A	A	A

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16611	**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 technique 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. Optimization of inducer concentration for recombinant protein expression
6. Optimization of time of inducer for recombinant protein expression
7. Sodium Dodecyl Sulphate-Poly Acrylamide Gel Electrophoresis (SDS-PAGE)
8. Western blotting
9. Hybridization with anti-sera
10. Polymerase Chain Reaction (PCR)

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", 3rd Edition, Blackwell Science Publications, 1993.

2. Ansubel FM, Brent, R, Kingston, RE, Moore, DD. "Current Protocols In Molecular Biology", 2nd Edition, Greene Publishing Associates, NY, 1988.

3. Berger, Sl, Kimmer, AR. "Methods In Enzymology", 2nd Edition, Vol 152, Academic Press, 1987.

4. Sambrook, Joseph and David, W. Russell. "The Condensed Protocols: From Molecular Cloning: A Laboratory Manual" 1st Edition, Cold Spring Harbor, 2006.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Electrophoresis Kit   1
2. PCR   1
3. Incubators   2

Mapping CO – PO-PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2
CO 1			A					B	A		C	C
CO 2		B	A		A			B	B		C	C
CO 3			A		A			B	A		B	C
CO 4	C		A					B	A		C	B

A – Strong; B – Moderate; C - Weak

Course Requirements

1. Scientific Calculator

Assessment Methods

1. Assignment 1 + CAT 1 ⎤
2. Assignment 2 + CAT 2 ⎬   Internal - 50 Marks
3. Assignment 3 + CAT 3 ⎦

4. Model Exam   -25 Marks

5. End semester exam   - 25 Marks

BT16612	**BIOPROCESS LABORATORY- II**	**L T P C**
		0 0 4 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

(Any FIVE Experiments)

1. Batch Sterilization kinetics
2. Batch cultivation with exhaust gas analysis.
3. Estimation of K_La – Dynamic Gassing-out method.
4. Estimation of K_La – Sulphite Oxidation Method
5. Estimation of K_La – 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. Belter, P.A., Cussler, E.L., and Houhu, W., "Bioseparations – Downstream Processing For Biotechnology", Wiley Interscience Publication, 2011.
2. Bailey, J.E & Ollis, D.F., "Biochemical Engineering Fundamentals", 3rd Edition, McGraw Hill, 2011.
3. Lee, J.M., "Biochemical Engineering", PHI, USA, 2009

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Reactors	6
2.	Light Microscopes	1
3.	Spectrophotometer	2
4.	Laminar Flow Chamber	1
5.	Glassware, Chemicals, Media	As required

Mapping CO – PO – PSO :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	A	A		A		B			A		A		A	A
CO 2	B	A		A	C	B		B	C		A		B	A
CO 3		B	A			A			A	A		B	A	A
CO 4		B	B			C			B	A		A	A	A

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internals - 50 Marks
3. Assignment 3 + CAT 3
4. Model practical exam   -25 Marks
5. End Semester practical exam   -25 Marks

		L T P C
GE16661	**INTERVIEW AND CAREER SKILLS LABORATORY**	**0 0 3 2**

OBJECTIVES:
- To enable learners to build confidence and enhance their language proficiency.
- To expose learners to the use of professional English.
- To equip them with employability skills.
- To expose learners to build entrepreneurship skills

UNIT I   LISTENING AND SPEAKING SKILLS   12

Conversation Skills – Types - Small Talk, Face-to-Face and Telephonic, Formal and Informal Conversations – Skills in presenting ideas and collating information during Conference Calls (one –to-one and technical group / team) – Academic and Workplace Situations – Conversing with Faculty/Visiting Faculty/Guests/Officials/Employers and Employees – Group Discussion – Etiquette and Dos and Don'ts, Turn-taking –Presentation Skills – Seminars and Projects using Digital Tools; Mock Interview – Etiquette and Dos and Don'ts – Audio-Visual interface for enhancement of Listening and Speaking Skills.

**UNIT II   READING / SPEED READING, CRITICAL THINKING AND   12
                                WRITING SKILLS**

Reading Comprehension – General and Scientific Texts/Articles/Case Studies from different or relevant fields of study for analysis and critical thinking; Employability Skills – Writing Job Applications – Cover Letter accompanying Résumé – Types of Business Letters and Email Writing and Etiquette; Writing Reports – Statement of Purpose – Writing Articles for Publication Style and Format – Creating Blogs or Company Profiles – Speed Reading of Voluminous Reports / Documents and Exacting Necessary Information and Abstract Preparation including Dissemination.

UNIT III   ENGLISH FOR PROFESSIONAL EXAMINATIONS   12

Sentences, Paragraphs and Reading Comprehension – Vocabulary Building – General and Technical Terms – Contextual Meaning – Spelling – Subject-Specific Words – Usage and User-Specific Terminology.

UNIT IV   ENTREPRENEURSHIP SKILLS   9

Introduction to Entrepreneurship; Developing Leadership Qualities and Team Work; Goal Setting and Real-Life Scenarios; Fundamentals of Entrepreneurial Skills – Marketing Strategies - Microcosmic and Macrocosmic Levels of Product Sales and Survey – Sector / Industry Appraisal and Appreciation (Review and Understanding State of the Nation / Economy / Environment / Sector Reports Published) - Interaction & Understanding Role of Multi-Lateral Financial / Institutional / Industrial Agencies such as World Bank, ADB, UNDP, CII etc.

TOTAL: 45 PERIODS

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.

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 graining proficiency and better participation in the class.
6. Learners to form team(s), select a module of external Industrial / Institutional interaction and prepare a short-thesis.

Lab Infrastructure

S.No	Description of Equipment (minimum configuration)	Qty Required
1	**Server** • PIV System • 1 GB RAM / 40 GB HDD • OS: Win 2000 server • Audio card with headphones • JRE 1.3	1 No
2	**Client Systems** • PIII or above • 256 or 512 MB RAM / 40 GB HDD • OS: Win 2000 • Audio card with headphones • JRE 1.3	60 No's
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
Students' performance and participation through the semester in various activities like presentations, group discussions and other activities will be observed and evaluated.

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 interviews 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 with & without PPT

4. Discussion – topics of different kinds; general topics, and case studies.

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.

Web Sources:
http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
http://www.washington.edu/doit/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.html

BT16701	BIOINFORMATICS AND COMPUTATIONAL BIOLOGY	L	T	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, PSI-BLAST and PHI-BLAST 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, *ab initio* 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

1. Develop bioinformatics tools with programming skills.

2. Apply computational based solutions for biological perspectives.

3. Pursue higher education in this field.

4. Practice life-long learning of applied biological science.

TEXT BOOKS:

1. Lesk, A. K., "Introduction to Bioinformatics" 4th Edition, Oxford University Press, 2013.

2. Mount, D.W., "Bioinformatics Sequence and Genome Analysis" 2nd Edition, Cold Spring Harbor Laboratory Press, 2004.

3. Tisdall, J., "Beginning Perl for Bioinformatics: An introduction to Perl for Biologists" 2nd Edition, O'Reilly Media, 2009.

4 Christiana D.Smolke, The Metabolic pathway engineering handbook fundamentals, CRC Press Taylor & Francis Group, 2010.

REFERENCES:

1. Dan Gusfield, "Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology" Cambridge University Press, 2013.

2. 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.

3. Baldi, P. and Brunak, S., "Bioinformatics: The Machine Learning Approach" 2nd Edition, MIT Press, 2001.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	B	C	B	B	A	B	B	C	B	C	B	C	B	C
CO2	A	A	A	B	B	B	C	B	B	B	B	C	C	B
CO3	C	C	B	B	B	B	C	C	C	B	C	C	C	B
CO4	B	C	C	C	B	B	C	C	C	C	C	A	C	B

A – Strong; B – Moderate; C - Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1

2. Assignment 2 + CAT 2   Internal - 50 Marks

3. Assignment 3 + CAT 3

4. End semester exam   -50 Marks

BT16702	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   DOWNSTREAM PROCESSING   8
Introduction to downstream processing principles characteristics of biomolecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pretreatment and stabilization of bioproducts.

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

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

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

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

TOTAL: 45 PERIODS

OUTCOMES:
Upon success 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.

TEXT BOOKS:
1. Belter, P.A. E.L. Cussler And Wei-Houhu – "Bioseparations – Downstream Processing For Biotechnology", Wiley Interscience, 1988.
2. Sivasankar, B. "Bioseparations: Principles and Techniques". PHI, 2005.
3. Roger G. Harrison, Paul W. Todd, Scott R. Rudge and Demetri P. Petrides, "Bioseparations science and Engineering", 2nd Edition, Oxford University Press, 2015.

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

Mapping CO – PO - PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO-1	PSO-2
CO1	A	B	A	B	A	B							B	A
CO2	A	B	A	B	A	B							B	A
CO3	A	B	A	B	A	B							B	A
CO4	A	B	A	B	A	B							B	A

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16703	CREATIVITY, INNOVATION AND NEW PRODUCT DEVELOPMENT	L T P C
		3 0 0 3

OBJECTIVES:
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 – brain storming - 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

OUTCOMES:
The student will be able to
- Realize the value of Innovation and innovative thinking

- Apply knowledge about various numeric models that are used in screening and evaluating projects

- Be knowledgeable about patenting protection of new products

- Conduct necessary planning for new products, model preparation and evaluation

TEXT BOOKS:
1. Adair, J. Effective Innovation, 1st Ed., Macmillan Publising, 2003

2. Twiss, B. Managing Technological Innovation, 2nd Ed., Pitman Publishing Ltd., 1992.
3. Watton, H.B. New Product Planning, 1st Ed., Prentice Hall Inc., 1992.

REFERENCES:
1. Nystrom, H. Creativity and Innovation, 2nd Ed., John Wiley & Sons, 1996.

2. Khandwalla, N. Fourth Eye - Excellence through Creativity, 1st Ed., Wheeler Publishing, 1992
3. Rivkin, S. & Seitel, F. Idea Wise, 1st Ed., East West Books, 2001.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	B	A	A	C	C	A						A	A	B
CO2	A		B	A							A		A	B
CO3			A			A			C	B	B		A	C
CO4	A		A	B							B		B	C

A – Strong; B – Moderate; C – Weak

Assessment Methods
1. Assignment 1 + CAT 1 ⎤
2. Assignment 2 + CAT 2 ⎬   Internal - 50 Marks
3. Assignment 3 + CAT 3 ⎦

4. End semester exam   - 50 Marks

BT16711	**COMPREHENSIVE VIVA VOCE**	**L T P C** **0 0 2 1**

OBJECTIVES
To enable the students

- To know broadly about the biotechnology subject related techniques, principles, objectives, methods, applications and issues
- To present the above details in a coherent manner as seminar
- To discuss and justify the details as viva voce
- To select the project work related to the topics

COMPREHENSIVE VIVA TOPICS COULD BE CHOOSEN FROM THE FOLLOWING SUBJECT AREAS

1. Biochemical, Bioprocess Engineering and Downstream processing techniques

2. Microbial and Immuno-techniques

3. Cell and Molecular Biology Techniques

4. Cancer Therapeutics

5. Bioinformatics, Computational System Biotechnology and System Biology

6. Genomics and Genetic Engineering

7. Entrepreneurship Development

8. Bioethics, Patents and IPR Techniques

9. Instrumental methods of applications in Biotechnology research

10. Plant and Animal Tissue culture techniques

11. Tissue engineering, Stem Cell Therapy and Biomaterials

12. Structural Biology, Biophysics and Molecular Drug Design

13.	Biopharmaceutical Techniques and Molecular Therapeutics
14.	Bio nano materials and Drug Delivery
15.	Bioorganic, Metabolic Engineering and Synthetic Biology Techniques
16.	Proteomics and Protein Engineering
17.	Food and Agricultural Biotechnology
18.	Degenerative Diseases, Toxicology and Antioxidant Therapies
19.	Medicinal Plants, Phytochemical analysis and Applications
20.	Biofuels, Bioenergy and Environmental Biotechnology
21	Marine and Aquatic Biotechnology
22	Medical Biotechnology

OUTCOMES:
- Students will get broad knowledge on different areas of biotechnology subject related techniques, principles, objectives, methods, applications and issues
- Students able to present the above details in a coherent manner as seminar and justify the details as viva voce

TEXT BOOKS:

1. Jens. N, John. V and Gunnar. L, "Bioreaction engineering principles", 2nd Edition, Kulwer Academic, 2002

2. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, 2nd Edition, Marcel Dekker Inc. 2002

3. Friefelder, David. Molecular Biology. Narosa Publications, 1999.

 1. Roitt I, Male, Brostoff." Immunology", Mosby Publ., 12th edition, 2011.

5. Primrose SB and R. Twyman., "Principles Of Gene Manipulation & Genomics", Blackwell Science Publications, 2006.

6. Lesk, A. K., "Introduction to Bioinformatics" 4th Edition, Oxford University Press, 2013.

7. Belter, P.A. E.L. Cussler And Wei-Houhu – "Bioseparations – Downstream Processing For Biotechnology", Wiley Interscience, 1988.

8. Charles, C.R. and Schimmel P.R., "Biophysical Chemistry", W.H. Freeman & Co., 1980.

9. Donald, V. and Judith, G. V., "Biochemistry", 4th Edition., John Wiley and Sons, 2010.

10. Wilson, K. and Walker, J., "Principles and Techniques of Biochemistry and Molecular Biology", 7th Edition, Cambridge University Press, 2010.

11. Sivasanker, B., Food Processing and Preservation, Prentice-Hall of India Pvt. Ltd. 2002.

12. Finkel, Richard, et al., "Lippincott's Illustrated Reviews Pharmacology" 4th Edition, Wolters Kluwer / Lippincott Williams & Wilkins, 2009.

13. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002

14. Stella, Pelengaris and Michael, Khan. "The Molecular Biology of Cancer", 2nd Edition. Wiley–Blackwell, 2013.

15. Chawla, H.S., "Introduction to Plant Biotechnology", 3rd Edition, Science Publishers, 2009.

16. Stephanopoulos, G.N., "Metabolic Engineering: Principles and Methodologies", Elsevier, 1998.

17. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York, 2005.

18. Edelstein, A.S. and Cammearata, R.C., Nanomaterials: Synthesis, Properties and Applications, Institute of Physics Publishing, 2nd Edition, Bristol and Philadelphia, 1996.

19. Allen, Kathleen. "Entrepreneurship for Dummies. Foster City, CA", IDG Books Worldwide, Inc., 2001.

20. Palsson, B.O., and Bhatia, S.N., Tissue Engineering, 1st Edition, Pearson Publishers, 2009.

21. Pamela, G & Michelle, M. Molecular Therapeutics: 21st Century Medicine, John Wiley & Sons Limited, 2008

22. Branden, C. and Tooze J., "Introduction to Protein Structures", 2nd Ed., Garland Publishing Inc, 1999.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	A	B	A	B	A	B							B	A
CO2	A	B	A	B	A	B							B	A
CO3	A	B	A	B	A	B							B	A
CO4	A	B	A	B	A	B							B	A

A – Strong; B – Moderate; C – Weak

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. Internal Exam   - 50 Marks

BT16712   **DOWNSTREAM PROCESSING LABORATORY**   L T P C
                                                                   0 0 2 4

OBJECTIVES:
- 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
3. Precipitation – ammonium sulphite precipitation
4. Ultra filtration separation
5. Aqueous two phase extraction of biologicals
6. High resolution purification – affinity chromatography
7. Product polishing – Gel filtration chromatography
8. Product polishing – spray drying, freeze drying
9. Cell disruption techniques – Homogenization
10. Cell disruption using organic solvent
11. Solid- liquid extraction

OUTCOMES:
At the end of the course,
- The students would have acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.

- 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.

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.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Centrifuge	1
2.	Cross flow filtration set up	2
3.	FPLC	1
4.	Sonicator	1
5.	Glassware, Chemicals, Media	As required

Mapping CO – PO - PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO-1	PSO-2
CO1	B	A		A	B		C	C	A	C	B	A	B	A
CO2	C		B	A		B	C		A		C		C	
CO3	C	A		A	A		C	C	A	B	C	B	C	A

A – Strong; B – Moderate; C – Weak

Course Requirements
    1. Scientific Calculator

Assessment Methods

1. Assignment 1 + CAT 1

2. Assignment 2 + CAT 2   Internal - 50 Marks

3. Assignment 3 + CAT 3

4. Model Practical exam   -25 Marks

5. End Semester exam   - 25 Marks

		L T P C
BT 16713	**IMMUNOLOGY LABORATORY**	**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 Immuno Sorbent 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 rossetting using sheep RBC

OUTCOMES:
- To know the functioning of Immune system by doing laboratory methods
- To develop the skills on immunotechnological techniques

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.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Elisa reader	1
2.	Microscopes	2
3.	Hot plate	1
4.	Microwave Owen	1
5.	Vortex mixer	1
6.	Table top refrigerated Centrifuge	As required
7	Fluorescent microscope	1
8	Gel electrophoresis apparatus	1

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	A			B			B				C			A
CO2		A	A		B	B		C	A		A	B	A	A

A – Strong; B – Moderate; C – Weak

Assessment Methods

1. Assignment 1 + CAT 1

2. Assignment 2 + CAT 2   Internal - 50 Marks

3. Assignment 3 + CAT 3

4. Model practical exam   -25 Marks

5. End Semester exam   - 25 Marks

BT16714	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

1. To understand basic commands in UNIX OS

2. To apply PERL programming to develop bioinformatics tools

3. To understand different biological databases

4. To carryout sequence and phylogenetic analysis

List of equipment for batch of 30 students

One computer for every 2 students with the software indicated.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	B	C	B	C	C	C	C	C	B	C	C	C	B	B
CO2	B	C	B	B	A	B	B	C	B	C	B	C	B	C
CO3	A	A	A	A	B	B	C	C	B	B	C	C	A	A
CO4	A	A	A	B	B	B	C	B	B	B	B	C	C	B

A – Strong; B – Moderate; C - Weak

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. Model Practical exam   -25 Marks
5. End semester exam   -25 Marks

BT16001   INTRODUCTION TO SYMBOLIC MATHEMATICS   L T P C

OBJECTIVES:

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   9
                    AND STATISTICS

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 &   9
                    DATAACQUISITION STATISTICS

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

OUTCOMES:

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

		L T P C
BT16002	**BIOPHYSICS**	**3 0 0 3**

OBJECTIVES:

- Enable student to acquire structural knowledge of biological systems.
- To acquaint the student with different 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 – hydropathy 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:

- At the end of the course, the students will learn to analyze the various forces responsible for biological molecular structure.
- At the end of the course, the students will familiar with different levels of conformation in biomolecules.

- At the end of the course, the students will gain the knowledge of cellular permeability, ion transport and dynamics of biological systems.

TEXT BOOKS:

1. Glaser, R., "Biophysics", Springer Verlag, 2000.

2. Duane, R., "Biophysics: Molecules In Motion", Academic Press, 1999.

3. Vasantha, P. and Gautham, N., "Biophysics", Kluwer Academic Publishers, 2002.

REFERENCES:

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

2. Donald, V. and Judith, G. V., "Biochemistry", 4th Edition., John Wiley and Sons, 2010.

3. Wilson, K. and Walker, J., "Principles and Techniques of Biochemistry and Molecular Biology", 7th Edition, Cambridge University Press, 2010.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C	A	A	A	A	C	C		C			A	C	A
CO2	C	A	A	A	A	C	C		C			A	C	A
CO3		A	B	A	A	C	C		C			A		B

A – Strong; B – Moderate; C – Weak

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16003	**PRINCIPLES OF FOOD PROCESSING**	L T P C
		3 0 0 3

OBJECTIVES
- To know about the different constituents and additives present in the food.
- To gain knowledge about the microorganisms that spoils the food, cause food borne diseases and usefulness of microorganisms in food industries.
- To help students understand different techniques used for the processing and preservation of food

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   6
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 AND FOOD SPOILAGE   9

Classification – food infections – bacterial and other types; food intoxications and poisonings – bacterial and non-bacterial; food spoilage – factors responsible for spoilage, Intrinsic and extrinsic factors, spoilage of vegetable, fruit, meat, poultry, beverage and other food products

UNIT V   FOOD PROCESSING AND PRESERVATION   12

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; non thermal processing of food

TOTAL : 45 PERIODS

OUTCOMES:
- At the end of this course, the students could know the properties of various constituents of food.
- Students will acquire knowledge on about the role of microorganism involved in processing of food and spoilage of food.
- At the end of this course, the students could know the basic fundamental principles involved in various food processing and preservation techniques and also on the impact of the process on food quality

TEXT BOOKS:
1. Sivasanker, B., Food Processing and Preservation, Prentice-Hall of India Pvt. Ltd. 2002.
2. Manay, N.S. and Shadaksharaswamy, M., Food-Facts and Principles, New Age International (P) Ltd. Publishers, 1987.
3. Desrosier, N.W. and Desrosier, J.N., The Technology of Food Preservation, CBS Publication, New Delhi, 1998.
4. Cooper, G.M., The Cell: A Molecular Approach, 4th Edition, ASM Press, 2007.

REFERENCE BOOKS:
1. T.P. Coultate – Food – The Chemistry of Its Components, 2nd Edn. Royal Society, 1992.
2. W.C. Frazier And D.C. Westhoff – Food Microbiology, 4th Ed., Mcgraw-Hill Book Co., 1988.
3. J.M. Jay – Modern Food Microbiology, Cbs Pub., 1987.
4. Potter NH, Food Science, CBS Publication, New Delhi, 1998

Mapping CO – PO - PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2
CO 1	B	A	A	A	B	A	B	A	C	A	B	A
CO 2	B	A	A	A	B	A	C	B	A	B	B	A
CO 3	A	A	B	C	A	A	B	B	B	C	A	A

A – Strong; B – Moderate; C - Weak

Assessment Methods

1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

| BT16004 | 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 modeling 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): Regulation of branched chain amino acids from oxaloacetate and pyruvate (Concerted inhibition, Allosteric regulation, Enzyme multiplicity, Sequential feedback)- 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).

UNIT II   PROTEIN TRANSPORT AND DEGRADATION   5

Protein targeting- Signal sequence- Secretion- Targeting of organelle proteins- Protein degradation- Receptor-mediated endocytosis- Turnover- Folding- Chaperons

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

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- Regulation- Targets and action of cholesterol lowering drugs.

UNIT IV   VITAMINS AND COENZYMES   9

Fat Soluble Vitamins- Pro-vitamins (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 on hormones- 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 range, organizing their ideas logically on a topic.

TEXT BOOKS:

1. Victor W. Rodwell ., David Bender., Kathleen M. Botham., Peter J. Kennelly & P. Anthony Weil Harpers Illustrated Biochemistry 30th Ed., McGraw-Hill Education., 2015
2. Nelson & Cox. Lehninger Principles of Biochemistry. 6th Ed, W H Freeman & Co., 2013.
3. Thomas, M. D. Textbook of Biochemistry with Clinical correlations. 7th Ed., Wiley Publishers, 2010.
4. Voet, D.J and J.G. Voet and C.W. Pratt "Principles of Biochemistry" 3rd Edition, John Wiley & Sons Inc., 2008.
5. Murray, R.K., Granner. D.K.,Mayes, P.A. & Rodwell, V.W. Harper's Illustrated Biochemistry . 27th Ed., McGraw-Hill, 2006

REFERENCES:

1. Sathyanarayana, U & Chakrapani. U. Biochemistry. 4th Ed., Elsevier India., 2013
2. Stryer, L. Biochemistry. 4th Edition, W.H Freeman & Co., 2000.
3. Salway, J.G. Metabolism at a Glance. 2nd Ed., Blackwell Science Ltd., 2000.
4. Carl, A.B., Edward, R. A., & Nobert, W. T. Textbook of Clinical chemistry. 3rd Ed., WB. Saunders
   Company., 1999

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	A	A	A	A	A	A	C		B			A	C	A
CO2	B	A	A	B	B	A	B		C			A	C	A
CO3	A	B	B	B	A	A	A		C			A	C	A
CO4	A	B	A	A	B	A	B		B			A	B	A

A – Strong; B – Moderate; C – Weak

Course Requirements

1. Note book to write metabolic pathways and equations.

Assessment Methods

1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16005 **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 applicationsspectroscopy

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

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 - Protein structure prediction by NMR Spectroscopy.

UNIT III MASS SPECTROMETRY 9

Ion sources sample introduction – Mass analyzers and ion detectors – Biomolecule mass sepctrometry – 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 tunnelling and atomic force microscopy – Combinatorial chemistry and high throughput screening methods - Characterization of nanoparticles using SEM and TEM.

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, X-ray diffraction and spectroscopic techniques for various biological applications
- About the microscopic techniques and applications

TEXT BOOKS:
1. Hammes G.G., "Spectroscopy for the Biological Sciences", 4th Edition, Wiley-Inter Science, 2005.
2. Ramamoorthy, A., "NMR Spectroscopy of Biological Solids", CRC Press, 2005.

3. Thomas C. Pochapsky, Susan Pochapsky., "NMR for Physaical and Biological Scientists", Taylor & Francis, 2006.

REFERENCES:
1 Campbell, I.D. and Dwek, R.A., "Biological Spectroscopy", Benjami Cummins and Company, 2005.
2. Pretsch, E., Bühlmann, P. and Badertscher M., "Structure Determination of Organic compounds: Tables of Spectral Data", 4th Edition Springer, 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" 1st Edition, Springer, 1999.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C	A	A	B	A	A	A		C			A	C	A
CO2	C	A	A	B	B	A	B		C			A	C	A
CO3		B	B	B	A	A	A		C			A		B

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16006	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.

UNIT I   INTRODUCTION   7

Pharmaceutical industry & development of drugs; Types of therapeutic agents and their uses; Economics and regulatory aspects.

UNIT II   DRUG ACTION, METABOLISM AND   9
PHARMACOKINETICS

Mechanism of drug action; Physico- Chemical principles of drug metabolism; Radioactivity; Pharmacokinetics.

UNIT III   MANUFACTURE OF DRUGS, PROCESS AND   7
APPLICATIONS

Types of reaction process and special requirements for bulk drug manufacture.

UNIT IV PRINCIPLES OF DRUG MANUFACTURE 15

Compressed tablets; Dry and wet granulation; Slugging or direct compression; Tablet presses; Coating of tablets; Capsule preparation; Oral liquids – vegetable drugs – Topical applications; Preservation of drugs; Analytical methods and other tests used in drug manufacture; Packing techniques; Quality management; GMP.

UNIT V BIOPHARMACEUTICALS 7

Various categories of therapeutics like Vitamins, Laxatives, Analgesics, Contraceptives, Antibiotics, Hormones and Biologicals.

TOTAL: 45 PERIODS

OUTCOMES:
- The students can acquire the knowledge about the legal steps involved in progressing a new drug to market and to grab the current regulatory acts and safety norms of the modern pharmaceutical industries.
- The course would facilitate the students to understand the mechanism of drug action and pharmacokinetics of a given drug.
- The students will gain the knowledge about the requirements to set up a biopharmaceutical industry and the applications of unit operations in biopharmaceutical industry.
- This course will felicitate the students to understand and evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market.
- This course will pave a way to the students to acquire knowledge on novel biotechnological and pharmaceutical products, current medicines and their applications in therapeutic and diagnostic fields.

TEXT BOOKS:
1. Finkel, Richard, et al., "Lippincott's Illustrated Reviews Pharmacology" 4th Edition, Wolters Kluwer / Lippincott Williams & Wilkins, 2009.
2. Shayne Cox Gad. Pharmaceutical Manufacturing Handbook, John Wiley & Sons, Inc., 2008.
3. Bernd Meibohm. Pharmacokinetics and Pharmacodynamics of biotech drugs, Wiley-VCH, 2006.

REFERENCES:
1. Gareth Thomas, Medicinal Chemistry - An introduction. 2nd Edition, John Wiley.England, 2007.
2. Katzung, B.G. Basic and Clinical Pharmacology, 11th Edition, Tata MaGraw- Hill,India, 2009.
3. Loyd, V. Allen, Jr. Nicholas, G. Popvich and Howard, C. Ansel, Ansels pharmaceutical dosage forms and drug delivery systems, 9th Edition, Wolters Kluwer publishers,New Delhi, 2011.
4. Bennett. Bill; Cole, Graham, Pharmaceutical production: An Engineering Guide, IChemE.UK, 2003.
5. Brahmankar, D.M., Biopharmaceutics and Pharmacokinetics A Treatise, Vallabh Prakashan,India. 1995.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO 1	B	A	A	A	B	A	B	A	C	A	B	B	B	A
CO 2	B	A	A	A	B	A	C	B	A	B	C	B	B	A
CO 3	A	A	B	C	A	A	B	B	B	C	B	B	A	A
CO 4	A	A	B	B	A	A	C	A	A	C	B	A	A	A
CO 5	B	A	B	A	B	A	C	B	A	C	C	B	B	A

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

MG16851   **PRINCIPLES OF MANAGEMENT**   **L T P C**
                                                  3 0 0 3

OBJECTIVES:

The student should be able to:

1. Relate, discuss, understand, and present management principles, processes and procedures in consideration of their effort on individual actions.

2. Participate, summarize and/or lead class discussions, case problems and situations from both the text and student experience that relate to the text material.

3. Knowledge and understanding of the Principles of Management will enable the student manager and/ or employee and gain valuable insight into the workings of business and other organizations.

UNIT I   **I INTRODUCTION TO MANAGEMENT AND ORGANIZATION**   **9**

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers – managerial roles and skills – Evolution of Management – Scientific, human relations , system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management.

UNIT II   **PLANNING**   **9**

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives –policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT III   **ORGANISING**   **9**

Nature and purpose – Formal and informal organization – organization chart – organization

structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management , Career planning and management.

UNIT IV	DIRECTING	9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

UNIT V	CONTROLLING	9

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course the students will able to

1. Discuss and communicate the management evolution and how it will affect future managers.
2. Observe and evaluate the influence of historical forces on the current practice of management.
3. Identify and evaluate social responsibility and ethical issues involved in business situations and logically articulate own position on such issues.

TEXT BOOKS:

1 Stephen P. Robbins & Mary Coulter, "Management", Prentice Hall (India) Pvt. Ltd., 10th Edition, 2009.

2 JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", Pearson Education, 6th Edition, 2004

REFERENCES:

1. Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management" Pearson Education, 7th Edition, 2011.

2. Robert Kreitner & Mamata Mohapatra, "Management", Biztantra, 2008.

3. Tripathy PC & Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C		A	B	A	A	A		C			A	C	A
CO2	C	A	A	B	B	A	B		C			A	C	A
CO3		B	B	B	A	A	A		C			A		B

Assessment Methods

1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT 16007   **ANIMAL BIOTECHNOLOGY**   **L   T   P   C**
                                                                            3   0   0   3

OBJECTIVES:
1. To understand about the basics of cell culture technique
2. To know the diagnosis of animal diseases and treatment
3. To know the applications of manipulation technique for the Transgenic animals in Biotechnology

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:
- Understand the scope of Animal Biotechnology
- Gain the knowledge on cell culture techniques and modern techniques in breeding of animals
- Know the concepts in the production of transgenic animal in modern Animal Biotechnology

REFERENCES

1   Freshney, R.I. Animal Cell Culture- a practical approach, 6th edition, Wiley-Liss, 2010

2   Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press, 2000

3   Srivatsa AK, Singh RK, Yadhav MP. Animal biotechnology Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003

4   Davis, J.M. Basic Cell Culture: A Practical Approach, 2nd edition, IRL Press, 2002.

5   Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002.

6   Ramadass P, Meera Rani S. Text Book of Animal Biotechnology. Akshara Printers, 1997.

7   Portner, R., "Animal Cell Biotechnology: Methods and Protocols", 2nd Edition, Humana Press, 2007

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C		B	C	C	B	A	A	A		B	C	B	A
CO2			C	B	B			C						C
CO3		B	A	A	A	A	B	A	A	A	B	B	B	A

A – Strong; B – Moderate; C – Weak

Assessment Methods
1. Assignment 1 + CAT 1 ⎤
2. Assignment 2 + CAT 2 ⎬ Internal - 50 Marks
3. Assignment 3 + CAT 3 ⎦
4. End semester exam   - 50 Marks

BT16008   MOLECULAR PATHOGENESIS OF INFECTIOUS DISEASES   L T P C
3 0 0 3

OBJECTIVES:
1. To understand about the Host Defense mechanism, microbial toxins and modern molecular pathogenesis
2. To know about the host pathogen interaction and identifying virulence factors
3. To control pathogens by modern approaches

UNIT I   OVERVIEW   9
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   9
PATHOGENIC STRATEGIES**
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   9
EXAMPLES)**
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; Enterohaemerrohogic *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** | **9** |

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** | **9** |

Classical approaches based on serotyping and immunological methods. Modern diagnosis based on highly conserved virulence factors. 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:

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

TEXT BOOKS:

1. Brenda B. Wilson, Abigail A. Salyers, Dixie D. Witt, Malcolm E. Winkler, Bacterial Pathogenesis, ASM press, 3rd Edition, 2011.
2. Iglewski B.H and Clark V.L, Molecular basis of Bacterial Pathogenesis, Academic Press, 1990.
3. 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, 1st Edition, Academic Press, 1998
2. Nester, Anderson, Roberts, Pearsall, Nester, "Microbiology: A Human Perspective", Mc Graw Hill, 3rd Edition, 2001.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1		C	C				A		C	C	C	C		A
CO2	C	B	A	B	B	A	B	C	C	A	C	C	B	A
CO3		B	A	A	A	A	B	A	A	A	A	A	A	A

A – Strong; B – Moderate; C - Weak

Assessment Methods

1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

	L	**T**	**P**	**C**

BT16009   **CANCER BIOLOGY**   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   5
                              IMMUNOLOGY**
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   12
                              ANTIGENS**
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   9
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", 6th Edition. W.H. Freeman, 2007.
2. Stella, Pelengaris and Michael, Khan. "The Molecular Biology of Cancer", 2nd Edition. Wiley – Blackwell, 2013.

REFERENCES:
1. Roitt, I, Brostoff, J. and Male, D. "Immunology", 6th Edition, Mosby, 2001.
2. Tannock, I. and Hill, R.P. "The basic science of oncology", 3rd Edition, McGraw-Hill, 1998.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	A		B						C					
CO2	A				A		B				C		A	A
CO3	A			C									A	A

A – Strong; B – Moderate; C – Weak

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

GE16002	FUNDAMENTALS OF NANOTECHNOLOGY	L T P C
		3 0 0 3

OBJECTIVES:
- To expose the students to the evolution of Nano systems and Nanotechnology.
- To learn about the preparation methods and nanofabrication techniques.
- To impart knowledge to the students about clean room environment & Safety Hazards.
- To learn about the different characterization techniques used for Nano systems

UNIT I	INTRODUCTION	9

Nanoscale Science and Technology- Introduction – Historical Development - Dimensionality and size dependent phenomena - Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- Classifications of nanomaterials based on dimensionality - Zero dimensional, one-dimensional and two dimensional nanostructures- multilayer thin films and superlattice. Carbon based nanomaterials – Properties, Synthesis and Applications of Carbon Nanotubes and Graphene.

UNIT II	SEMICONDUCTOR PROCESSING AND MICROFABRICATION	9

Introduction to semiconductor processing - Necessity for a clean room- different types of clean rooms- Structure and requirements of a clean room- Safety issues, flammable and toxic hazards, biohazards – Microfabrication process flow diagram – Chip cleaning, coating of photoresists, patterning, etching, inspection – Process integration - Etching techniques- Wet and Dry Etching- Reactive Ion etching.

UNIT III	GENERAL METHODS OF PREPARATION	9

Preparation of nanoscale materials: Spray Pyrolysis, Co-Precipitation, Sol-gel, Mechanical Milling, Self-assembly, Preparation of thin films: Electroplating, Sputtering, Evaporation, MOCVD, Molecular Beam Epitaxy, Atomic Layer Epitaxy and Pulsed laser deposition.

UNIT IV	CHARACTERIZATION TECHNIQUES	9

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.

UNIT V	APPLICATIONS	9

Nanobiotechnology: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery – Micro Electro Mechanical Systems (MEMS), Nanosensors, energy efficient battery technology, LEDs, Lasers, solar cell. Nanoelectronics: quantum transport devices, molecular electronics devices, memory, Nano motor, Nano robot

TOTAL: 45 PERIODS

OUTCOMES:

- To understand unique properties of Nano material structure and apply them for Electrical and
  Electronics Engineering.
- The Student will develop knowledge on fabricating and characterizing Nanodevices

TEXT BOOKS:

1 Chattopadhyay K.K and A.N Banerjee, Introduction to Nanoscience and nanotechnology, PHI, 2009

2 T. Pradeep, Nano the essentials, Tata-McGraw Hill Education, 2007

REFERENCES:

1. Charles P. Poole & Frank, J. Owens, Introduction to nanotechnology, Wiley India, 2003.

2. Fahrner W.R.,Nanotechnology and Nanoelectronics, Springer (India) Private Ltd., 2011.

3. Mark Madou , Fundamentals of Microfabrication, CRC Press, New York, 1997

Assessment Methods

1. Assignment 1 + CAT 1

2. Assignment 2 + CAT 2   Internal - 50 Marks

3. Assignment 3 + CAT 3

4. End semester exam   - 50 Marks

BT16010	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, disease resistant plants, improvement of crop yield, molecular pharming, theraputic 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", 3rd Edition, Science Publishers, 2009.
2. Gamburg OL, Philips GC, "Plant Tissue & Organ Culture fundamental Methods", Narosa
   Publications, 1995.
3. Adrian Slater, Nigel Scott, Mark Fowler," Plant Biotechnology: The genetic manipulation of plants", 2nd Edition, Oxford University Press, 2008.

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.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C	B	C	B	B							B	C	B
CO2	C	B	B	B	B							B	C	B
CO3	C	B	A	A	A							B	C	A
CO4	B	A	A	A	A							B	C	A

A – Strong; B – Moderate; C – Weak

Course Requirements - Nil

Assessment Methods

1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16011	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 *Saccharomyces cerevisae* and *Zymomonas 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   9
**   MODEL**

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 13C labeling studies in mammalian cell culture.

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

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:
- At the end of the course, the students will learn learn stoichiometry and energetics of metabolism.
- At the end of the course, the students will be able to apply practical applications of metabolic engineering in chemical, energy, medical and environmental fields.
- At the end of the course, the students will be able 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", 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 - Advances in Biochemical Engineering Biotechnology", Springer, 2001.
3. Cortassa, S., Aon, M.A., Iglesias, A.A. and Llyod, D., "An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Company. Private. Ltd, 2002.
4. Smolke, C.D., "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.
5. Kholodenko, B.N. and Westerhoff, H.V., "Metabolic Engineering in the Post Genomic Era", Horizon Bioscience, 2004.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C	A	A	A	A	C	C		C			A	C	A
CO2	C	A	A	A	A	C	C		C			A	C	A
CO3		A	B	A	A	C	C		C			A		B

A – Strong; B – Moderate; C – Weak

Assessment Methods

1. Assignment 1 + CAT 1 ⎤
2. Assignment 2 + CAT 2 ⎬ Internal - 50 Marks
3. Assignment 3 + CAT 3 ⎦
4. End semester exam   - 50 Marks

BT16012	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 basmati 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, Wadworth Publisher & co, 2013.

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, 4th Edition, 2011.
2. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, 7th Edition, 2011.
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.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C	B	-	-	C	-	A	A	-	B	B	-	B	C
CO2	B	C	-	-	B	B	A	A	A	C	B	-	B	C
CO3	C	B	B	-	-	B	C	A	A	C	C	A	A	B

A – Strong; B – Moderate; C - Weak

Assessment Methods

1. Assignment 1 + CAT 1

2. Assignment 2 + CAT 2   Internal - 50 Marks

3. Assignment 3 + CAT 3

4. End semester exam   - 50 Marks

GE16004	ACCOUNTING FOR ENGINEERS	L T P C
		3 0 0 3

OBJECTIVES:
To enable the students to understand on
- Financial Issues
- Analysis of Finance system
- Preparation of Financial Report
- Accounting and Budgeting

UNIT I   Introduction to Financial Issues   5
Course Introduction, Introduction to Financial Reporting, Journal entries, Financial reporting environment

UNIT II   Financial Analysis   10
How financial statements are prepared, Cash Flow Statement and how to analyse it, Ratio analysis, Hints on your Final project, Pro Forma statements for new products

UNIT III   Preparation of Financial Report   8
Reporting and analysing revenues, Reporting and analysing inventory, Reporting and Analysing Long-Term Operating Assets, Reporting and Analysing Liabilities

UNIT IV   Cost Accounting   12
Introduction to Leases and Pensions, Introduction to Managerial Accounting, Cost Behaviour, Activity Analysis and Cost Estimation, Continue Cost work, Cost/Volume/Profit Analysis and Planning, Relevant Costs and Benefits for Decision Making, Product Costing, Activity Based Costing,

UNIT V   Budgeting and Profit Planning   10

Introduction to Bridgeton Case, Bridgeton Case Discussion, Operational budgeting and Profit Planning, Standard Costs, Introduction to ABC Case, Presentation of Financial Analysis Projects

TOTAL : 45 Periods

OUTCOMES:

After completing the course, students should be able to:

1. Understand and analyse a company's income statement, balance sheet and statement of cash flows

2. Understand the company's statements and financial health to prepare an analysis of the financial health of a that company

3. Prepare a detailed financial budget and to make decisions using managerial accounting information.

TEXT BOOKS:

1. Dyckman Magee, Pfeiffer Hartgraves and Morse M. Financial and Managerial Accounting for Decision Makers. 5th edition, Stanza Publishing House, 2013

2. Reitell, Charles, Van Sickle,Clarence, Accounting Principles For Engineers. McGraw Hill Book Polishing, 2005

Reference Books:

1. S. Bobby Rauf, Finance and Accounting for Energy Engineers, Fairmont Press, 2010.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C		A	B	A	A	A		C			A	C	A
CO2	C	A	A	B	B	A	B		C			A	C	A
CO3		B	B	B	A	A	A		C			A		B

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16013	BIOCONJUGATE TECHNOLOGY AND APPLICATIONS	L T 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**   **9**
                                  AND CONJUGATION

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

TEXT BOOKS:
1. G.T. Hermanson, "Bioconjugate Techniques", Academic Press, 1999.

REFERENCES:
1. Roger L. Lundblad, "Chemical Reagents for Protein Modification", 4th Edition, CRC Press, 2014.
2. Ravin Narain, "Chemistry of Bioconjugates – Synthesis, Characterization and Biomedical applications", Wiley, 2014.
3. Shan S. Wong, "Chemistry of Protein conjugation and cross linking", CRC Press, 1991.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	A	B	A	B	A	A							B	A
CO2	A	B	A	B	A	A							B	A
CO3	A	B	A	B	A	A							B	A

A – Strong; B – Moderate; C – Weak

Assessment Methods

1. Assignment 1 + CAT 1

2. Assignment 2 + CAT 2   Internal - 50 Marks

3. Assignment 3 + CAT 3

4. End semester exam   - 50 Marks

BT16014	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 analyse 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 on-going personal and professional development and advancement

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

REFERENCES:
1. Allen, Kathleen. "Entrepreneurship for Dummies. Foster City, CA", IDG Books Worldwide, Inc., 2001.
2. Bygrave, William, D. and Andrew, Zacharakis. "The Portable MBA in Entrepreneurship", 3rd Edition. Hoboken, NJ: John Wiley & Sons, 2004.
3. Cohen, William A. "The Entrepreneur & Small Business Problem Solver", 3rd Edition. Hoboken, NJ: John Wiley & Sons, 2006.
4. Hiam, Alexander Watson and Karen Wise Olander. "The Entrepreneur's Complete Sourcebook", Englewood Cliffs, NJ: Prentice Hall, 1996.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C		B			A	A			B		C	A	
CO2			B		A		B		B		B		B	A
CO3	C		B	A		B	A	B		A		A	A	A
CO4	C			A		A		A		B				A

A – Strong; B – Moderate; C – Weak

Assessment Methods

1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16015	PROCESS EQUIPMENT, PLANT DESIGN AND ECONOMICS	L 3	T 0	P 0	C 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   9

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   9
                FLUIDS, PRESSURE VESSEL STRUCTURE**
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   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.

UNIT V   COST ESTIMATION, PROFITABILITY AND ACCOUNTING   9
Capital investment, Concept of time-Value of money, Source Sink concept of Profitability, Capital Costs, Depreciation, Estimation of Capital costs, Manufacturing Costs, Working Capital; Profitablity Standards, Project profitability evaluation, Alternative investments and Replacements; Annual reports, Balance Sheets, Performance Analysis.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the student would be able understand
- 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, extraction towers, distillation towers and absorption towers
- Would have learned working principles, constructions, usage of various pump, seals , valves and pipes

TEXT BOOKS:
1. Brownbell I.E., Young E.H. "Chemical Plant Design" Kern D.Q. "Heat Transfer". McGraw Hill, 1985
2. McCabe, W.L., J.C. Smith and P. Harriott "Unit Operations of Chemical Engineering", 6th Ed, McGraw-Hill, 2001
3. James R. Couper, W. Roy Penney, James R. Fair "Chemical Process Equipment: Selection and Design" Butterworth-Heinemann,3rd Ed, 2012

REFERENCES
1. Ray Sinnott And Gavin Towler "Chemical Engineering Design", 5th Ed, Butterworth - Heinemann, 2009
2. Sean Moran, "An applied Guide to Process and Plant Design", 2nd Ed, Butterworth - Heinemann, 2015
3. Peters M.S., Klaus D. Plant Design and Economics for Chemical Engineers. McGraw-Hill International Edition, Chemical Engineering series, 1991.

Mapping CO – PO – PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C	A		B	A		A		C			A	C	A
CO2	C		A			A			C			A	C	
CO3	A		C		A		C	C				A	C	

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16016	DISASTER MANAGEMENT AND INDUSTRIAL SAFETY	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 and non-structural measures, Roles and responsibilities of community, Panchayat 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   9
                                 DEVELOPMENT**

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, programs 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   9
                                 STUDIES AND FIELD WORKS**

Landslide Hazard Zonation - Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure - Case Studies, Drought Assessment - Case Studies, Coastal Flooding, Storm Surge Assessment, 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
• Access 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.

TEXT BOOKS:
1. Gupta Anil K, Sreeja S. Nair. "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi, 2012.
2. Kapur Anu, "Vulnerable India: A Geographical Study of Disasters", IIAS and Sage Publishers, New Delhi, 2010.

REFERENCES:
1. Damon P.Cappola, "Introduction to International Disaster Management", 3rd Edition, Elsevier Store, 2015.
2. Dr. Mrinalini Pandey, "Disaster Management", Wiley, 2014.
3. Jagbir Singh, "Disaster Management: Future Challenges and Opportunities", I.K. International, 2007.
4. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
5. Government of India, National Disaster Management Policy, 2009.

Mapping CO – PO – PSO :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	A	A	A	B	C	B	A	B	-	-	C	B	-	A
CO 2	A	A	A	B	C	-	A	-	-	-	C	B	B	A
CO 3	A	A	A	-	-	-	A	-	-	-	C	-	-	A

CO 4	A	A	B	B	B	C	A	-	-	-	C	B	C	A

A – Strong; B – Moderate; C – Weak

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

GE16005	MARKETING ISSUES FOR ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To help you develop an in-depth understanding of marketing so that you can better partner with marketers going forward.
- To challenge marketing strategies and insure in-market success.

UNIT I	Evolution of Marketing	5

Introduction on marketing, Note on Marketing Strategy, Uses of Social Websites in Marketing the products Marketing Strategy Plans

UNIT II	Products Selling	10

Products Selling through Social Websites, Brands and Branding, Positioning the Market of the products, Principles of Pricing

UNIT III	Marketing Plans	8

Reporting and analysing revenues, The coming Era of "On demand" Marketing on Sales, Group Marketing and Marketing Plans

UNIT IV		12

Market Customization and Research, Customer Centricity and Competitive Analysis, the Future of Marketing

UNIT V		10

Introduction to Bridgeton Case, Introduction to Leases and Pensions, Marketing branded and Non branded products, Completive marketing for high profile products, Understanding the marketing speed of the products

TOTAL : 45 Periods

OUTCOMES:
After completing the course, students should be able to:
- Expose the students to a number of marketing concepts, challenges and allow them to figure out solutions.
- Transform the students into a more rounded engineer
- Help them to better understanding the challenge marketers' currently face.

TEXT BOOKS:

1.	Tim Calkins, Breakthrough Marketing Plans, Palgrave Macmillan. 2012

2.	Gary L. Lilien, Arvind Rangaswamy, and Arnaud De Bruyn,. Principles of Marketing Engineering.2nd Edition, Macmillan., 2014
REFERENCE BOOKS	
1	Das- Praxis, Handbuch and Schneider.Marketing Engineering, Springer., 2008

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C		A	B	A	A	A		C			A	C	A
CO2	C	A	A	B	B	A	B		C			A	C	A
CO3		B	B	B	A	A	A		C			A		B

A – Strong; B – Moderate; C – Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

CH16504   PROCESS INSTRUMENTATION, DYNAMICS AND CONTROL

L T P C
3 0 0 3

OBJECTIVES:
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   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

OUTCOMES:
- Students will Understand and discuss the importance of process control in process operation
- The role of process control engineers in process operation
- Students will 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 Edition., McGraw Hill, New York, 2008.
3. Marlin, T. E., "Process Control ", 2nd Edition, McGraw Hill, New York, 2000.

REFERENCES:
1. Smith, C. A., & Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edition, John Wiley, New York, 1997.
3. Speyer, J.L., & Chung, W.H., "Stochastic Processes, Estimation, and Control", PHI (2013).

Mapping CO – PO- PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	A		A		B	B	C		A	B	C			A
CO 2	B	B		C			B		B		B			A
CO 3		A	B	B	A	C	C		A	C		C		A

A – Strong; B – Moderate; C - Weak

Course Requirements
1. Scientific Calculator

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16017   **TISSUE ENGINEERING**   **L   T   P   C**

3 0 0 3

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, haematopoetic, 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, ethical 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. Palsson, B.O., and Bhatia, S.N., Tissue Engineering, 1st Edition, Pearson Publishers, 2009.

REFERENCES:

1. Gorodetsky, R., and Schafer, R., Stem cell based tissue repair, Cambridge: RSC Publishing, 2011.
2. Fischer, J.P., Mikos, A.G., and Bronzino, J.D., Tissue Engineering, CRC Press, 2012.
3. Hench, L.L., and Jones, J.R., Biomaterials, Artificial Organs and Tissue Engineering, CRC Press, 2005.
4. Potten, C.S., Stem Cells, Academic Press, 1997

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	A	C	A	C	C	C	C	C	-	-	C	A	C	C
CO2	A	C	A	A	C	A	C	A	-	-	C	A	C	C
CO3	A	C	A	A	C	A	-	A	A	-	C	A	C	C
CO4	A	C	A	A	C	A	-	A	C	-	C	A	C	C

A – Strong; B – Moderate; C – Weak

Assessment Methods
1. Assignment 1 + CAT 1
2. Assignment 2 + CAT 2   Internal - 50 Marks
3. Assignment 3 + CAT 3
4. End semester exam   - 50 Marks

BT16018	**NEUROBIOLOGY AND COGNITIVE SCIENCES**	L T P C
		3 0 0 3

OBJECTIVES:

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

UNIT I   **NEUROANATOMY**   9

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 neuritis, 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, 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 analyse how drugs affect cellular function in the nervous system.

☐ To understand the basic mechanisms associated with behavioural science

TEXT BOOKS:

1. Larry, R. S., Floyd. B., Nicholas. C. S. & Darwin. B. Fundamental Neuro Science, 4th Ed. Elsevier publication, 2013.

2. Michael, G., Richard, B. I & George, R. M. Cognitive Neuroscience. 3rd Ed., 2008

3. Longstaff, A. Instant Notes Neuroscience. 2nd Ed, Taylor and Fransis Taylor Group, 2005

4. Mathews, G.G. Neurobiology. 2nd Ed, Blackwell Science, 2000

5. Gordon, M. Shepherd, G.M & Shepherd. Neurobiology, 3rd Ed, Oxford University Press,1994

REFERENCES:

1 Liro, P. J. Introduction to Cognitive Science. Venus publishing Aps., 2012

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

3 Gordon, M., Shepherd, MD. Creating Modern Neuroscience: The Revolution. Oxford University Press, Kindle Edition,2010

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	C	B	B	B	C	C		C	B		C	A	C	A
CO2	C	B	B	B	C	C		C	B		C	A	C	A
CO3	C	B	B	B	C	B		C	B		C	A	C	A
CO4	C	B	B	B	C	B		B	B		C	A	C	A

A – Strong; B – Moderate; C – Weak

Assessment Methods

1. Assignment 1 + CAT 1

2. Assignment 2 + CAT 2   Internal - 50 Marks

3. Assignment 3 + CAT 3

4. End semester exam   - 50 Marks

BY16019	**MOLECULAR THERAPEUTICS**	**L T P C**
		3 0 0 3

OBJECTIVES

To enable the students

- To know about the gene therapeutic techniques
- To understand the cellular therapeutic techniques.
- To know about the recombinant DNA techniques
- To know about the immune therapeutic techniques
- To know about the gene silencing techniques

UNIT I   GENE THERAPY   9

Gene therapy - Intracellular barriers to gene delivery, Overview of inherited and acquired diseases for gene therapy, Retro and Adeno virus mediated gene transfer, Liposome and nanoparticles mediated gene delivery.

UNIT II   CELLULAR THERAPY   9

Cellular therapy- Stem cells definition, properties and potency of stem cell, Sources - embryonic and adult stem cells, Concept of tissue engineering - Role of scaffolds, Role of growth factors, Role of adult and embryonic stem cells, Clinical applications, Ethical issues.

UNIT III   RECOMBINANT THERAPY   9

Recombinant therapy - Clinical applications of recombinant technology, Erythropoietin, Insulin analogs and its role in diabetes, Recombinant human growth hormone, Streptokinase and urokinase in thrombosis, Recombinant coagulation factors.

UNIT IV   IMMUNOTHERAPY   9

Immunotherapy - Monoclonal antibodies and their role in cancer, Role of recombinant interferons, Immuno-stimulants, Immuno-supressors in organ transplants, Role of cytokine therapy in cancers, Vaccines - types, recombinant vaccines and clinical applications.

UNIT V   GENE SILENCING TECHNOLOGY   9

Gene silencing technology - Antisense therapy, si RNA, Tissue and organ transplantation, Transgenics and their uses, Cloning, Ethical issues.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, students will be able:

 To treat the diseases through gene therapeutic techniques.

 To understand the tissue engineering techniques.

 To know how to produce recombinant and immune therapies.

☐ To understand the basic mechanisms associated gene silencing techniques.

TEXT BOOKS:

1. Bernhard, O. P & Sangeeta, N. B. Tissue Engineering, 2nd ed., Prentice Hall, 2009.

2. Pamela, G & Michelle, M. Molecular Therapeutics: 21st Century Medicine, John Wiley & Sons Limited, 2008.

REFERENCES:

1 Goldsby, R.A., Kindt, T.J., Osbome, B.A & Kerby, J. Immunology, 5th Ed., W.H Freeman, 2003.

2. Winnacker, E.L., From Genes to clones: Introduction to Gene Technology, Panima Publishing Corporation, 2003.

3. Glick, B.R., & Pasternak, J.J., Molecular Biotechnology: Principles and applications of recombinant DNA, 3rd Ed., ASM Press, 2003.

4. Lemonie, N.R., & Cooper, D.N., Gene therapy, Oxford BIOS Scientific Publishers, 1996.

Mapping CO – PO - PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	A	B	A	B	A	B							B	A
CO2	A	B	A	B	A	B							B	A
CO3	A	B	A	B	A	B							B	A
CO4	A	B	A	B	A	B							B	A

A – Strong; B – Moderate; C – Weak

Assessment Methods

1. Assignment 1 + CAT 1

2. Assignment 2 + CAT 2   Internal - 50 Marks

3. Assignment 3 + CAT 3

4. End semester exam   - 50 Marks